

Applied Engineering and Technologies

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From the Desk of Editor

Dear Readers,

It is a proud moment indeed for all of us at the Institute to present the third annual issue of technical journal titled ‘**Applied Engineering and Technologies**’. The theme of ‘**Applied Engineering and Technologies**’ focuses on applications in the areas of Electronics, Electrical, Communication and Bio-Medical Engineering and Educational Technology. The journal will provide a forum for engineering professionals to showcase their research talents and expose them to the use of contemporary tools and the developments in various fields of Engineering.

This year the issue includes 62 papers which have been blindly reviewed by eminent guest editors and the in-house editorial team comprising highly experienced faculty. Further the papers have been checked for content originality on IEEE cross check web portal. This will ensure that good quality reviewed research papers are included.

The target readers are research students, undergraduate and postgraduate students and practicing upcoming professionals from industry and academia. This will further serve to facilitate their interaction and intellectual exchange of ideas with academia, industry and research personnel and help them to chisel and hone their talents to become better professionals.

“Provoked by intellect, propelled by values.” Guided by this inspiring motto, Vidyalkar Institute of Technology has been taking bold strides ahead in its quest to be a destination for not just budding engineers who can be at par with their global counterparts, but also for research scholars who can push the limits of knowledge beyond existing boundaries. This initiative takes the Institute one more step forward in realising the dream of being an innovative research-based educational centre, envisaged by its visionary founder Prof. C. S. Deshpande. Through the ideas generated by ‘**Applied Engineering and Technologies**’, we hope to contribute to the thought aptly put forth by Dr. Carl Sagan, “Somewhere, something incredible is waiting to be known...” The success of this initiative depends on your response. I would appreciate your feedback.

Anjali Deshpande

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PERFORMANCE ANALYSIS AND ESTIMATION OF PLANAR ANTENNA USING DEFECTED GROUND AND MICROSTRIP STRUCTURES

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ABSTRACT

This paper presents the parameter study of defected ground structure and its effect on equivalent inductance of micro strip line. It describes the impedance matching of micro strip antenna by defected ground structure, without using any matching circuitry. It studies an improved method of size reduction of a micro strip antenna using defected micro strip structure. Further it shows the simple method to reduce the mutual coupling between closely spaced planar antenna using defected ground structure between the antennas. The proposed antennas are simulated using ADS 2009 software.

Keywords : Defected ground structure (DGS), Defected microstrip structure (DMS), effective inductance, microstrip antenna.

I. INTRODUCTION

DGS is realized by etching a defect in the ground plane of planar circuits, which disturbs the shield current distribution in the ground plane and change the characteristics of a transmission line such as line capacitance and inductance. The DGS applied to micro strip line creates a resonance in the circuit with the resonant frequency controllable by changing the shape and the size of the slot. The combination of DGS elements and micro strip line yields sharp resonances at microwave frequencies which can be controlled by changing shape and size of DGS circuitry [3]. The photonic band gap (PBG) research was done in the optical fields originally, but the photonic band gap structures can be applied to wide frequency ranges including the microwave frequency band by properly scaled dimension. Recently, there has been an increasing interest in microwave and millimeter-wave applications of PBG [1]. A photonic band gap structure, which has a period, has been known as providing rejection of certain frequency bands, i.e., band gap or stop band effect. However, it is difficult to use a PBG circuit for the design of the microwave or millimeter-wave components due to the difficulties in finding of its equivalent circuit and parameters. There are too many design parameters, which effect on the band gap properties, such as the number of lattice, lattice shapes, lattice spacing, and relative volume fraction.[1]DGS adds an extra degree of freedom in microwave circuit design and opens the door to a wide range of application [2]

Defected micro strip structure (DMS) [7], has been successfully used in reducing the size of, and as a tuning technique

for, rectangular patch antennas The DMS is similar to the structure called spur line. The spur line is a type of radiofrequency and microwave distributed element filter with band-stop (notch) characteristics, most commonly used with micro strip transmission lines. Spur line usually exhibit moderate to narrow-band rejection, at about 10% around the central frequency [7]. The parameter study of defected ground structure is carried out and its effect on equivalent inductance of micro strip line is seen. Then, how the impedance matching of micro strip antenna is achieved by defected ground structure, without using any matching circuitry is analyzed. It focuses an improved method of size reduction of a micro strip antenna using defected micro strip structure. Further it shows the simple method to reduce the mutual coupling between closely spaced planar antenna using defected ground structure between the antennas.

II. PARAMETER STUDY OF DGS

Defected Ground Structures (DGS), as the name implies, refers to some compact geometries commonly known as a "unit cell" etched out as a single defect or in periodic configuration with small period number on the ground plane of a microwave printed circuit board. The DGS slots are resonant in nature. They have different shapes and sizes with different frequency responses and equivalent circuit parameters. The presence of a DGS under a printed transmission line actually perturbs the current distribution in the ground plane and thus modifies the equivalent line parameters over the defected region. Thus it influences the guided wave characteristics and is found to exhibit (1) Bandgap properties as revealed due to EBG structures, and (2) a slow wave effect, which helps in compacting the printed circuits [1].

Dumbbell shape DGS which is designed by connecting two square PBG cells with a thin slot is fabricated using TACONIC CER 10 with 62 mil thick (1.5748 mm) and dielectric constant of 10 as shown in Fig.1 .

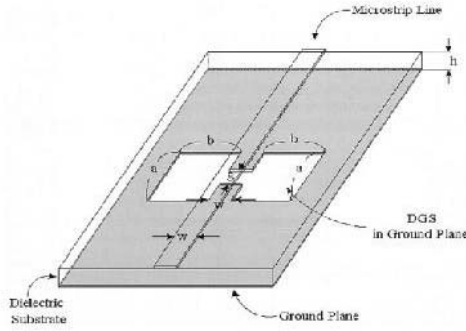


Fig. 1 Dumbbell shaped DGS cell

As shown in the figure two PBG cells are of dimensions ($a \times b$) mm and thin slot is of g mm dimension. In order to see the effect of dimension on the equivalent inductance of microstrip line they are varied. It is observed that dimension ($a \times b$) mm has the effect on the series equivalent inductance of microstrip line and g has effect on the equivalent capacitance of microstrip line. Hence, to study the effect of $a \times b$ dimension of unit cell DGS on inductance of microstrip line they are varied as shown in the table Fig. 2.

Sr.No	Parameter	DGS Dimensions		
		$a = b = 1.3\text{mm}$	$a = b = 3\text{mm}$	$a = b = 4.6\text{mm}$
1	Inductance	1.21 nH	2.89 nH	4.56 nH
2	Capacitance	0.22 pF	0.28 pF	0.29 pF
3	f_c is the 3 dB cut-off frequency	6.732 GHz	3.400 GHz	2.405 GHz
4	f_0 is the resonant frequency	9.677 GHz	5.550 GHz	4.323 GHz

Fig.2 Table for Equivalent circuit parameters of DGS section

$$C_p = 5f_c / \pi(f_0^2 - f_c^2) \text{pF} \quad 1$$

$$L_p = 250 / C_p (\pi f_0)^2 \text{nH} \quad 2$$

$$\omega_0 = 1 / \sqrt{C_p} \sqrt{L_p} \quad 3$$

To calculate the effect of dimensions on parameters of line S parameter are calculated that are S_{11} and S_{21} input reflection coefficient and transmission coefficient respectively. These S-parameters are used to calculate the inductance L and capacitance C of microstrip line using the above formula[4]. The DGS is equivalent to parallel LC components as shown in the Fig. 3

The S-parameters for different $a \times b$ dimensions of unit cell dumbbell shaped DGS is simulated using ADS 2009 to calculate f_0 and f_c which are required to calculate equivalent capacitance and inductance of microstrip line. The basic element of DGS is a resonant gap or slot in the ground metal, placed directly under a transmission line and aligned for efficient coupling to the line. The equivalent circuit for a DGS is a parallel tuned circuit in series with the transmission line to which it is coupled [5].

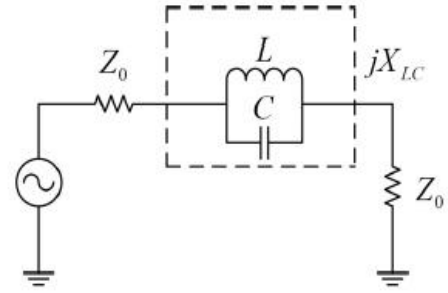


Fig.3 LC equivalent ckt of Dumbbell shaped DGS

It can be seen that as the dimensions $a \times b$ changes from 1.3 to 4.6 the equivalent inductance of microstrip line increases from 1.21nH to 4.56nH, but the equivalent capacitance remains almost constant because the gap g of the DGS cell is kept constant. Hence, by changing the dimensions of DGS cell in appropriate manner the inductance can be increased leading to the increase in the impedance of microstrip line.

III. IMPEDANCE MATCHING USING DGS

Microstrip antennas are fed with different feeding Techniques, but for coplanar application connecting the microstrip line directly at the edge of a patch is better option. The microstrip line used to feed the microstrip antennas has generally 50 ohm impedance and input impedances of a resonant microstrip antenna ranges from 120 to 450 ohm and hence impedance matching problem arises when microstrip antenna has to be fed at its edge.

Fig 4 Dumbbell shaped DGS cell used for impedance matching

In this paper we proposed a matching technique of microstrip antennas using a dumbbell shaped defected ground structure (DGS) unit cell. It is fabricated on substrate having thickness of 1.6mm and dielectric constant of 2.2 where $a = 7\text{mm}$ and $b = 18.7\text{mm}$ and $g = 0.4$. The characteristic Impedance of the microstrip line is controlled by the additional effective inductance of the DGS structure, a microstrip line with very high impedances can be easily realized [6]. As a result, microstrip antennas can be easily fed by a simple DGS microstrip line.

Dumbbell shaped DGS which is designed by connecting two square PBG cells with a thin slot having dimension $a \times b$ and g respectively as shown in Fig.4. The length of the narrow gap is the same as the width, of the microstrip line on the other plane. The cutoff frequency depends on the etched square area $a \times b$ in the ground plane. Therefore, the square area gives control to increase or decrease the effective inductance of a microstrip line depending upon its dimension and helps to achieve impedance matching of microstrip antenna using DGS structure.

A. Microstrip patch with dumbbell shaped DGS

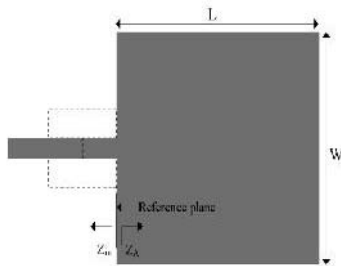


Fig. 5 Microstrip patch with dumbbell shaped DGS

The Fig. 5 shows the design of microstrip patch with dumbbell shaped DGS which is designed and simulated using ADS2009 software. It is fabricated on substrate having thickness of 1.6mm and dielectric constant of 2.2 where $L=W=56\text{mm}$. The simulation results shows that impedance matching is achieved at 1.747 GHz having return loss of -10.406 as shown in Fig.6, then gain of 3.52 db and directivity of 6.897 db is resulted. Finally efficiency of 46.068% is obtained.

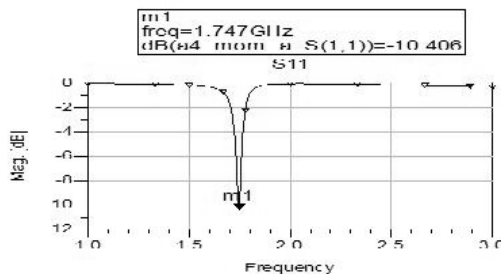


Fig. 6 S parameter of Microstrip patch with dumbbell-shaped DGS

B. Microstrip patch with circular head dumbbell shape DGS

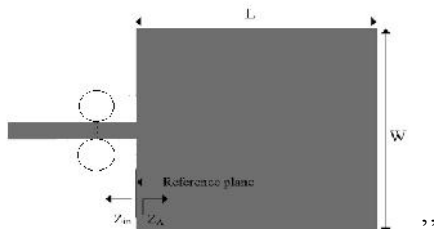


Fig. 7 Microstrip patch with circular head dumbbell shape DGS

The Fig.7 shows the design of microstrip patch with circular head dumbbell shape DGS which is designed and simulated using ADS2009 software. It is fabricated on substrate having thickness of 1.6mm and dielectric constant of 2.2 where $L = W = 56\text{mm}$, here circular head of DGS is of radius of 5.5mm and $g = 0.4\text{mm}$. The simulation results show that impedance matching is achieved at 1.755 GHz having return loss of 20.754 as shown in Fig.8, then gain of 4.124 db and directivity of 7.081 db is resulted. Finally efficiency of 50.624 % is obtained. This shows that microstrip patch with circular head dumbbell shape DGS has improved performance in terms of return loss, gain, bandwidth and efficiency as compared to microstrip patch with dumbbell shaped DGS.

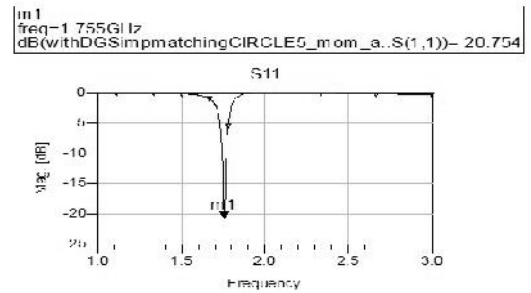
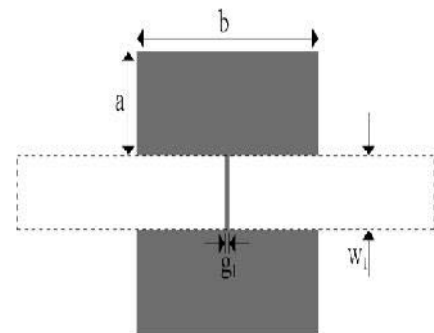


Fig.8: S parameter of Microstrip patch with circular head dumbbell shape DGS

IV. COMPACT MICROSTRIP PATCH ANTENNA

A. Defected microstrip structure (DMS) to achieve compact microstrip antenna

In this paper Defected microstrip structure (DMS), has been used in reducing the size of microstrip patch antennas or to achieve compactness. The DMS is similar to the structure called spurline. DMS achieves a greater associated inductance. DMS also presents a greater slow wave effect, since it has more discontinuities, providing a longer trajectory to the electromagnetic wave. Simultaneously, DMS also performs a greater stop band bandwidth compared to spur line, both having the same dimensions.



The use of DMS allows an increase in the slow wave factor (SWF) in transmission lines in which they are introduced. This phenomenon can be used to reduce the size of passive planar circuits like microstrip line lengths, coupling lines and microstrip antennas, among other microstrip structures [7]. It is fabricated on substrate having thickness of 1.6mm and dielectric constant of 4.4 where $L=30$ $W=21\text{mm}$ as shown in Fig. 9

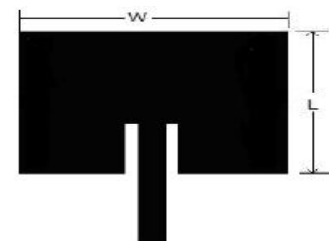


Fig. 9 Microstrip patch antenna resonating at 2.47GHz

The antenna result shown in Fig. 10 is simulated using ADS2009 and the simulated results states that it resonates at 2.47 GHz .

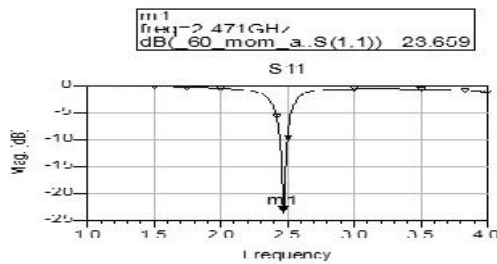


Fig.10 :S parameter for microstrip patch antenna resonating at 2.5GHz

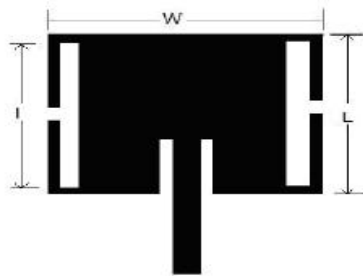


Fig 11 Microstrip patch antenna with DMS resonating at 2.05G Hz

The microstrip antenna shown in Fig.11 is modified , that means defects are introduced on the conducting patch which is called as defected microstrip structure DMS as shown in the Fig 18 .The defect is introduced on the patch of $L=30\text{mm}$ $W=21\text{mm}$ having dimension $28.2\text{ mm} \times 0.7\text{ mm}$ where $l=28.2\text{ mm}$.

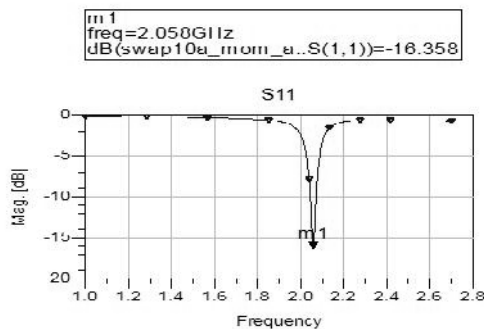


Fig.12 : S parameter for microstrip patch antenna with DMS Resonating at 2.05GHz

The antenna result shown in Fig. 12 is simulated using ADS2009 and the results shows that it resonates at 2.058 GHz with 16.358 return loss. Hence, it states that by introducing defect on the microstrip patch the resonant frequency shifts from 2.47GHz to 2.058GHz which results in compactness of microstrip antenna. This is due to slow wave effect introduced by defect in the microstrip patch antenna.

B. Defected microstrip structure (DMS) and Defected ground structure (DGS) to achieve compact microstrip antenna

The antenna shown in the Fig 13 is same as the above antenna shown in Fig 18 but here the difference is along with DMS defected ground structure DGS is also introduced shown with dotted line having dimension $19\text{mm} \times 3.7\text{mm}$ and is placed as shown in the Fig 20 . The effect of inserting a rectangular shape defected ground structure (DGS) into the ground plane of the conventional rectangular microstrip patch antenna (CRMPA)[8].

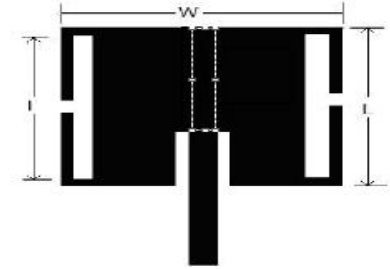


Fig.13 : Microstrip patch antenna with DMS and DGS resonating at 2.03GHz

The antenna is simulated using ADS2009 software and the simulated results shown in Fig.14 shows that antenna resonates at 2.03GHz with return loss of 21.430dB which is better than 16.35dB obtained by employing only DMS. Thus we can say that including DGS with DMS shows improvement in the return loss of the microstrip patch antenna and achieve compact microstrip patch antenna.

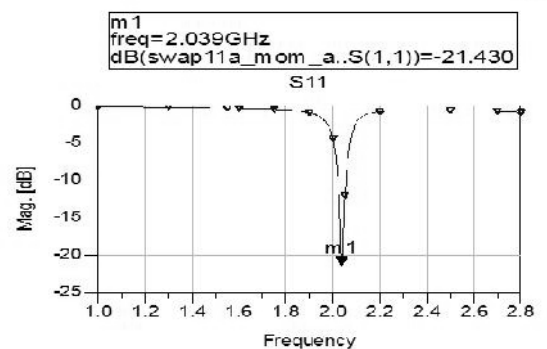


Fig. 14 : S parameter for Microstrip patch antenna with DMS and DGS resonating at 2.03GHz

V.REDUCTION OF MUTUAL COUPLING BETWEEN CLOSELY SPACED ANTENNA USING DGS

Signal fading is a critical problem in wireless communication systems operating in rich multipath environments. Multiple input – multiple-output (MIMO) systems overcome this issue by employing diversity receiver and transmitter antennas. The use of multiantenna structures, such as MIMO antennas, is one of the effective ways to improve reliability and increase the channel capacity of MIMO systems. Linear array of microstrip antennas are popular candidates for multiple input multiple output (MIMO) systems and radar applications such as spatial tracking.

An important requirement for these applications is high integration densities to utilize available substrate space efficiently [9]. It is very difficult to integrate multiple antennas closely in a small and compact space while maintaining good isolation between antenna elements [10]. The use of defected ground structure (DGS) to achieve high port isolation or reduction in mutual coupling is being studied in this session.

A. Two patch antenna spaced closely without DGS

The Fig 15 shows array of two patch antenna to achieve multiple input multiple output system. It is fabricated on FR4 substrate with relative permittivity of 4.4, loss tangent of 0.02 and thickness of 1 mm. The patch is of $L=11\text{mm}$ and $W=15\text{mm}$, these antenna are spaced at 9mm apart from each other.



Fig. 15 Rectangular patch array without DGS

The antenna is simulated using ADS2009 software and simulated results are obtained as shown in the Fig 16. showing that antenna resonates at 8.943GHz and transmission coefficient or coupling taking place between two antennas is 23.690dB. To reduce this coupling several techniques are utilized and studied. In this paper DGS is used to reduce the coupling between the two antennas.

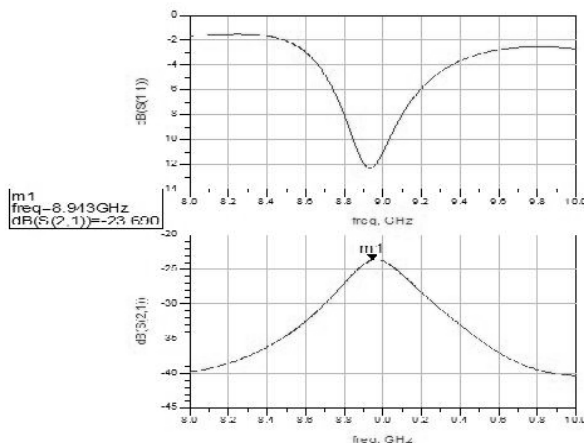


Fig 16 : S parameter for rectangular patch array without DGS.

B. Two patch antenna spaced closely with DGS

The antenna shown in Fig 17 is having two patch antennas closely spaced at 9mm with three rectangular slots on the ground plane acting as defected ground structure to reduce the mutual coupling between the two antennas.

It is fabricated on FR4 substrate with relative permittivity of 4.4, loss tangent of 0.02 and thickness of 1 mm.

The patch is of $L = 11\text{mm}$ and $W = 15\text{mm}$ and $D = 2.25\text{mm}$, $W = 1\text{mm}$, $L = 9.75\text{mm}$ and $g = 0.5\text{mm}$.

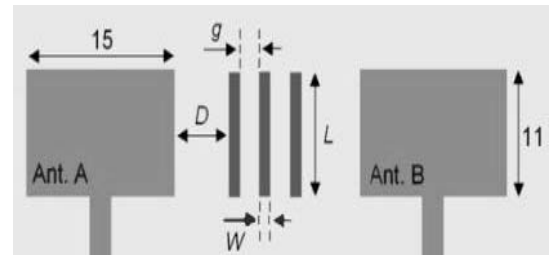


Fig.17 Rectangular patch array with DGS

The antenna is simulated using ADS 2009 software and the results obtained are shown in the Fig 18 which states that antenna resonates at 9.00GHz and the transmission coefficient or mutual coupling between two antennas is 32.210 dB which is less than the 23.690dB obtained without employing DGS. This states that by introducing defect in the ground with three rectangular slots reduction in the mutual coupling is being achieved by 8.52 dB.

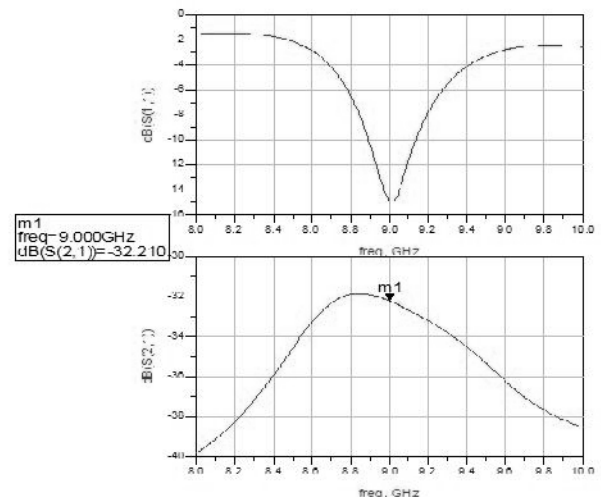


Fig. 18 S parameter for Rectangular patch array with DGS

VI. CONCLUSION

In this paper Microstrip patch antenna (planar antenna) was designed using different defected ground and microstrip structures to obtain improved performances. The parameter study of defected ground structure and its effect on equivalent parameter of microstrip line was studied. Circular head DGS is better than dumbbell shaped DGS for the impedance matching of microstrip antenna, without using any matching circuitry was discussed. It studies an improved method of size reduction of a microstrip antenna using defected microstrip structure and effect of adding rectangular slot as DGS. Further it shows the simple method to reduce the mutual coupling between closely spaced planar antenna using defected ground structure between the antennas.

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DESIGN OF E SHAPE PATCH ANTENNA WITH BROAD DUAL BAND RESPONSE

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ABSTRACT

Microstrip antennas have been the subject of some inventive work in recent years, and are currently one of the most dynamic fields in antenna theory. A broadband E-shaped dual band microstrip antenna is proposed in this paper. Its bandwidth is further increased by inserting a pair of tapered slits into an appropriate radiating edge of the rectangular patch antenna instead of rectangular cut or slits. Further modified E shape structure is studied and its effect on the response of impedance bandwidth of an antenna. The Antenna is designed and simulated on ADS2009 software.

Keywords : Microstrip antenna; E shaped patch; rectangular patch, Resonant Frequency, slotted patch, Band- width.

I. INTRODUCTION

In modern wireless communication systems and other telecommunication applications, the micro strip patch antennas have a great attention because of their advantages such as light weight, low profile, compatibility integration with other circuits and subsystems and ease of fabrication. However, those have inherently narrow impedance bandwidth. Various methods have been accomplished to overcome this serious drawback. The main disadvantages of microstrip antenna can be low efficiency, low throughput, narrow bandwidth and low frequency range [1]. However, it is desirable to use it in some low bandwidth applications. Of course, increasing the thickness of the substrate can expand the bandwidth efficiency. However, this increases the surface waves that is an undesirable factor, because waves can be absorbed in the environment. Surface waves move on the surface layer, scattered in the surface curvature and discontinuities (cuts dielectric surface) and reduce antenna patterns and polarization characteristics. When bandwidth is large, surface waves can be eliminated using the holes [5]. Narrow bandwidth is a serious one of them and different techniques are used to overcome this limitation, including increasing the thickness of the dielectric substrate, decreasing the dielectric constant and using parasitic patches [6]. A broadband E-shaped MSA obtained by cutting a pair of rectangular slots on one of the radiating edges of a rectangular MSA (RMSA) is reported in. In this Letter, a broadband suspended E-shaped MSA in the 900 MHz band is discussed.

Its BW is further increased by cutting a pair of tapered slots [2]. Further modified E shape structure is studied and its effect on the response of impedance bandwidth of an antenna

II. ANTENNA GEOMETRY AND DESIGN

We designed the rectangular microstrip patch antenna first, and then incorporated the two parallel slots into the patch. The geometry of the E shaped patch antenna is shown in Figure 1. The microstrip patch is fabricated on glass epoxy substrate of which dielectric constant ϵ_r is 4.3, height 0.159 cm and loss tangent is 0.02. The substrate is suspended over the ground plane with an air gap of 2.0 cm, giving a total substrate thickness of 2.159 cm ($0.07 \div 0$). The resonant frequency of microstrip patch antenna can be given by the following formula.

$$f = c / 2L\sqrt{\epsilon_r} \quad \text{---}$$

So, increasing L can reduce the antenna's resonant frequency. With slotting on the radiation patch, current can take a tortuous detour, so the valid patch can be variable longer and the resonant frequency can be decreased and the Q value decreased [3], which can be shown by figure. The bandwidth of the antenna can also be correspondingly increased

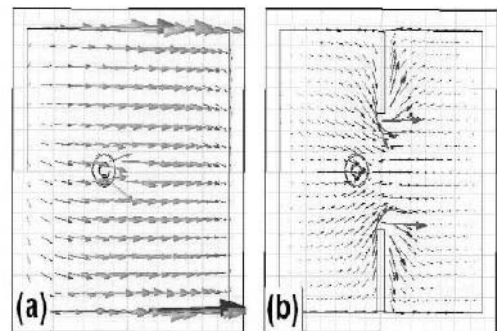


Fig. 1. Current Distribution (a) Without slots (b) With slots

Fig. 1a shows the current distribution on a patch surface with no slots. The patch without slots allows a straight path across the patch, whereas the slots force currents to take a longer path, as in Fig. 1b.

This longer path corresponds to a longer resonant length, thereby tuning the patch to lower resonant frequency and helping the patch to obtain higher bandwidth. By optimising the slot dimensions, the separation between the two slots and the feed point location, a broadband response is obtained.

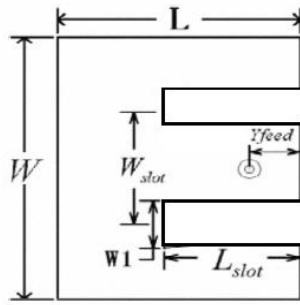


Fig. 2. E shape patch antenna

A. E shape patch antenna with rectangular slots

The E shape patch antenna is designed making two slots on the rectangular patch as shown in the figure where length L is 13cm, width W is 15cm, slot length L_{slot} is 8cm, distance between two slot given by W_{slot} is 2.5cm, W_1 and $W_2 = 1$ cm and Y_{feed} is optimised to get proper desired result as shown in Fig.2.

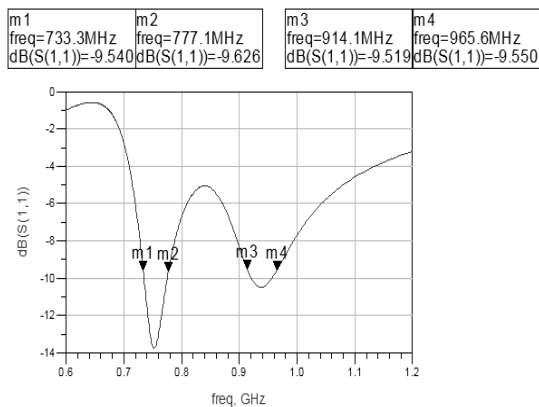


Fig. 3. S parameter for E shape patch antenna

The antenna is simulated using ADS software, giving dual band of response as shown in Fig 3. From the above simulated result we can say that it provides dual band of response with impedance bandwidth of 38 MHz for first band and impedance bandwidth of 51.5 MHz for second band. The figure shows the input impedance plot on smith chart from which we can say that good impedance matching is achieved at two resonant frequency that is 755.2 Mhz and 917.2 Mhz as shown in Fig. 4.

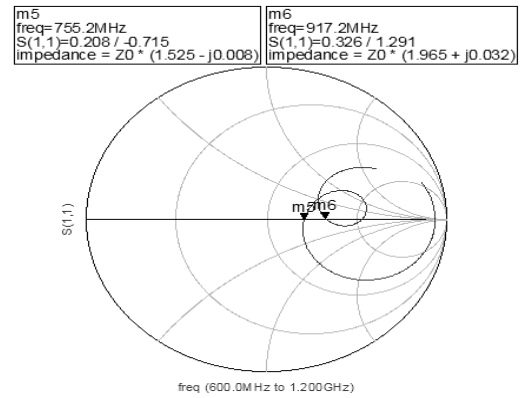


Fig. 4. Impedance plot for E shape patch antenna

B. E patch antenna with tapered slots

In this antenna tapered slots are made instead of rectangular slots this is to improve the bandwidth of antenna where length L is 13cm, width W is 15cm, slot length L_{slot} is 8cm, distance between two slot given by W_{slot} is 1.2cm, $W_1 = 1.2$ $W_2 = 0.2$ cm and Y_{feed} is optimised to get proper desired result as Fig. 5

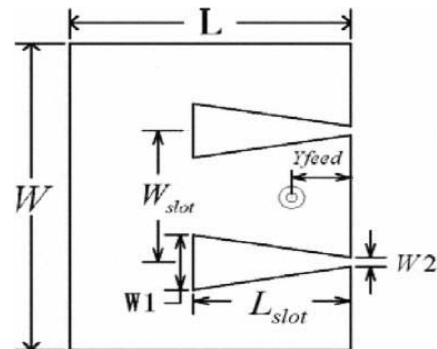


Fig. 5. Tapered slot E shape patch antenna

The antenna is simulated using ADS2009 software. The simulated results are obtained as follows as shown in Fig. 6. The above simulated results show that the impedance bandwidth of both bands has increased from 38 MHz to 86 MHz and for the second band from 51.5 MHz to 113.1 MHz. The Fig. 7 shows the input impedance plot from which we can say that good impedance matching is achieved at two resonant frequency that is 710.9 Mhz and 928.2 Mhz. Thus by tapering the slots and properly adjusting the W_2 to W_1 ratio with proper feeding point, impedance bandwidth of E patch can be increased.

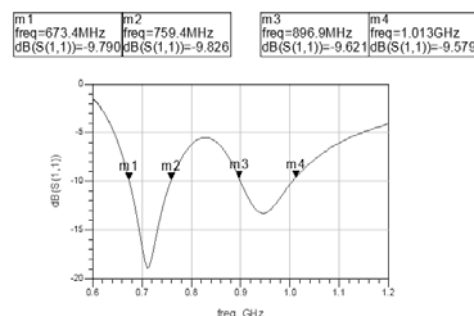


Fig. 6. S parameter for tapered slot E shape patch antenna

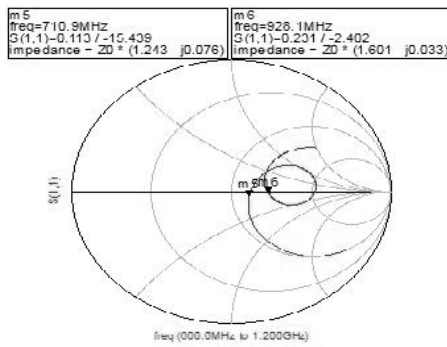


Fig. 7. Impedance plot for tapered slot E-shape patch antenna

C. E patch antenna for 4G

The E shape patch antenna is designed making two slots on the rectangular patch as shown in the Fig. 8 where length L is 17.2mm, width W is 20 mm, slot length L_{slot} is 10mm and $W_1=5.9$ mm, $W_{\text{r}}=1.0$ mm, $W_{\text{f}}=6.2$ mm. The design of this antenna, the substrate RT/duroid 5870 /5880 of thickness 3.175mm and with low permittivity ($\epsilon_r=2.2$) value is selected.

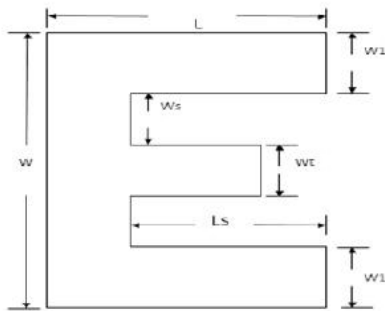


Fig. 8. : E shape patch antenna for 4G

The antenna is simulated using ADS giving the result as shown in Fig. 9 providing dual band of operation having impedance bandwidth of 480 Mhz for first band and 252 Mhz for second band. The input impedance is plotted on smith chart showing good impedance at desired frequency shown in Fig. 10

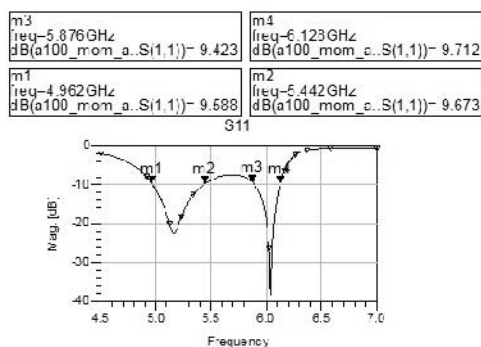


Fig. 9. : S parameter of E shape patch antenna for 4G

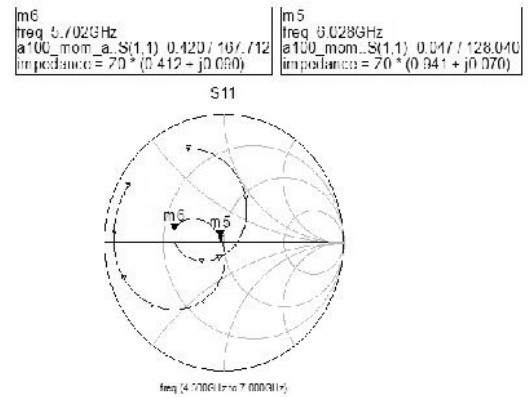


Fig. 10. Impedance plot of E shape patch antenna for 4G

D. Modified E patch antenna for 4G

The modified E shape patch antenna is designed making two slots on the rectangular patch as shown in the figure where length L is 17.2mm, width W is 20mm, slot length L_{slot} is 10mm and $W_1=5.9$ mm, $W_{\text{r}}=1.0$ mm, $W_{\text{f}}=6.2$ mm but with this antenna is modified by taking two more slots at the edges of the patch as shown in Fig.11 The dimensions d_1 and d_2 of the patch in the proposed multi slot patch antenna are taken as 2mm and 4mm respectively. The modified E patch antenna incorporates extra slots [4] as shown in the figure having dimension d_1 and d_2 which causes increase in the length of the current path which results in improvement of impedance bandwidth.

The antenna is simulated using ADS giving the result as shown in Fig. 12 providing dual band of operation having impedance bandwidth of 550 Mhz for first band and 304 Mhz for second band. Thus, showing improvement in the impedance bandwidth by modifying. The input impedance is plotted on the smith chart showing good impedance at desired frequency shown in Fig. 13

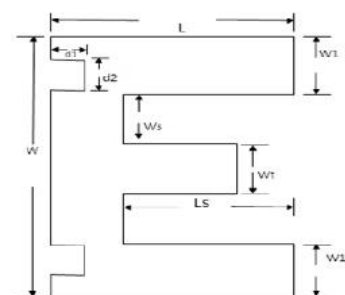


Fig. 11. : Modified E shape patch antenna for 4G

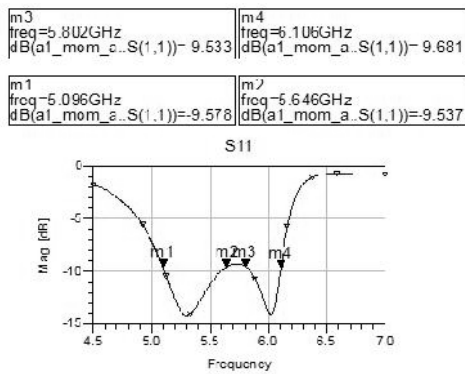


Fig. 12. : S parameter of modified E patch antenna for 4G

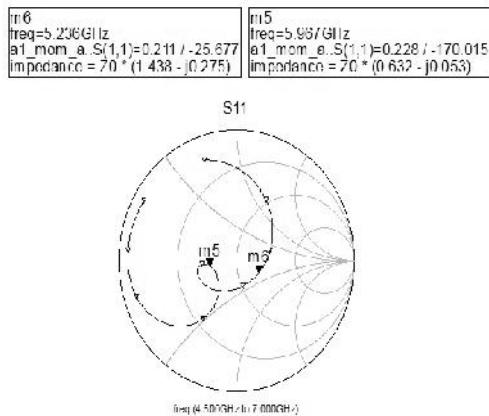


Fig. 13 Impedance plot of modified E patch antenna for 4G

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III. CONCLUSION

The broadband E shaped microstrip antenna is proposed in this paper. The impedance bandwidth of the antenna is broadened by inserting a pair of tapered slits into an appropriate radiating edge of the rectangular patch antenna instead of rectangular slit. Further modified E patch antenna is studied providing improvement in the impedance bandwidth which can be used for 4G application.

UNIVERSAL NFC RECEIVER : AN INTRODUCTION TO PREPARATION OF SEVERAL MODULES

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ABSTRACT

This paper is focused on the preparation of modules of making an Universal NFC receiver. It consists of several modules such as AVR board for interfacing with NFC receiver, MAX 232 module for interfacing with PC / Laptop , Power Supply is also the most important module. Several multiple applications will develop on Mobile using Android Apps. For this purpose , Software Development Kit(SDK) is used. The NFC receiver is installed at the target system which will be connected with AVR microcontroller board. In this paper, we are using AVR Atmega 8 Microcontroller which is having feature of 8 KB flash memory. AVR board is connected to NFC receiver along with server at the target through MAX 232 serial communication. Power supply circuit is also provided for this implementation. This universal NFC receiver will handle several applications such as Banking Transactions , Searching Various items while shopping in the mall etc.

Keywords: Android, AVR Board, Mobile Computing, MAX 232 , Near Field Communication , Power Supply .

I. NEAR FIELD COMMUNICATION

Near field communication (NFC)[1] is a set of standards for smart phones and similar devices to establish radio communication with each other by touching them together or bringing them into close proximity, usually no more than a few inches. Present and anticipated applications include contactless transactions, data exchange, and simplified setup of more complex communications such as Wi-Fi. Communication is also possible between an NFC device and an unpowered NFC chip, called a "tag".

In NFC, the communication occurs when two NFC compatible devices are brought together less than four centimeters, or simply by touching themselves. It operates at 13.56 MHz and can transfer data up to 424 Kbits per second. In an NFC model two devices are involved in the communication, which are called initiator and target. Initiator is an active NFC device which is responsible for starting the communication.

Also it has an embedded energy component whereas target can be either a tag, RFID card[10] or an NFC device which responds the initiator's requests.

Working distance with compact standard antennas: up to 20 cm . Supported data rates: 106, 2012, 424 or 848 Kbit/s information in the NFC device is used for further operations.

II. OPERATING MODES OF NFC

A. Reader / Writer Mode

In the reader/writer mode, NFC devices can read and write data from/to NFC tags and smart cards. NFC device acts as an initiator and passive tag is the target. Passive tag does not need any source of power. Active NFC device creates magnetic inductive coupling and transfers energy to smart card when it gets close enough. After the smart card is powered, communication starts. In this mode of communication the data speed can increase up to 106 Kbit/sec.

NFC enabled mobile phone creates magnetic field and powers the NFC tag within 4 cm

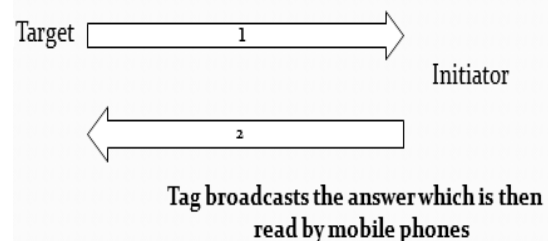


Fig. 1 Reader/Writer mode

B. Card Emulation Mode

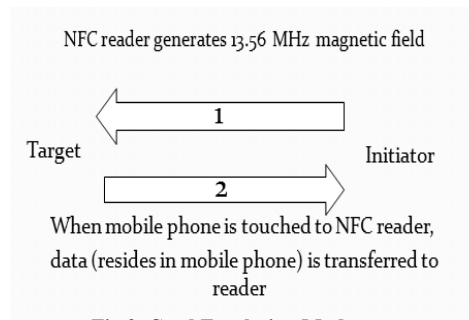


Fig 2. Card Emulation Mode

In the card emulation mode, NFC device[1] acts as an RFID card and other NFC device can read data from this NFC device. The advantage of this mode is that there is not any need for NFC tag or a RFID card[3], and stored information in the NFC device is used for further operations.

C. Peer to Peer Mode

In P2P mode, two NFC devices can exchange data. For example, you can share Bluetooth or WI-FI link set up parameters, and exchange data such as virtual business cards or digital photos. P2P mode is standardized on the ISO/IEC standard. P2P is less used in when compared to other modes, though it is studied for device pairing, networking and file transfer operations. This mode is the classic NFC mode, allowing data connection for up to 424 kbps.

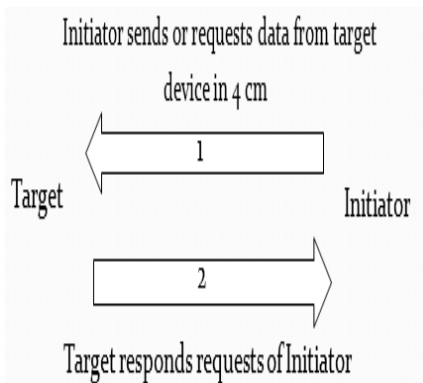


Fig 3. Peer to Peer mode

III. MODULES OF NFC

A. Power Supply

A power supply is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source. Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. In this work, power supply makes an important role.



Fig. 4 Power Supply Module

B. AVR Microcontroller Board

In this work, we are using AVR Atmega8 Microcontroller having 8 KB flash memory. The various features of AVR Atmega8 Microcontroller is as follows :-

- 8-bit Controller.
- Advanced RISC Architecture.
- 8 KB flash memory.
- 512 bytes of EEPROM.
- Two 8-bit timers/counters with separate prescaler and compare mode.
- One 16-bit timer/counter with separate prescaler, compare mode and capture mode.
- Low power consumption basically 250µA in

Active mode and 0.1 µA in Idle mode.

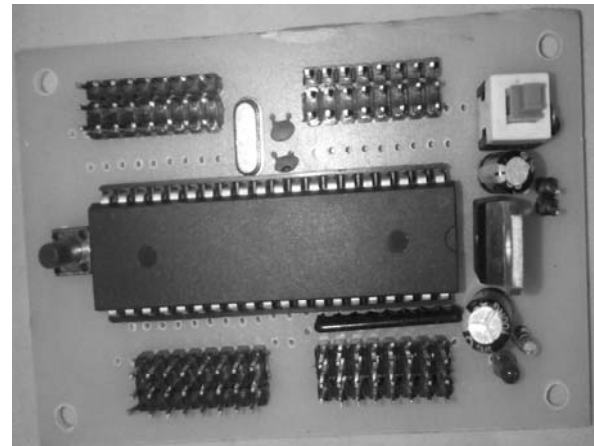


Fig. 5 AVR Atmega8 Microcontroller Module

C. MAX 232

The MAX 232 is an IC that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits. The MAX 232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single +5 V supply via on-chip charge pumps and external capacitors.

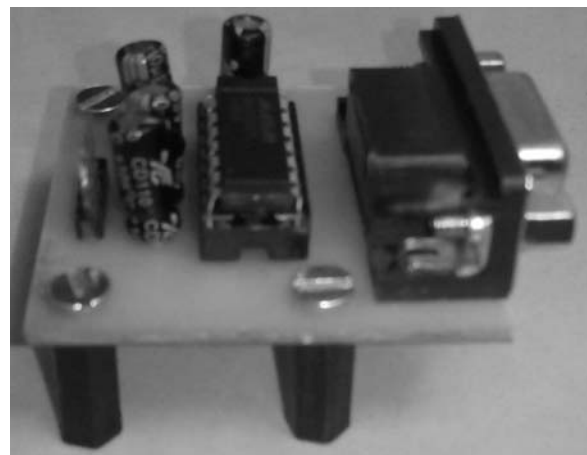


Fig. 6 MAX232 Serial Module

This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to +5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V. The MAX232(A) has two receivers (converts from RS-232 to TTL voltage levels), and two drivers (converts from TTL logic to RS-232 voltage levels). This means only two of the RS-232 signals can be converted in each direction. Typically, a pair of a driver/receiver of the MAX232 is used for TX and RX signals, and the second one for CTS and RTS signals. There are not enough drivers/receivers in the MAX232 to also connect the DTR, DSR, and DCD signals. Usually these signals can be omitted when e.g. communicating with a PC's serial interface. If the DTE really requires these signals, either a second MAX232 is needed, or some other IC from the MAX232 family can be used. Also, it is possible to directly wire DTR to DSR without going through any circuitry. This gives automatic (brain dead) DSR acknowledgment of an incoming DTR signal. In this work, this MAX 232 module is used which gives an interface between AVR Board and NFC receiver with PC or Laptop.

IV. WORK TO BE IMPLEMENTED

In future, the different modules implemented that are discussed above is then combined and interfaced. The AVR board which consists of AVR Atmega8 Microcontroller along with NFC receiver module is then interfaced with PC or Laptop with MAX232 serial communication module. Power supply module also plays an important role. Also, the applications need to develop on Android platform which will be available on mobile phone.

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AN OVERVIEW OF DIFFERENT PATCH ANTENNAS WITH STRUCTURAL DEFECTS TO ACHIEVE MULTIBAND CHARACTERISTICS

(Review paper)

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ABSTRACT

Antennas with structural defects have become popular due to the peculiar properties that make them suitable for multiband applications, few of which include low cost of fabrication and low profile features of such antennas that has inspired many researchers to investigate their performance parameters. This paper provides an overview of different microstrip patch antennas possessing structural defects. The simulation results obtained portray good input return loss at multiple frequencies with values exceeding 10dB. In this paper, the concept of a fractal has been applied to the geometry of a hexagon and square microstrip patch antennas to obtain multiband frequency operation.

Keywords : Antennas, fractals, multiband, multi-frequency antennas, resonant frequency, structural defects.

I. INTRODUCTION

There has been an unceasing demand, in both the military as well as the commercial sectors, for antenna designs that possess the below mentioned highly desirable attributes:

1. Compact size
2. Low profile
3. Conformal
4. Multi-band or broadband

These design objectives can be achieved by utilizing a variety of approaches that have been developed over the years. For instance, an excellent overview of various useful techniques for designing compact (i.e., miniature) antennas may be found in [1] and [2]. Apart from this, a number of approaches for designing multi-band (primarily, dual-band) antennas have been mentioned in [3].

The term fractal, which means broken or irregular fragments, was originally coined by Mandelbrot [4] to describe a family of complex shapes that possess an inherent self-similarity or self-affinity in their geometrical structure. The term has its roots in the Latin word *fractus* which is related to the verb *frangere* (meaning: to break). The original inspiration for the development of fractal geometry came largely

from an in-depth study of the patterns of nature. For example, fractals have been successfully used to model complex natural objects such as galaxies, cloud boundaries, coastlines, mountain ranges, snowflakes, leaves, ferns, trees, and much more.

Since the pioneering work of Mandelbrot and many researchers, a wide variety of applications for fractals continue to be found in many branches of science and engineering. Developing new types of antennas that employ fractal rather than Euclidean geometric concepts in their design has been a matter of interest in recent years. We refer to this new and rapidly growing field of research as fractal antenna engineering. The purpose of this article is to provide an overview of recent developments in the theory and design of fractal antenna elements. In this paper, different structures namely Sierpinski carpet, Sierpinski gasket, hexagonal pattern and square pattern are being discussed.

II. SOME GEOMETRIES FOR FRACTAL ANTENNA ENGINEERING

This section comprises of some of the common fractal structures which have been used in many applications along with a couple of proposed structures. The first fractal structure that will be considered is the popular Sierpinski gasket [5]. The first few stages in the construction of the Sierpinski gasket are shown in Fig. 1. The geometrical construction procedure of this fractal begins with an equilateral triangle, as illustrated in Stage 0 of Fig. 1. The next step in the construction procedure (see Stage 1 of Fig. 1) is to eliminate the central triangle with vertices that are located at the midpoints of the sides of the original triangle (see Stage 0 of Fig. 1). The same process is then repeated for the three remaining triangles, as shown in Stage 2 of Fig. 1. The Sierpinski gasket fractal is generated by carrying out this iterative process an infinite number of times. One way of looking at it is, the white triangular areas represent regions where metal has been removed, whereas the black triangular areas represent a metallic conductor.

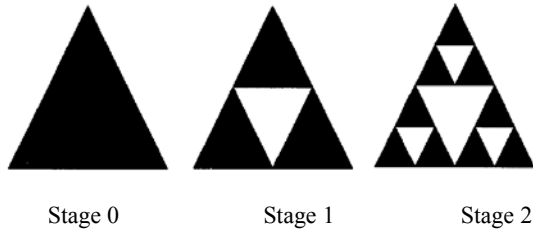


Fig. 1. Iterative Stages in the construction of a Sierpinski gasket Fractal

The Sierpinski carpet[8] is constructed using square geometry. This type of fractal antenna begins with a square in the plane which is divided into nine smaller congruent squares where the open central square is removed. The remaining eight squares are then divided into another nine smaller congruent squares with each central square dropped. Figure 2 shows the iteration process for Sierpinski carpet fractal antenna (up to third iteration).

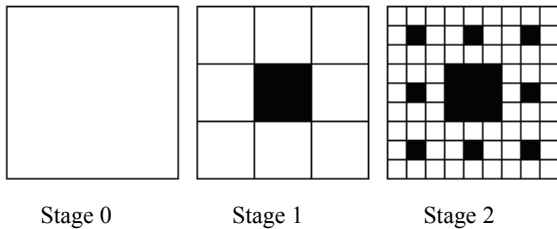


Fig 2. Sierpinski carpet square antenna with Second iteration

One of the proposed structures consists of a regular hexagon. Construction of such a fractal antenna begins with a regular hexagon (see Stage 0 of Fig. 3). In the first iteration, a regular hexagon obtained by joining the midpoints of adjacent sides is cut (see Stage 1 of Fig. 3). Another hexagon is then inserted using the same procedure (see Stage 2 of Fig. 3). Later infinite iterations can be obtained by following afore mentioned steps. A regular hexagon with microstrip feeding resonates at a frequency as stated in [7].

$$f_r = \frac{X_{mn}c}{2\pi s \sqrt{\frac{2.598}{\pi}} \sqrt{\epsilon_r}}$$

Another proposed structure is a square pattern; construction of which starts with a normal square (see Stage 0 of Figure 4). In the first iteration, a square obtained by joining the midpoints of original square is cut (see Stage 1 of Figure 4). Another square is then inserted using the same procedure (see Stage 2 of Figure 4). Later infinite iterations can be obtained by following afore mentioned steps recurrently. Mathematical equations for the proposed structures is not yet formulated and this can be an area for investigation in the future.

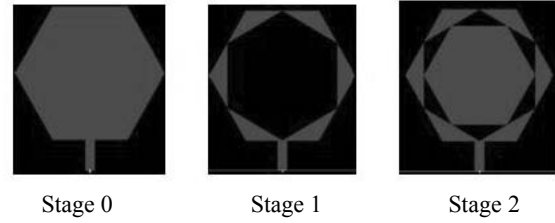


Fig. 3. Several stages in the construction of Hexagonal structure

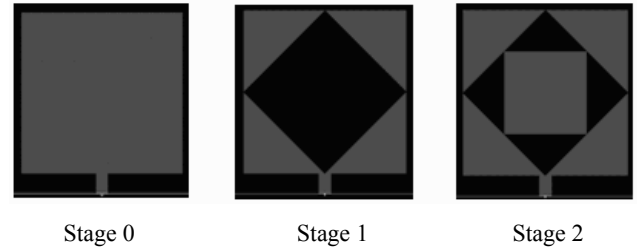


Fig 4. Several stages in the construction of square structure

III. SIMULATION ASSUMPTIONS

Simulation results of hexagonal and square structures are shown in the figures 5 and 6 respectively. The substrates used are FR4 and Alumina having dielectric constants 4.5 and 9.5 respectively. Their loss tangents are 0.019 and 0 respectively. The results are obtained assuming ideal conditions.

SIMULATION RESULTS AND OBSERVATIONS

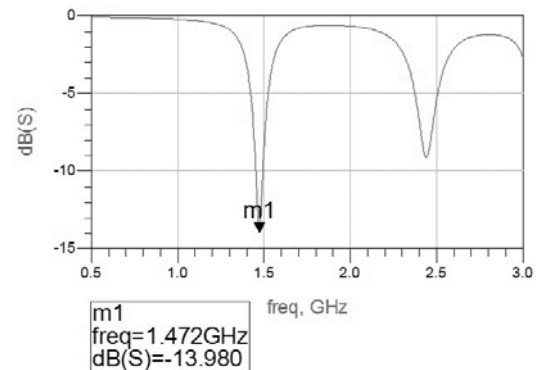


Fig. 5a Simulation result for zeroth iteration
(see Fig. 3 stage 0)

The plot (see Figure 5a) depicts the S_{11} parameter of the regular hexagon structure i.e. zeroth iteration with 30 mm side length and FR4 as substrate exhibiting 1.472 GHz simulated resonance frequency and 1.51 GHz as calculated resonance frequency using the equation stated in [7].

Following plot represents the S_{11} parameter of the Stage 2 hexagon structure having side length of 30 mm which resonates at three frequencies.

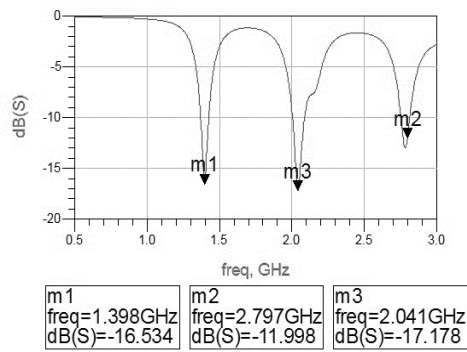


Fig. 5b. Simulation result for first iteration
(see Fig. 3 stage 2)

Of the obtained frequencies, we observe that m1 and m2 are orthogonal with m1 as the fundamental frequency and m2 as first harmonic.

Following figure (see Figure 6a) represents Stage 5 square structure which was simulated using FR4 substrate.

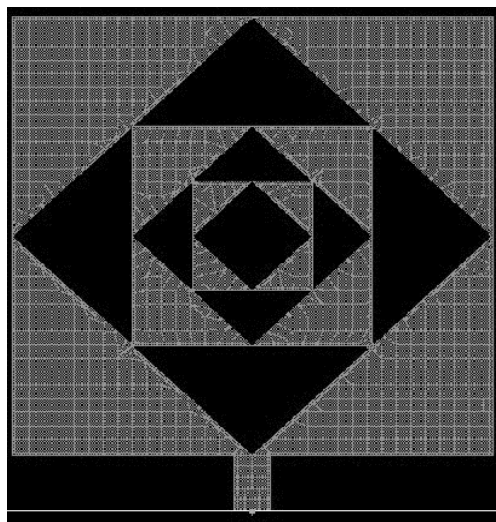


Fig. 6a. Stage 5 of Square Structure

The plot in Figure 6b represents S_{11} parameters of the Stage 5 square structure (see Fig. 6a) having side of length 80mm. In this structure, we have added conductor on all the sharp edges present in the iterations performed to obtain better results.

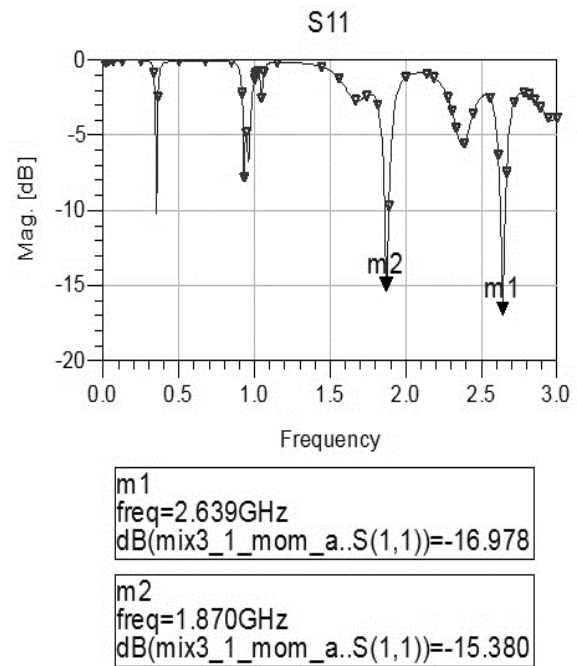


Fig. 6b. Simulation result for second iteration

Better response having five resonant frequencies (see Fig. 7b) was observed in Stage 5 hexagonal structure (see Fig. 7a) using Alumina substrate having dielectric constant 9.5.

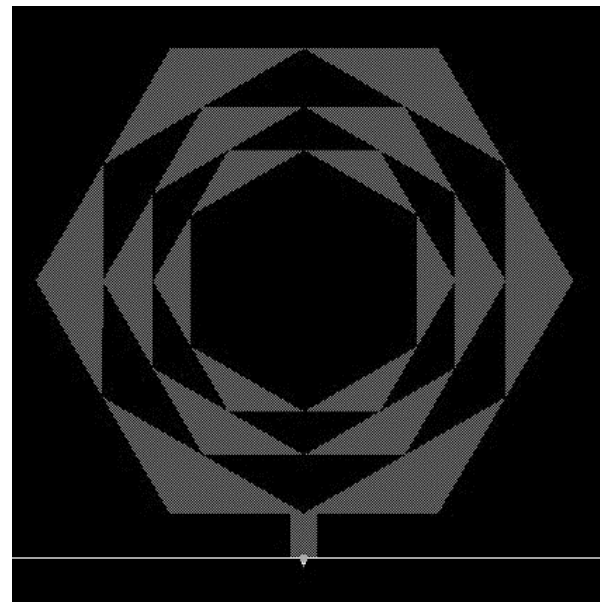


Fig. 7a Stage 5 of Square Structure

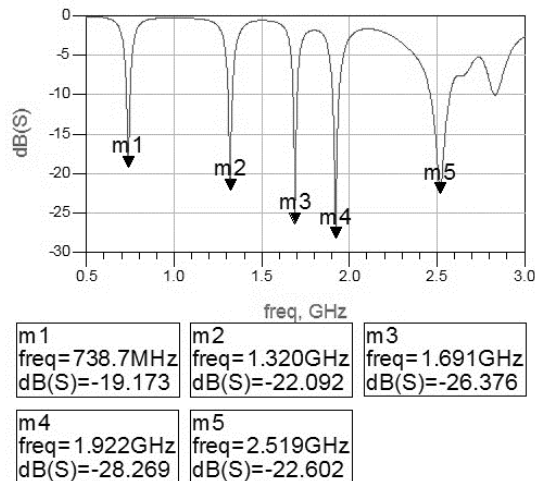


Figure 7b Stage 5 of Square Structure

Above obtained results are purely simulation based and are yet to be validated experimentally.

CONCLUSION

Fractal antenna engineering represents a relatively new field of research that combines attributes of fractal geometry with antenna theory. Applications of fractal geometry are becoming increasingly widespread in the fields of science and engineering. Research in this area has recently yielded a rich class of new designs for antenna elements as well as arrays. Stages of hexagonal and square microstrip patch antennas were constructed using structural defects and corresponding multiband characteristics were obtained. The results indicate that the antenna exhibits a good input return loss at multiple frequencies and can be implemented for applications such as 4G using MIMO, OFDM in military as well as commercial sectors.

From the S_{11} simulation results, we obtain two and more resonant frequencies with return loss more than 10 dB as well as five with a single patch using alumina as substrate. This type of antenna is the best candidate for future broadband wireless communications. Mathematical equations can be formulated so that exact reasoning of the above obtained results can be understood such that desired design parameters can be obtained for specific applications.

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SMART ANTENNA SYSTEM FOR EFFICIENT RESOURCE UTILIZATION IN WIRELESS BACKHAUL

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ABSTRACT

Wireless backhaul systems have been considered as a promising candidate of beyond 3G wireless broadband system for mobile communications. The achievable transmission performance over radio relay channel depends on antenna directivity and radiation patterns of each antenna element. To improve the transmission and reception performance, it is effective to control the antenna directivity by employing multiple antenna signals (i.e. transmission and reception). The benefit of using multiple antenna smart system is better range or coverage which focuses the energy sent out into the cell increases base station range and coverage. This is because of the inputs from multiple antennas are combined to optimize available power required to establish given level of range and coverage. Adaptive arrays allow the antenna to steer the beam to any direction of interest while simultaneously nulling interfering signals. A decision has to be made by user as to which beam to access. The Smart antenna system using adaptive antenna array which increases throughput of the system is proposed in this paper.

Keywords : Smart Antenna System(SAS) , Adaptive Array Antenna , Butler Matrix , Beam forming

I. INTRODUCTION

Smart and Directional antennas have been proposed to enhance performance of wireless networks that includes increasing capacity, increasing the range of coverage, reducing the susceptibility of antennas to detection, interception, and jamming, conserving energy. Over the last decade the number of subscribers for wireless network has grown exponentially creating difficulties in providing service to all the end users. The most practical solution to this problem is using spatial processing which is the main idea behind Smart Antennas[1]. As andrew viterbi, founder of qualcomm inc. said: "spatial processing remains as the most promising, if not the last frontier, in the evolution of multiple access systems".

Smart Antenna are also popularly known as adaptive array antennas, multiple antennas and recently MIMO try to focus and shape the beam of the antenna and all the energy on the desired user/target. Thus, by decreasing the interference with the undesired users as shown in fig. 1.

To achieve that, various smart signal processing algorithms are used like to identify spatial signal signature such as Direction of arrival of the signal from the desired user to calculate location of the desired user.



Fig. 1. Smart antennas system beam forming

Initially in cellular communication, base station antennas were normally omni-directional. Omni directional antenna radiates its energy equally in all directions. That results in the wastage of resources because majority of transmitted energy signal radiates in other directions instead of desired user. The signal power radiated throughout the cell area will increase interference and reduce SNR. The interference can be reduced up to certain level by dividing the entire cell into sectors and by employing sector antennas, but still some interference exist.

Smart antenna system ensures provides a relief by transmitting/receiving the power only to/from the desired directions and suppressing the undesired user.

In this paper we have discussed the Smart Antenna Technology System, the next step is to protrude a beam in the desired direction and a null in the interfering direction which done by beam forming algorithm.

II. SMART ANTENNA

Radio waves propagating through a transmitting antenna, when travel through free space undergo reflection, refraction, absorption, diffraction, and scattering. Radio waves are greatly affected by the atmosphere, ground terrain, and the objects in their path, like buildings, hills, trees, etc.

These types of physical phenomena, termed as fading, are responsible for changes in the characteristic features of the received signal, showing random fluctuations in the received signal level.

The Concept of smart antennas is not new, because similar techniques were already used in radar systems for surveillance in military. Recently, the smart antenna technology has become most important and promising area for mobile communication, especially the development of the first practical third generation mobile communication system. The Quality of the communication system (i.e. Transmission and Reception) can be increased by maximizing the Antenna gain in desired direction, and by minimizing the interference of radiation pattern in undesired region. [2].

The smart antenna system technology is increasing rapidly because of the major problems faced by wireless companies:

- Demand for greater user capacity and higher data rates
- Frequency spectrum is limited
- Co-channel interference
- Multipath signal fading

All the above parameters are majorly dependent on a unique factor known as spectrum efficiency.

Traditional omni-directional antennas as shown in figure 2A, it converts electromagnetic energy into electrical energy (i.e. like transducer), and are not efficient to combat inter-cell and intra-cell interferences. Cost-effective solution to this problem is to divide the entire cell into multiple sectors using sectorized antenna concept. As shown in figure 2B, sectorized antennas transmit and receive in a desired direction and range of the cell to combat interference, one-third of the circular area is covered by each antenna, thereby reducing the overall interference in the system.

Efficiency can be further increased by using spatial diversity or beamforming (i.e. by focusing a narrow beam on a target). In beamforming, it requires multiple number of antennas and powerful processors for "smart" transmission and reception of signals.

Smart antenna system consists of multiple radiating elements at the transmitting and receiving side of the communication system, a coupler/Isolators/Crossover networks and a controlling unit designed using digital signal processors (DSP). In Reality, Smart antennas systems are not smart, because the system becomes smart by the combination of powerful DSP, adaptive beamforming control system and multiple radiating antenna elements, which makes the system very much complex than the ordinary omni-directional antenna system. The antennas which are used for Smart system are same as that of ordinary antennas.

The signals are processed adaptively in order to optimize the radiation pattern and reception as per the user moves within the coverage area. Also, the signals are processed adaptively in order to exploit the spatial dimension of the mobile radio channel. The processing is performed at transmitter/receiver or at both the ends of the communication system, the techniques can be defined as single-input multiple-output (SIMO), multiple-input single-output (MISO), or multiple-input multiple-output (MIMO). The system capacity increases by exploiting the spatial dimension, by improving the quality of the link through the mitigation of a number of impairments of communication system (co-channel interference fading between the antennas), by increasing the data rate through the continuous transmission/reception of multiple data streams by multiple antennas[3].

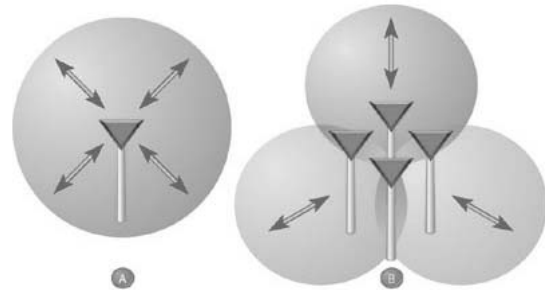


Fig. 2. Non-smart-antenna system beamforming

If we compare traditional omni-directional antennas and sectorized antennas (i.e. smart-antennas), it provides:

- Coverage area for each cell site increases
- Co-channel interference is reduced due to highly directional antennas
- Power is conserved as beam steered only on target
- System capacity increases as frequency can be reused
- Reduction in dropped calls

Directional antennas are used instead of traditional omni-directional antennas, to focus the beam only on the target. Directional transmission/reception can be achieved by two techniques viz., Create an antenna geometry to focus in a desired direction and other technique by Synthesizing directionality by using an array of antennas through constructive and destructive interference. Transmission power gain is achieved by first technique, as energy is focused in desired narrow direction rather than in all direction as that in omni-directional. In second technique, the power achieved in the main lobe is the sum of transmitted power from each element of the array and does not provide transmission power gain. The same signal energy could be achieved if the sum of excitation energy power of each element is applied to just one element.

The array is used instead of single beam steering antenna, as the beam of the array can be easily steered and also the diversity support is also much more than beam steering antenna. Ideally, directional antennas should have only mainlobe (i.e. only in desired direction), but practically it has many lobes (sidelobes, backlobes) along with the mainlobe [4]. Figure 3 shows a hypothetical power pattern of the directional antenna along with various parameters.

The directivity of the main beam can be defined in terms of the half power beamwidth (HPBW) or beamwidth between first nulls (BWFN). The selectivity of the directional antenna is the ratio of the main beam maximum gain to the gain of the largest sidelobe (i.e. the maximum sidelobe level (MSLL)).

The mobility of the antenna in network will cause the change in relative direction between antennas, and the randomness of traffic will cause the instantaneous pointing of the antenna beam in same direction. Under these conditions, the system requires high intelligence where to point the antennas and subsequently to focus the beam in that direction.

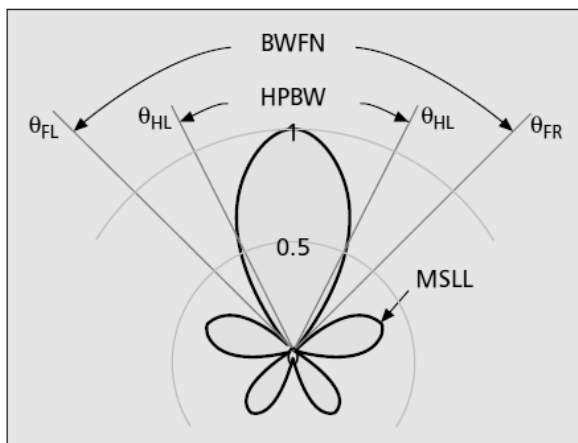


Fig. 3. Power pattern plot of a directional antenna

Antenna system which can do proper focusing in desired direction are known to be smart antenna systems. Smart Antenna Systems has been proven effective in combating fading due to environmental changes and cochannel interference caused by adjacent base stations. Several researches are being made to overcome these challenges. The resultant of these researches are multiple access techniques, channel coding techniques, equalization and Smart antenna employment. The level of smart antenna system are mainly divided into three types and varies on its level of intelligence.

A. Types of Smart antenna System

- 1) Switched Beam
- 2) Adaptive array
- 3) Dynamically Phased Arrays

Switched Beam

In switched beam antennas, there are a predefined selected number of directions in which an antenna beam can be focused. This type of antenna consists of multiple directional antennas, each focused towards different region. The region is focused by selecting corresponding antenna element. When a mobile user moves in the cell, the switched beam antenna system monitors the signal strength of the user and selects from one of several predetermined, fixed beams, and switches from one antenna to other antenna.

Switched beam antenna systems offers many advantages of more complex smart antenna systems at relatively low cost, however, there are many limitations such as incapacity for providing protection from multi-path components arriving near the desired signal and for taking advantage of path diversity by combining coherent multi-path components, as well as fluctuation of the received power level due to scalloping [5].

In wireless networks, it is mandatory to transmit omnidirectionally. There is a misperception that this can be done by active transmission of all directional antenna elements simultaneously. Such an experiment of multiple antennas will likely create undesirable radiation pattern by constructive and destructive interference. Practically, Omnidirectional antennas are used for omnidirectional broadcast in these types of systems.

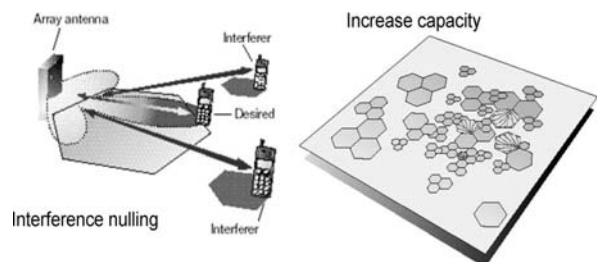


Fig. 4 Adaptive antenna system [8]

The type of use of different antennas will result in a difference in range for omnidirectional and directional transmissions. This difference normally requires some sort of power control for efficient utilization of resources.

Adaptive Array

Adaptive arrays use sophisticated signal processing techniques to continuously distinguish between desired signals and multi-path/interfering signals, as well as to update its beam pattern. Adaptive array system achieve greater performance improvements than switched beam systems, by combining adaptive digital signal processing with spatial processing techniques. The increased intelligence of adaptive antennas includes techniques for reducing interference by steering nulls.

A nice summary of techniques for this purpose can be found in [6]. Adaptive array technique is the most advanced technique in smart antenna system approach to date.

Adaptive antenna has become core system component of future generation mobile networks because of its operational benefits, by exploiting spatial domain via adaptive beamformer. and are extensively used for current and the future mobile communications systems. Widrow et al. [7] defined a system of adaptive array, applying adaptive filtering technique in the optimum array processing to design a receiving antenna system. The adaptive antenna system samples its current environment by a given beam steering command, and then using selected algorithms automatically adjusts the beam i.e. radiation pattern with nulls in the direction of other undesired user equipments to minimize the interference as illustrated in figure 3[8].

Various useful algorithms are used both in space and time domain to reject the noise components in spatial and frequency domain. The adaptive algorithm should be precisely optimized and implemented in either digital or analog domain. Adaptive beamforming technique is employed with a selected algorithm is derived from traditional phased array approach at various frequencies(i.e. radio frequency/intermediate frequency) , [9], where the signals are collected from each of the antenna element are processed and summed in analog devices, and then down converted to baseband. The disadvantage of performing the weighting process in the RF or IF analog domain is that it is relatively inflexible, and become extremely complex as the number of space-division multiple-access (SDMA) channels to be generated increases.

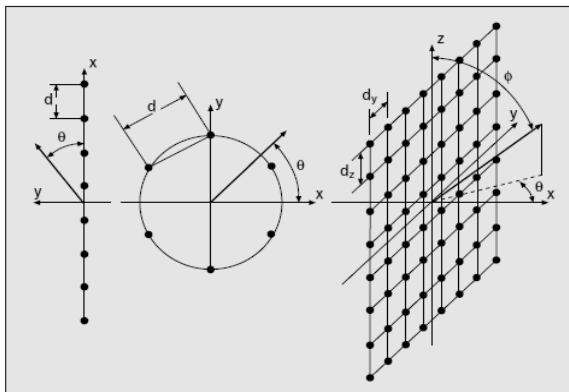


Fig. 5. Main beam focusing directions of linear, circular and planar arrays.

The digital beamforming (DBF) approach is having several advantages over analog beamforming approach [10]. The main disadvantage of the DBF technique is dynamic range characteristics of analog-to-digital and digital-to-analog converters, cost, availability and bandwidth.

Dynamically Phased Arrays

Dynamically Phased array of antenna elements can be focused in a desired direction by varying the phase of the signals emitted from each element, so they arrive on the wavefront in the desired direction at the same time, thus constructively interfering in the desired direction and destructively interfering in all undesired directions. The total power pattern of an array antenna element is the product of the power pattern of the individual antenna elements, assuming the same characteristics and power patterns of array factor for antenna elements which results for the constructive and destructive interference. There are different arrangements of antennas viz., linear, circular, and planar arrays as shown in figure 5. The linear arrays are formed by placing antenna elements along a line with equal spacing between them. The array factor of a linear array results in a beam pattern that produces toroid shape by sweeping about the axis.

When the array factor is combined with the power pattern of dipole elements (i.e., a toroid) that are normal to the array axis, then the results are conical beams that are mirror to each other across the array axis and are normal to the antenna elements. The beamwidth of main beam of the antenna is determined by overall width of the array. Also, the number of sidelobes and mainbeams is determined by spacing and number of elements in the array. Directivity is affected by steering the mainbeam.

The circular arrays are formed by placing antenna elements by equal spacing apart on a circle. The advantage of circular array is that it generates only one mainlobe that is swept fully around the circle. antenna size determines the width of the mainbeam and the quantity and spacing of elements determines the number of sidelobes, it is similar to linear arrays.

The planar arrays are formed by placing linear arrays with equal spacing apart. Similar to linear array, effects of the number of elements and their spacing except they are now in two dimensions, which results in an array factor that produces beams with lower maximum side lobe level and instead of toroidal it generates conical fingers. The direction of arrival (DOA) of signals is the ability of the dynamically phased array that is the enhancement in intelligence that comes and then focusing of the antenna in desired direction for better reception. Direction of arrival is determined by scanning all the beams and by finding the strongest signal. Finding direction of arrival by any technique requires time to process an incoming signal, if more than one signal present at a time then because of the resolution of the antenna or ambiguity as to which is the receiver signal, it is very difficult to decide where to direct the antenna beam

Butler Matrix

The Butler matrix is a type of microwave network, normally employed in beamforming and scanning network for linear and circular antenna arrays. Butler matrix could also have n inputs and N outputs. It consists of hybrid junctions and phase shifters and are implemented with different microwave techniques. The antenna beam is steered in a specific direction in one plane depending on which of n inputs is activated. It performs same function as that of phased array antenna system.

The Butler matrix was first derived by Jesse Butler and Ralph Lowe in [11]. Butler matrix is a passive reciprocal network and it works the same when it transmits energy as when it receives energy. Some basic properties of a butler matrix are isolation between input and output, linearity in phase with respect to the position of output and the increment in phase depending upon the selection of input. Also, Butler matrix can steer a beam with magnitude and fixed phased.

III. SMART ANTENNA SYSTEM

Microstrip Patch Antenna is designed for ISM Band, edge feed square microstrip Patch Antenna as illustrated in fig. 6.



Fig. 6. Edge feed microstrip patch antenna

The Butler matrix is one of the most popular switching beam networks. Its advantage is easy to fabricate and requires very few components to build compared to other networks. The loss involved is very small, which comes from insertion loss in hybrids, phase shifters and transmission lines. The beamwidth and beam angles vary with frequency causing beam squint with frequency.

Butler Matrix consists of N input ports with N output ports or radiating elements. A signal introduced at one input produces equal amplitude excitations at all outputs but with a constant phase difference between them, results in radiation at a certain angle in space. The design of Butler matrix is constructed by combining hybrid couplers, phase shifters and crossover as illustrated in figure 7a.

The planar microstrip square patch antenna is integrated on butler matrix for beamforming (i.e. focusing the antenna beam in the desired direction). As illustrated in figure 7b, the planar microstrip square patch antenna array has four beams at four different directions by implementing the 4×4 Butler matrix as a feeding network to the 4×4 planar microstrip antenna array is designed. Adaptive array along with signal processor steers the radiation beam towards desired mobile user. The system follows the user as he moves and it minimizes the interference from other users by introducing nulls in their directions.

The adaptive array systems are really smart in true sense and can be actually be referred to as smart systems. The smartness in these systems comes from the intelligent digital processors incorporated within the system.

The Adaptive array system work as the signals incident at the individual antenna elements are combined intelligently to form a single desired beamformed output. Adaptive array system uses DSP to weight the incoming signals. The processor interprets the incoming data information, determines the weights and multiplies the weights to each element output to optimize the array pattern.

The optimization is based on particular criteria which minimizes the contribution from noise and interference and produces maximum gain in the desired direction for better transmission and reception of desired user.

The Smart antenna system calculates direction of arrival of all the incoming signals including interfering signals and multipath signals are estimated and calculated using direction of arrival algorithm. The desired user is selected and separated from all the other unwanted incoming signals. The beam is steered in the direction of desired user and user is tracked as he moves while placing nulls at the unwanted directions by constantly updating the algorithm. It rejects the multipath components by correcting delays to enhance signal quality. The overall coverage and system capacity is increased.

IV. CONCLUSION

Smart antenna system spatially filters to focus narrow beams only in the mobile desired direction and introduce nulls in the undesired directions. Smart antenna system uses array of multiple antennas that give rise to narrow beam. The narrow beam increases the directivity, gain, range and overall system capacity. As range increases limited number of systems are required to cover the given area. Therefore, the overall system capacity increases. Smart antennas are cost effective solutions in terms of power as it radiates narrow beam in the desired direction only, so there is no wastage of power.

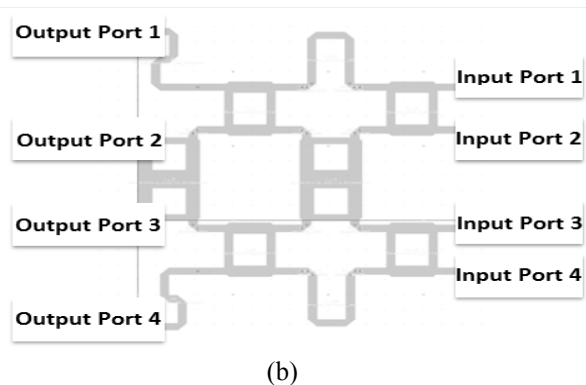
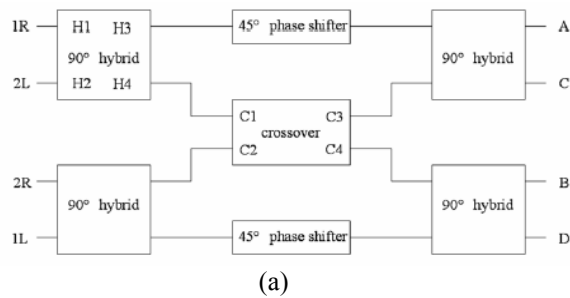


Fig. 7. a) Block diagram of Butler Matrix ;
b) Butler Matrix with Antenna

Smart Antenna System has been discussed for efficient resources utilization. Concept of smart antenna system is discussed for better range and coverage which focuses the energy sent out into the cell increases base station range and coverage, thus further increases the system throughput.

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A NOVEL ESTIMATION OF HYBRIDIZATION METHODS FOR GAIN ENHANCEMENT OF MICROSTRIP PATCH ANTENNA.

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ABSTRACT

In the recent era of wireless communication, Microstrip antenna (MSA) is hot research topic attracting attentions of many researchers. MSAs have few foremost drawbacks such as narrow impedance and Axial Ratio Bandwidth (A.R.BW), low gain as well as power handling capability. To overcome this problems novel hybridization is proposed. A hybridization method includes array method, superstrate cover, change in dielectric material and many more. To achieve the high efficiency, air is used as dielectric medium between feed patch and ground plane and also between superstrate and feed patch. Due to low cost, availability and ease of fabrication FR4 material used as superstrate. Proposed system results using simulation clearly indicates improvement in gain at 2.4 GHz resonating frequency.

Index Terms — Array method, gain enhancement, hybridization. Microstrip patch antenna, superstrate cover.

I. INTRODUCTION

In wireless communication for long coverage of wireless devices there is need for the antenna which works on high frequency range. For the need of wireless devices MSAs are perfect choice because of it work on the high range frequencies i.e. from 1GHz to 300GHz. But microstrip antennas too have drawbacks like narrow bandwidth and low gain. Many researchers have worked out vigorously to remove these drawbacks and have even succeeded in achieving their goal upto a certain extent. From this study it is observe that for further gain improvement there is still scope. The conventional microstrip antennas (MSAs) made up of single conducting patch on grounded dielectric substrate fed by microstrip line or coaxial probe. MSAs have number of advantages over the other antennas such as low profile, light weight, low cost and it is very easy to integrate with accompanying electronics. MSAs show inherent resonant performance because of this they have efficient narrow BW operation. Its typical BW is to 1 to 4% [1]. MSAs have low gain to improve that various methods are analyses such as stack structure configuration which offer high gain and also compatibility for dual frequency operation.

Other methods for gain enhancement for the MSAs are introduction of superstrate cover, inserting parasitic patch on superstrate cover, array method, fabry perrot cavity and partial substrate removal are improves gain of MSAs. License free ISM (Industrial Scientific and Medical) band frequencies typically 5.725GHz to 5.875GHz and 2.4 GHz to 2.5 GHz. on these frequency range compact, high performance and low cost wireless equipment requires for the communication system for these reason MSA got importance. ISM radio band of frequencies (2.4GHz to 2.5 GHz and also 5.7 GHz to 5.8 GHz) will be used for the entire antenna design, simulation and operation. To establish high gain MSAs array structure is incorporated which puts the limitation in chip module due to substrate size. Therefore high gain compact MSAs have been integrated with monolithic microwave integrated circuits (MMICs).

Proposed system is design implemented and results of simulation are presented.

II. LITERATURE SURVEY

Before two and half decades Deschamps from USA and also Gutton and Bassinot from France delivered the concept of Microstrip antenna (MSA). Later Munson developed microstrip antenna which use as low profile flush mounted antenna on rocket and missiles proved that microstrip antenna was practical concept for use in many antenna system problems and from his valuable invention new era of antenna industry come into birth [1]. Researchers studied the MSAs considering different parameters such as gain, BW, radiation pattern etc. They also consider methods to improve these parameters such as change in shape of patch antenna, change in dielectric substrate, using superstrate, removal of substrate, and combination of different methods.

For enhancement of gain of MSAs array method is effectively used by H. Wang et.al designed 2 x 2 MSA line feed U-slot rectangular array these antenna gave gain of 11.5 dBi and 18% BW [2]. Chao Sun, Jiu-sheng Li proposed planar microstrip antenna for WLAN application at 5GHz WLAN band without any modification as observed in [2] this structure gave gain of 19.72 dBi [3].

M.T.Ali et. al developed 2 x 2 MPA with air substrate at 5.8 GHz operating frequency and they found enhancement of gain up to 38.21% [4]. Horng-Dean Chen, Chow-Yen-Desmond Sim, Jun-Yi Wu, and

Tsung-Wen Chiu modified MSA by developing two novel array antenna i.e 3 x 2 and 3 x 3 array antennas for WiMAX application and these antenna structure gave gain of 17 dBi and cover up to 3.3 GHz to 3.8 GHz WiMAX band operating frequency [5]. Tommy Reynalda et al designed 4 x 4 array antenna using dielectric constant of 2.5. This structure is inspired by [4] having difference in number of array and dielectric substrate. Later it compare with single patch antenna having dielectric constant of 2.5. Researcher observed that modified structure has gain 16.02 dB and 150 MHz BW, while single patch antenna has gain 6.10 dB and 50 MHz BW [6]. This proved that array structure enhances the gain of the MSAs.

Halim Boutayeb et al proposed new design of MSA introducing cylindrical EBG structure which enhanced the gain of 2.9 dB as compare to conventional MSAs [7]. Shi – Wei Qu et al in the same year designed Y shaped stub proximity coupled V-slot MPA (Microstrip Patch Antenna) and observed 21% BW enhancement and 9 dBi gain feeding technique of this antenna is different than that of researchers [7] [8]. Jung-han Kim et al used very new structure for designing MSA known as SAP i.e. Short Annular Patch structure it improves a gain by 3.12 dBi and 300 MHz BW compare to reference simple rectangular patch antenna [9]. Bahadır Yildirim et.al projected antenna in which a rectangular loop shaped parasitic radiator placed at different distance away from the patch antenna at 1.6 GHz operating frequency gain increases up to 3.3 dB [10]. Change in feed patch structure i.e modification of patch leads to enhance the gain this showed by the authors.

Modifications in shape of antenna tends to increase gain of MSAs was scrutinize by these researchers. Furthermore change in dielectric substrate also influences the gain of the MSA. Sudhipta chattopadhyay et.al devises rectangular MPA with part of dielectric substrate as PTFE and rest is air and enhanced gain of the MSA [11]. Dongying Li et al considered structure in which low meta-material used as substrate at 9.45 GHz frequency range and observed 80% gain enhancement [12].

Using superstrate in MSAs also contributes in gain enhancement Avinash R. Vaidya et.al deliberate the superstrate height on MSA. They observed that high gain is achieved by placing superstrate layer at above integral multiple of half wavelength above the ground plane [13].

Siew bee yeap and Zhi Ning Chen improved gain of MSA by partial removing the substrate and observed that gain enhanced up to 2.4 dB to 2.7 dB by this method [14].

Different gain enhancement method is studied by the many researchers some authors also combine two methods like V. Priyashman et.al analyzed the performance of elliptical shaped antenna by using

superstrate with random slots at 5.8GHz frequency they also showed that gain and BW influenced by the superstrate structure [15]. In this author combine change in shape along with the superstrate cover. Kaushik Mandal and Partha Prtim Sarkar designed U-shaped patch antenna with two equal arms using PTFE (poly tetra fluoro ethylene) substrate. Just under the U shaped patch introduced inverted U-shaped slot on circular shaped ground plane. They achieved 4.1 dBi gain and BW enhancement of 86.76%. Structural modification in MSAs effect the gain of the MSAs these proved by the researches [16]. Author achieved high gain by combining two gain enhancing method that are change in feed patch shape and change in dielectric material. This stated that hybridizing gain enhancement methods help to improve the gain of MSAs.

It is summarized that different methods have been attempted for enhancing gain of MSAs. This study reveals that there is further scope to improve gain of MSAs by attempting the hybridization of existing method. In the next section the proposed system which includes hybridization method is presented in detail.

III. PROPOSED SYSTEM

Proposed system will be hybridization of the techniques used for gain enhancement to analyze the effect on the gain of MSAs. First study of the individual methods for gain enhancement will be essential. After theoretical analysis of each method, simulation will be done and results will be examined. Hybridize different methods and result will observe on the software. In this section few terms related to antenna such as antenna gain is defined along with the brief introduction of some of gain enhancement method.

A. Antenna Gain :

Antenna gain defined by the intensity of an antenna in a given direction to the intensity that would be produced by a hypothetical ideal antenna that radiates equally in all directions or isotropically and has no losses. Since the radiation intensity from a lossless isotropic antenna equals the power into the antenna divided by a solid angle of 4π steradians, we can write the following equation:

$$\text{Gain} = 4\pi \left(\frac{\text{Radiation Intensity}}{\text{Antenna Input Power}} \right) \dots\dots\dots(1)$$

$$\text{Gain} = 4\pi \left(\frac{U(\theta, \phi)}{P_{in}} \right) \dots\dots\dots(2)$$

Where radiation intensity define by constant $U(\theta, \phi)$ and P_{in} is the antenna input power. The gain of a rectangular microstrip patch antenna with air dielectric can be very roughly estimated as follows.

Since the length of the patch, half a wavelength, is about the same as the length of a resonant dipole, we get about 2 dB of gain from the directivity relative to the vertical axis of the patch. If the patch is square, the pattern in the horizontal plane will be directional, somewhat as if the patch were a pair of dipoles separated by a half-wave; this counts for about 2-3 dB. Finally, the addition of the ground plane cuts off most or all radiation behind the antenna, reducing the power averaged over all directions by a factor of 2 (and thus increasing the gain by 3 dB). Adding this all up, we get about 7-9 dB for a square patch, in good agreement with more sophisticated approaches.

B. Methods to Enhance Gain in Microstrip Patch Antenna:

Most compact microstrip antenna designs show decreased antenna gain owing to the antenna size reduction. To overcome this disadvantage and obtain an enhanced antenna gain, several designs for gain-enhanced compact microstrip antennas with the loading of a high permittivity dielectric superstrate or the inclusion of an amplifier-type active circuitry have been demonstrated. Use of a high-permittivity superstrate loading technique gives an increase in antenna gain of about 10 dBi with a smaller radiating patch. An amplifier-type active microstrip antenna as a transmitting antenna with enhanced gain and bandwidth has also been implemented. There are various techniques to achieve the high gain such as change of dielectric substrate, use of array method, Use of superstrate and partially substrate removal. The brief review of all these method given below

- **Gain enhancement using microstrip antenna array :** In this method, MSA with antenna array of 2 by 2 [1] is used for enhancing the gain of antenna. For producing better efficiency and gain thick substrate with lower dielectric is used. The performance will be analyzed in terms of gain, return loss, VSWR, and radiation pattern.
- **Gain enhancement using different dielectric substrate :** In this method different dielectric substrate such as FR4, air, foam etc and observe the effect on MSAs. Different dielectric substrates have different dielectric constant which tends to establish different structure of MSAs. These change influences the parameter of MSAs such as gain, BW, radiation etc.
- **Gain enhancement using superstrate structure :** In this method covering above the feed patch is introduce with specific height and using appropriate substrate between the feed patch and the covering these kind of structure is known as superstrate structure. This is contributing in gain enhancement of MSAs.
Gain of antenna is enhanced by employing superstrate structure, such as Fabry-Perot resonator (FPR) antenna [2]. The FPR antenna generally consists of radiator sources placed over

a ground plate and a partially reflective plate placed in front of the radiator.

- **Gain enhancement using removal of partial substrate :** In this method effect of substrate with different dielectric constant is observed [4]. For the simulation purpose substrates with different dielectric constants such as air, foam and roger will be used. Then the effect of removing partial substrate will be observed. By observing effect of various methods on the performance characteristics of MSA a hybridized methods for enhancing gain of MSA will be developed and verified. The method will be proposed for enhancing gain and directivity of the antenna.

C. System Overview

The proposed system diagram is shown in figure A below system consisting of basic MSA with radiating patch. The antenna consisting of ground plane with radiating patch with superstrate cover. Air will be used as a substrate with $\epsilon_r=1$. Parasitic patch is used for creating the cavity and it will help for increasing the antenna directivity and gain. One more superstrate cover is used above to increase the gain and directivity. Both the superstrate will act like a cavity and radiate the antenna with more directivity. Fig. 1 shown below is 3D view of proposed system designed in the IE3D software.

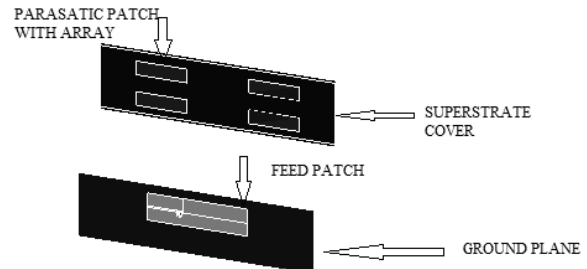


Fig.1. Proposed System

IV. DESIGN OF REFERENCE ANTENNA AND PROPOSED SYSTEM

In the design process of antenna it is prerequisite to do analysis of antenna in terms of length, width, ϵ_r , thickness etc. the analysis in terms of mathematical expression is presented below.

A. Choice of Substrate:

Choosing a substrate is as crucial as the design itself. The substrate itself is part of the antenna and contributes significantly to its radiating properties. Many different factors are considered in choosing a substrate such as dielectric constant, thickness, stiffness as well as loss tangent. The dielectric constant should be as low as possible to encourage fringing and hence radiation. A thicker substrate

should also be chosen since it increases the impedance bandwidth. However, using a thick substrate would incur a loss in accuracy since most microstrip antenna models use a thin substrate approximation in the analysis. Substrates which are lossy at higher frequencies should not be used for obvious reasons. The choice of a stiff or soft board basically depends on the application at hand. In our project we have selected air as the dielectric material having dielectric constant as 1.

B. Element Length :

To chose the resonant length would also mean choosing the frequency of resonance since the resonant frequency of the patch is determined by the patch length. The length of the patch should be slightly less than half the dielectric wavelength since the actual patch is 'longer' due to the fringing fields. The length of the patch is given as

$$L_{\text{eff}} = \frac{C}{2f_0 \sqrt{\epsilon_{\text{eff}}}} \quad (3)$$

Where L_{eff} represented effective length of antenna, f_0 represent the resonant frequency, C represented velocity of light, ϵ_{eff} effective dielectric constant and ΔL represent the line extension at the ends given by Hammerstad as

$$\Delta L = 0.412h \frac{(\epsilon_{\text{eff}} + 0.3) \left(\frac{W}{h} + 0.264 \right)}{(\epsilon_{\text{eff}} - 0.258) \left(\frac{W}{h} + 0.8 \right)} \quad (4)$$

Where W is the width of the feed patch and h is the height of the feed patch from the ground plane. The effective dielectric constant ϵ_{eff} may be static or frequency dependent value which is given as follow.

$$\epsilon_{\text{eff}} = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left(1 + 12 \frac{h}{W} \right)^{-\frac{1}{2}} \quad (5)$$

Where ϵ_r represented relative dielectric constant of material Therefore length of the feed patch can be calculated as

$$L = L_{\text{eff}} - \Delta L \quad (6)$$

C. Element Width:

For an efficient radiator, width is given by

$$W = \frac{C}{2f_0 \sqrt{\frac{\epsilon_r + 1}{2}}} \quad (7)$$

D. Design of refferance MSA antenna:

- Type of substrate: air
- Substrate dielectric (ϵ_r) : 1
- Thickness of the substrate (h): 5mm

- Length of feed patch(L): 54.8mm
- Width of feed patch (W): 54.8mm
- feed location: 11 mm along length towards right
- Size of ground plane(G) :- infinite
- Feed line characteristic Impedance : 50 Ω
- Antenna resonating frequency: 2.4 GHz
- Type of connector: SMA
- Radius of connector (r): 0.6mm

Fig. 2 shows the 3D view of reference antenna simulated in IE3D software.

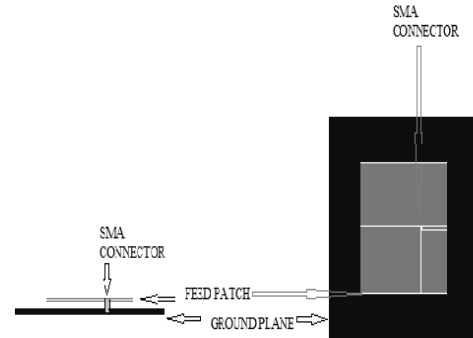


Fig.2. 3D View of reference antenna

E. Design of MSA antenna with superstrate cover for gain enhancement:

- Type of substrate: air
- Substrate dielectric (ϵ_r) : 1
- Thickness of the substrate (h): 5mm
- Length of feed patch(L): 54.8mm
- Width of feed patch (W): 54.8mm
- feed location: 11 mm along length towards right
- superstrate height: 67.34
- Size of ground plane(G) :- infinite
- Feed line characteristic Impedance: 50 Ω
- Antenna resonating frequency: 2.4 GHz
- Type of connector: SMA
- Radius of connector (r): 0.6mm

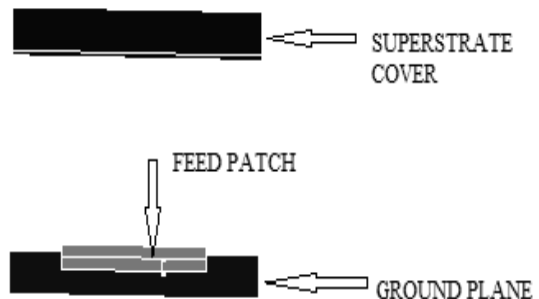


Fig.3. MSA with superstrate cover

F. Design of MSA antenna with superstrate cover for gain enhancement:

- Type of substrate: air
- Substrate dielectric (ϵ_r) : 1

- Thickness of the substrate (h): 5mm
- Length of feed patch(L): 52.8mm
- Width of feed patch (W): 54.8mm
- feed location: 11 mm along length towards right
- superstrate height: 67.34
- Size of ground plane(G) :- infinite
- Feed line characteristic Impedance: 50 Ω
- Antenna resonating frequency: 2.4 GHz
- Type of connector: SMA
- Radius of connector (r): 0.6mm

V. RESULTS AND DISCUSSIONS

Antenna as per designed are simulated on software IE3D and results are presented below. Two type of antennas are simulated first one is reference antenna and the second one is the MSA with superstrate cover one of the method to enhance the gain of MSAs. Results of the antennas are verified and compared by checking five parameters such as return loss, gain, directivity, antenna efficiency and radiating efficiency of the antenna.

A. Simulation of reference antenna:

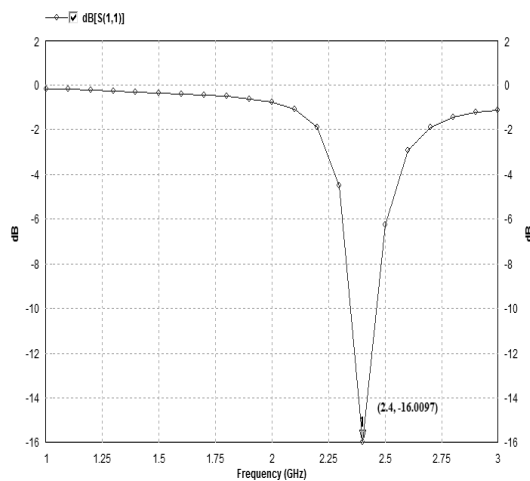


Fig.4. Return loss of reference antenna

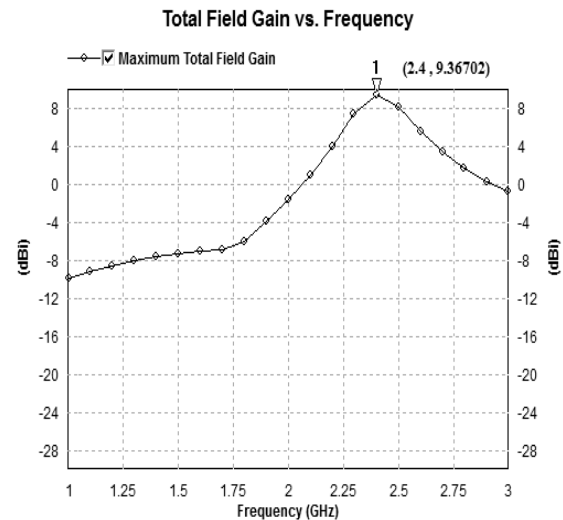


Fig.5. Gain of reference antenna

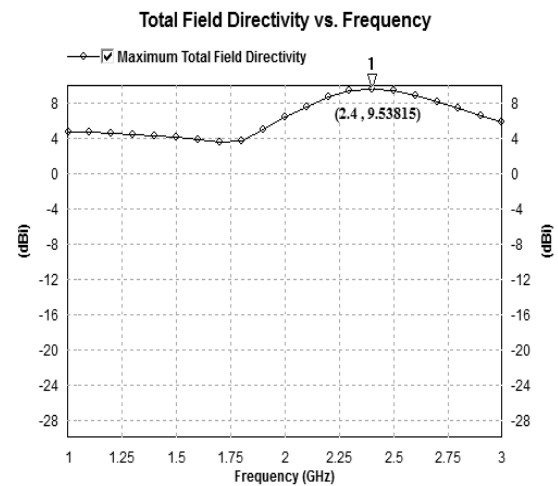


Fig.6. Directivity of reference antenna

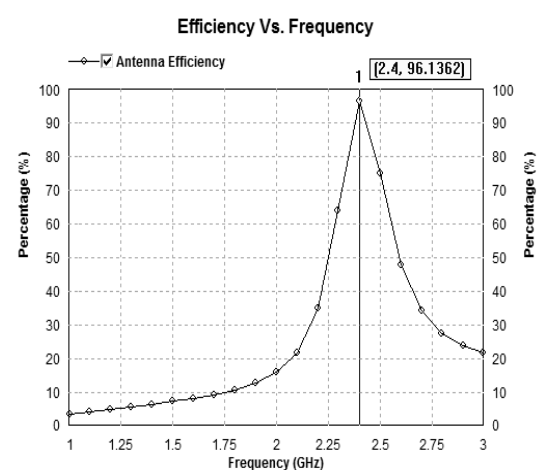


Fig.7. antenna efficiency of reference antenna

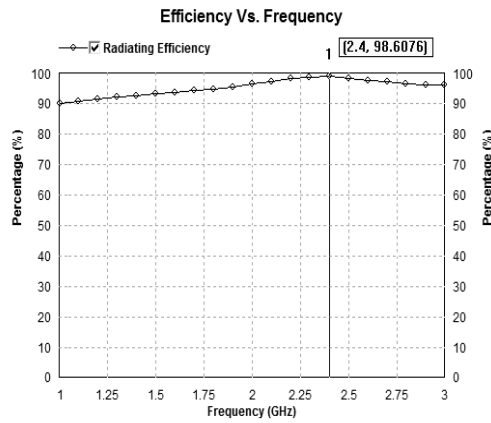


Fig.8. Radiating efficiency of reference antenna

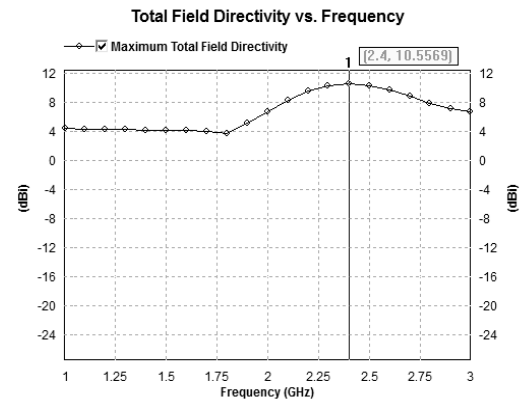


Fig.11. Directivity of antenna

B. Simulation of MSA antenna with superstrate cover:

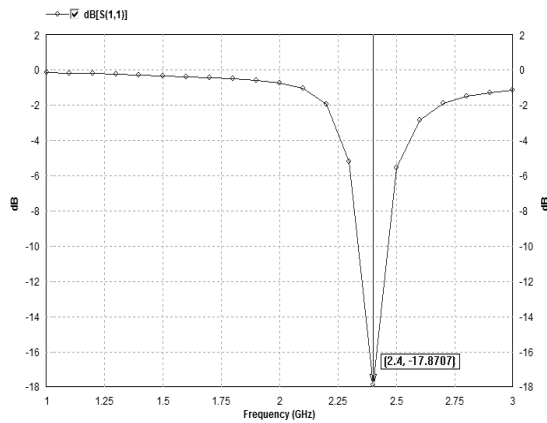


Fig.9. Return loss of antenna

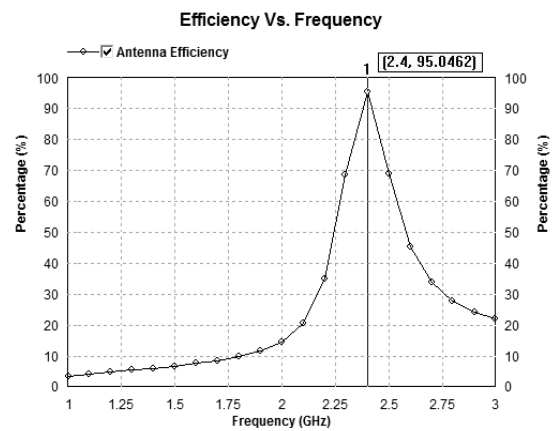


Fig.12. antenna efficiency of reference antenna

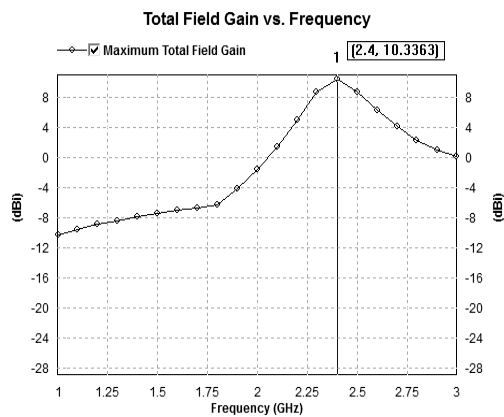


Fig.10. Gain antenna

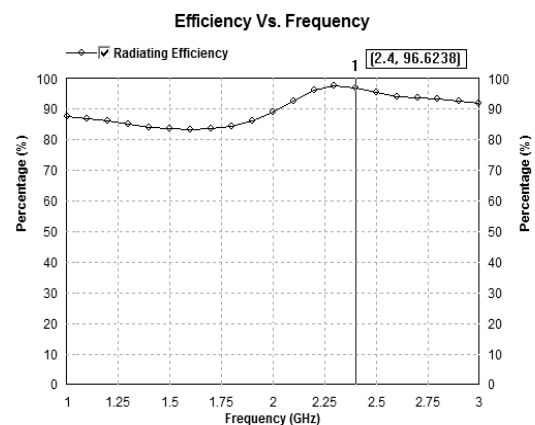


Fig.13. Radiating efficiency of antenna

C. Simulation of MSA antenna with array:

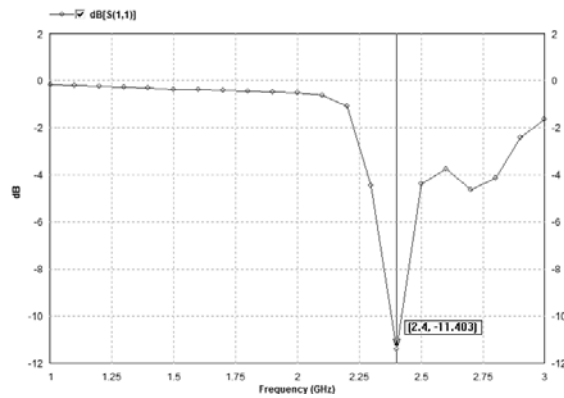


Fig. 14 Return loss of antenna

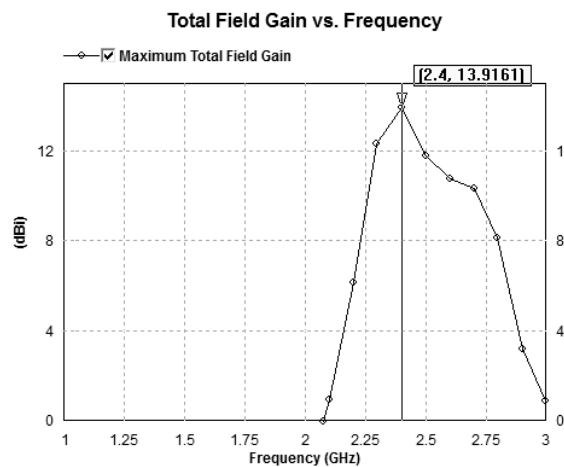


Fig.15. Gain antenna

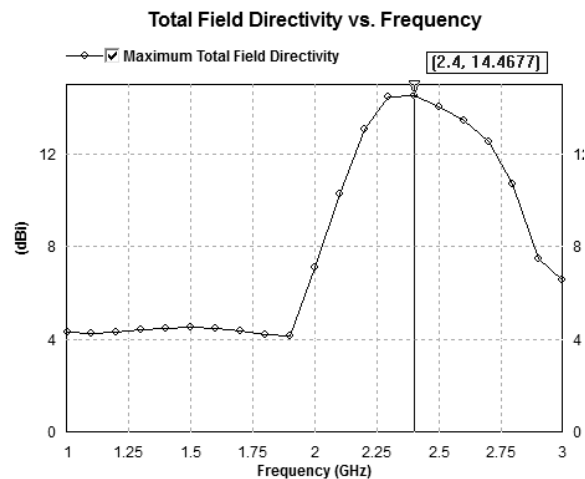


Fig.16.Directivity of antenna

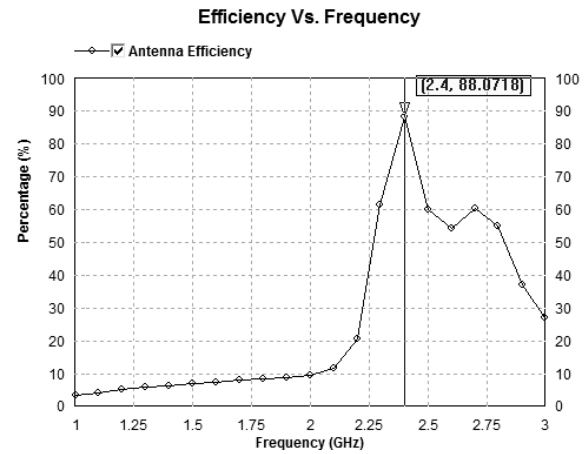


Fig.17. antenna efficiency of reference antenna

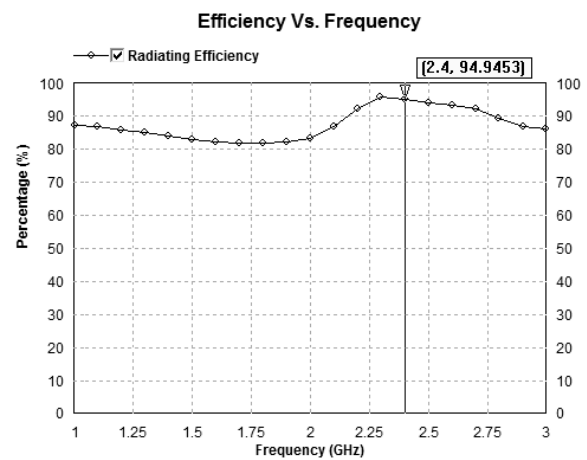


Fig.13.Radiating efficiency of antenna

In these section simulated results of the reference antenna and MSA with superstrate cover is presented for different parameter which describe earlier at resonating frequency 2.4 GHz. Table 1 offered below summarized with the comparative study of two antennas considering five parameters as mentioned before.

TABLE I. COMPARISON OF ANTENNAS WITH DIFFERENT PARAMETER

	Return loss (dB) at 2.4GHz	Gain (dB) at 2.4GHz	Directivity (dB) at 2.4GHz	Antenna efficiency (%) at 2.4GHz	Radiating efficiency (%) at 2.4GHz
Reference MSA	-16.00	9.36	9.538	96.13	98.60
MSA with superstrate cover	-17.87	10.33	10.55	95.06	96.62
MSA with Array 2x2	-11.40	13.91	14.46	88.07	94.94

VI. CONCLUSION

Some of the existing methods available for enhancing the gain of Microstrip Patch antenna are studied. Basic MSA and with superstrate cover are designed and simulated on IE3D software and results are presented in table 1. Table 1 showed that all described parameter are enhanced in the MSA with superstrate cover compare with the reference MSA. Gain of the MSA with array is more than that of the reference and superstrate MSA. Still there is scope of enhancement of the gain of MSAs. The proposed system will be used for constructing high gain antennas for the application of wireless communication to operate in ISM frequency band.

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METAMATERIAL LOADED MICROSTRIP PATCH ANTENNA WITH IMPROVED CIRCULAR POLARIZATION BANDWIDTH

(Research Paper)

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ABSTRACT

Conventional Microstrip Patch Antennas (MPA) inherently have low bandwidth and gain. There have been continuous efforts to increase the bandwidth of MPA using many techniques. In this paper, we examine the effect of use of metamaterial structure on the circular polarization bandwidth of MPA. The circularly polarized (CP) MPA's are always preferred over linearly polarized (LP) MPA's because of their property of eliminating unintended frequency and also to make orientation of antenna independent of the direction of the arrival of signal. Metamaterials in the form of split ring resonators (SRR) are used to improve the CP bandwidth of MPA. The use of SRR not only increases the CP bandwidth but also miniaturizes the MPA. We have used the commonly available low profile FR-4 substrate for the fabrication of MPA and metamaterial. The metamaterials are designed in the form of array of SRR and are loaded in specific way over the MPA to improve its CP bandwidth. Various structures of metamaterial SRR configuration are tried and the best is selected through simulation. The antenna prototype is fabricated and tested for its performance. It has been found that, there is a good amount of synchrony between simulated results and the measured results.

Keywords : Microstrip Patch Antennas (MPA's), Meta-material, Split Ring Resonators (SRR's), Circular Polarization

I. INTRODUCTION

Planar microstrip antennas are drawing more attention because they can be easily and economically fabricated. Moreover, they also support both linear and circular polarizations. However, their low bandwidth is a major impediment for their use in wireless communication applications requiring high data rate. In addition, their size is often too large for specific applications. Hence, in order to make these antennas ideal for wideband applications, it is imperative to augment their bandwidth and miniaturize them further. Various approaches such as stacking, planar array, use of shorting posts, slotted structure etc are examined in the literature [1]. Metamaterials are the artificial structures having the property of negative refractive index obtained by either through obtaining negative permittivity or by negative permeability [2]. Negative permittivity is obtained by selecting engineered thin rods of metal forming their specific array in the bunched form and negative permeability is obtained most popularly by synthesizing subwavelength dimension split ring resonators grouped in the form of some suitable array [3]. In [3] SRR are arranged in a specific way to increase the gain significantly, but the maximum percentage 3 dB CP bandwidth is found to be just 2% with 2.47 GHz center resonance. In this paper we used inexpensive, low

profile FR-4 substrate for fabrication of microstrip line fed MPA and the metamaterial cover. Firstly, a resonant MPA is designed to radiate right hand circularly polarized waves (RHCP). Empirical formulae are taken from [1] to design it a resonant frequency of 2.45 GHz and the RHCP 3 dB bandwidth is found about 4 % with center resonance 2.45 GHz (2.38 GHz – 2.48 GHz). Different metamaterial SRR cells are then designed on the same substrate to observe the frequency response. The best SRR structure is then selected to cover the original MPA and it has been found that RHCP 3 dB bandwidth is improved to 6.5 % with center resonance 2.45 GHz (2.32 GHz – 2.48 GHz) respectively. The gap introduced in the double concentric SRR blocks the current in a specified direction, this property is used to reduce the cross polarization of linearly polarized MPA. The arrangement of metamaterial cover consisting of SRR array or matrix over the MPA at specific height found to enhance the CP bandwidth. Various combination of placing the cover in horizontal and vertical configuration have been tried. The field in the boresight 'Z' direction is radiated effectively with minimal reflection loss and thus stood responsible for improvement in CP bandwidth. Moreover, metamaterials have properties attained from the unit structure and not its individual constituent materials which cause miniaturization of the antenna to a great extent, hence negating all the major disadvantages of a conventional microstrip antenna. Such an astonishing improvement in antenna parameters was made possible due to properties of metamaterials such as negative permeability and field straightening, which were unheard of in the past. Simulation results obtained on Agilent's Advanced Design System [4]. The practical results, obtained after fabrication, using the vector network analyzer have been used to quantify the obtained results.

Obtaining Negative Permeability: The Split Ring Resonator (SRR) has been used to react to the magnetic component of electromagnetic field. This acts as a part of the unit cell of the meta-material giving $\mu < 0$. SRR can be considered as LC resonator. Now, consider a circular metal plate placed in an oscillating magnetic field polarized normal to flat surface. This plate is magnetically active but weak. The field induces a circular current in the round plate, this induces a magnetic flux opposing the external magnetic field, exhibiting Lenz's law. Since, the circular current is confined to the outer region; the inner portion can be eliminated, resulting in a ring structure. The response of the ring structure is purely inductive. In order to bring about resonance behavior, capacitance had to be introduced. This was done by creating a gap by splitting the Split Ring Resonator and preventing a complete circular current.

II. METHODOLOGY

The above mathematical computations give the optimum length of the single meta-material unit structure, which is smaller than the wavelength given at the resonant frequency of the microstrip patch antenna. As discussed earlier the dimensions of the meta-material unit structure have to be about the fraction of the wavelength of interest to give homogenized material parameters.

$$A = \frac{20}{60} \sqrt{\frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{\epsilon_r + 1} \left[0.23 + \frac{0.11}{\epsilon_r} \right]}$$

$$A = \frac{50}{60} \sqrt{\frac{4.4 + 1}{2} + \frac{4.4 - 1}{4.4 + 1} \left[0.23 + \frac{0.11}{4.4} \right]}$$

$$A = 1.529$$

$$\frac{W}{d} = \frac{Qe^A}{e^{2A} - 2}$$

$$\frac{W}{d} = \frac{8e^{1.529}}{e^{2 \times 1.529} - 2}$$

$$\frac{W}{d} = 1.9138$$

$$\frac{d}{W} = 0.5225$$

$$\epsilon_e = \frac{\epsilon_r + 1}{2} + \frac{\epsilon_r - 1}{2} \left[1 + \frac{12d}{W} \right]^{-1/2}$$

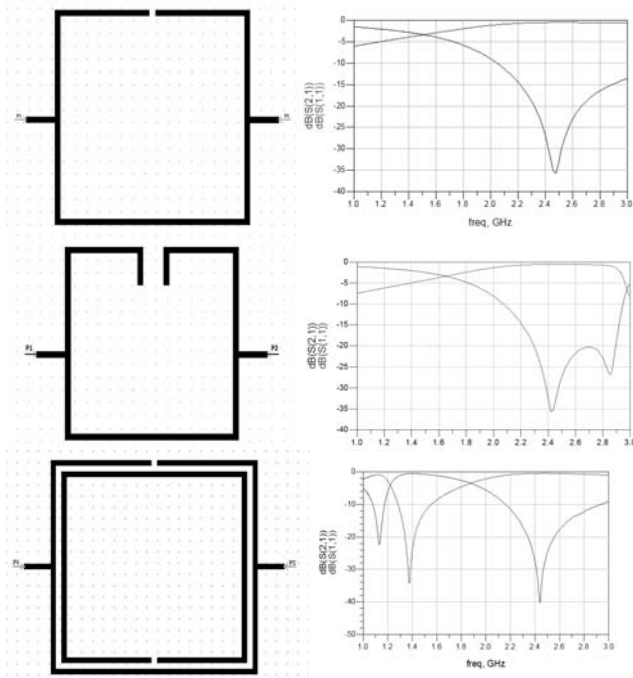
$$\epsilon_e = 3.33$$

At frequency $f = 2.4$ GHz, we have wavelength $\lambda_0 = 125$ mm.

Now,

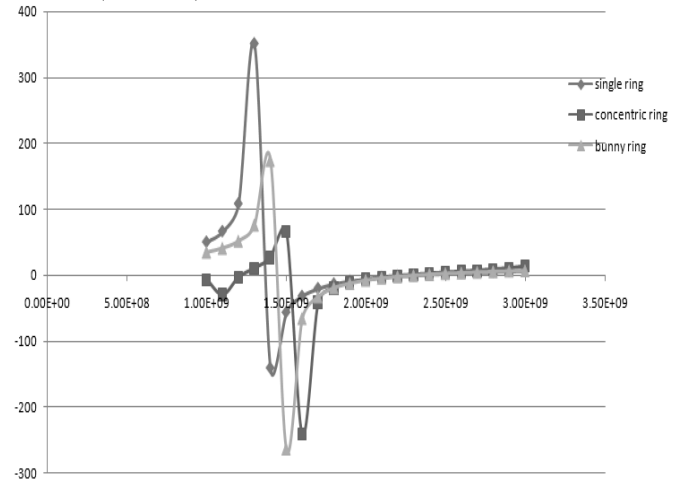
$$\lambda_{eff} = \frac{\lambda_0}{\sqrt{\epsilon_e}} \quad \lambda_{eff} = 68.5 \text{ mm}$$

Therefore the SRR dimension about 34 mm will be in subwavelength range.



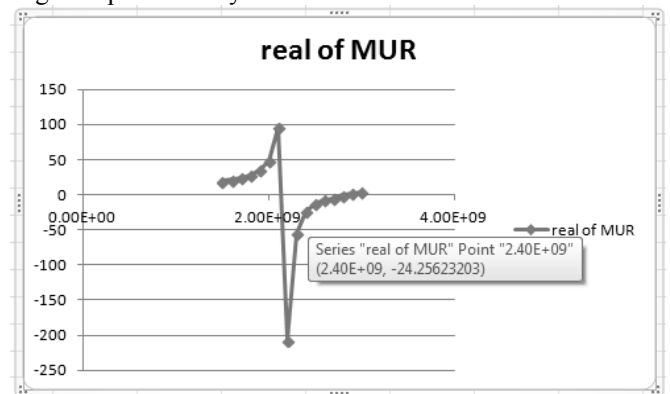
Comparison of various SRR structures

We simulated three different structures of SRR acting as metamaterial providing negative permeability. Simple splitted square ring, bunny ring and splitted concentric square rings. On the right hand side of above structure we plotted their S parameters (S_{11} – reflection coefficient and S_{21} – transmission coefficient) All the above three SRR are with subwavelength dimension. A common fact is found that all of these SRR shows stop band characteristics (minimum S_{21} with maximum S_{11}) around the frequency of 2.4 GHz. With the knowledge of these S parameters we have calculated the real part of permeability for these three structures from [5]. This negative permeability is shown in the following figure. With the stop band characteristic obtained nearly at 2.4 GHz, we observe that, maximum negative permeability is obtained in frequency range of 1.5 to 2 GHz which is offset from desired resonating frequency of MPA (2.4 GHz).



Graph of negative permeability verses frequency

We have selected double concentric splitted square loop resonators and further scaling is performed to get peak negative permeability near to 2.4 GHz as shown below:

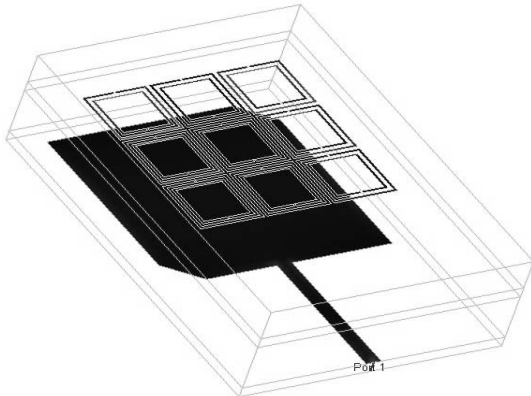


Graph of negative permeability for double concentric SRR

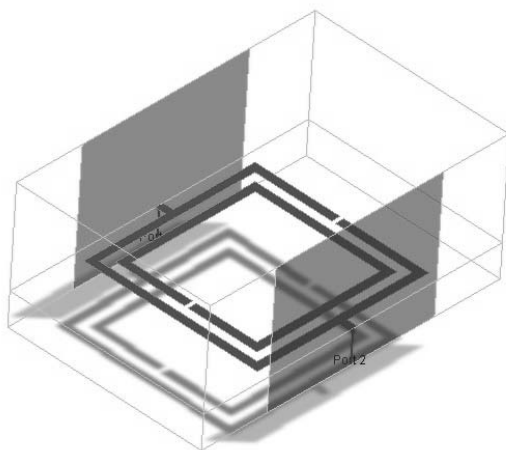
III. MPA LOADED WITH METAMATERIAL SRR

The following structure shows MPA with diagonal chopped configuration fed with microstrip transmission line matched at 50 ohms is designed to resonate in the range 2.4 to 2.5 GHz. It is loaded with array of metamaterial SRR at air gap of around 7 mm. This height of SRR cover is optimized and found to be providing maximum possible 3 dB RHCP

bandwidth. This antenna radiates RHCP wave predominantly. This MPA is fabricated on low cost FR-4 substrate of dielectric constant 4.4 and thickness 1.6 mm. The dimensions of circularly polarized MPA with chopped corners are calculated from [1].

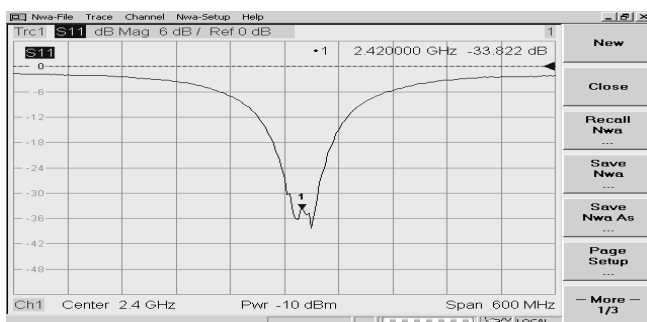


The below figure indicates unit cell of double square concentric loop SRR used as cover over the MPA. This SRR is designed to provide maximum peak negative permeability around 2.4 GHz as discussed earlier. The MPA and SRR are simulated in ADS-2009.

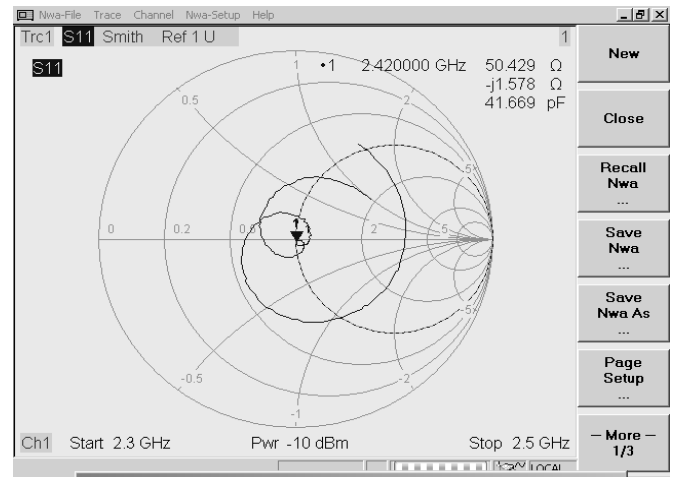


IV. MEASUREMENTS

The RHCP MPA and double array of 3 X 3 cells of finalized metamaterial structure mounted on each other with air gap of 7 mm together on MPA is fabricated and tested with R & S Vector Network analyzer in the laboratory. The measured return loss, impedance plot are below:

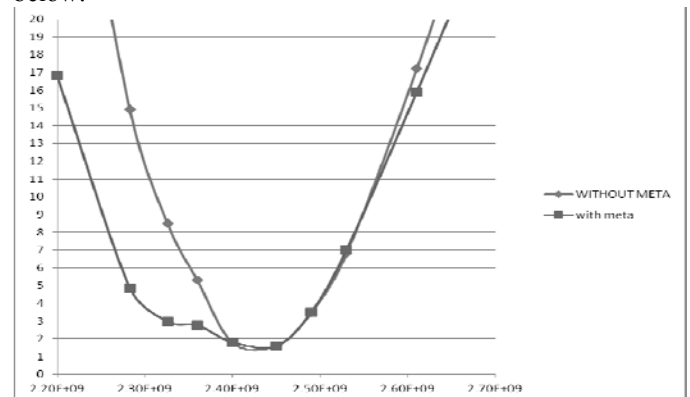


Measured Return Loss on Vector Network Analyzer



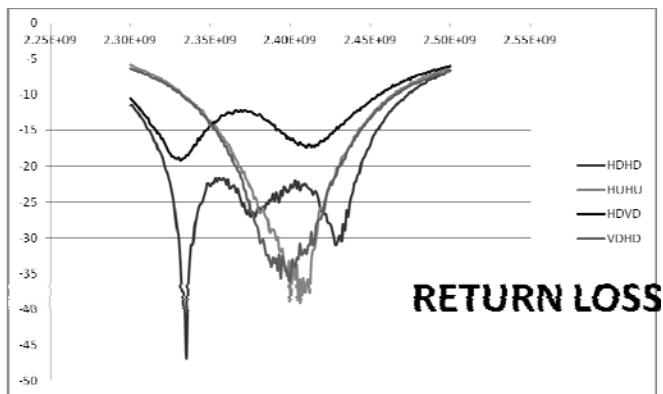
Measured Impedance Plot on Vector Network Analyzer

It has been observed that, RHCP frequency around 2.42 GHz is obtained with good impedance match of 50 Ohms. The small loop (known as kink) as given in [1] is an indication of obtaining CP. The comparison of simulated axial ratio bandwidth for RHCP is plotted for single MPA and MPA loaded with double 3 X 3 metamaterial array as shown below:



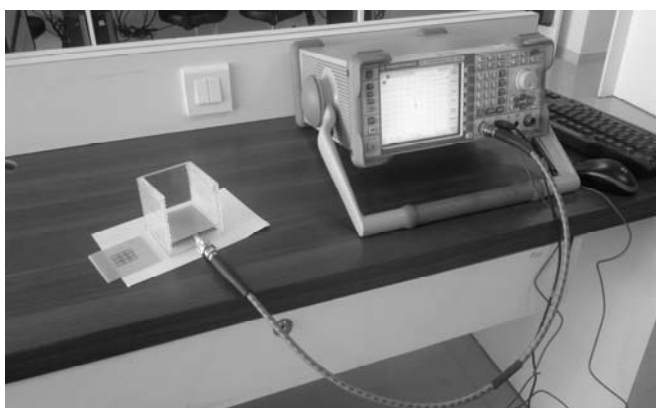
Axial Ratio Bandwidth comparison

It is found that, axial ratio bandwidth of 6.5 % is obtained with loading of double layer SRR metamaterial cover as compared to 4 % provided with single CP MPA. The SRR array of concentric double square split rings are apposite to each other and are fabricated on the single side of the FR-4 substrate. Such a two layers of SRR substrates are experimented in different ways of placing on each other over the main MPA. The orientation of gaps of 3 X 3 SRR arrays are arranged in horizontal axis and vertical axis over the MPA by keeping them constant air gap of 7 mm. The return loss characteristics of such four combinations are shown below:

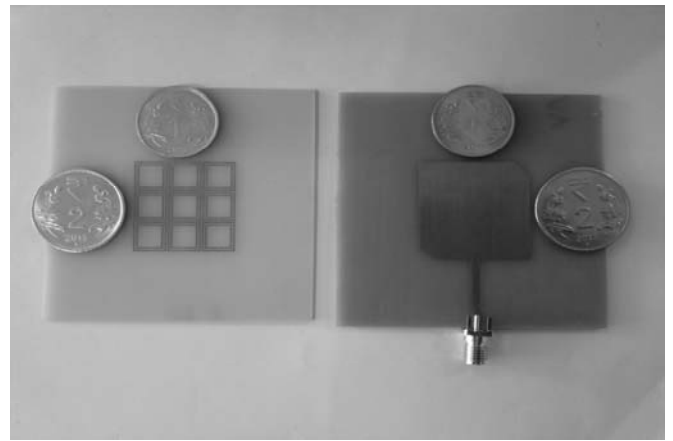


Return Loss verses Frequency for various combinations

HDHD indicates horizontal alignment of open gaps of SRR layers downside facing to MPA, HUUH indicates horizontal alignment of open gaps of SRR layers upside facing to MPA, HDVD indicates top SRR layer horizontally oriented with open gaps and downside MPA while the middle SRR layer is oriented in vertical direction for its open gaps facing downside of MPA, VDHD indicates top SRR layer is oriented in vertical direction for its open gaps and facing downside of MPA with middle SRR layer oriented gaps in horizontal direction facing downside of MPA respectively. All these combinations give excellent return loss characteristics ($VSWR = 2$) and broadband operation. Particularly Horizontal down, combination of top and middle SRR layer facing downside of MPA gives extra large linear bandwidth. Enhancing the CP bandwidth is a very difficult task as compared to enhancement of LP bandwidth for the MPA. The basic principle to generate either LHCP or RHCP wave is to have two electric field components equal in magnitude with constant phase difference of 90 degree maintained throughout. Use of metamaterial seems to make this task easier compared to other methods of obtaining CP. The following figure shows the experiment set up during the measurement procedure in laboratory and the fabricated prototype antenna with its metamaterial cell layer.



Experimental Measurement Set up



Fabricated Prototype of Antenna: Metamaterial cover (Left side) MPA (Right Side)

IV. CONCLUSION

The analysis of metamaterial structure designed to provide negative effective permeability is utilized to enhance the linear as well as circular polarization bandwidth of microstrip patch antenna. A CP right handed bandwidth about 6.5 % is obtained with double layers of 3×3 concentric square open loop rings loaded over MPA whose resonating frequency is 2.4 GHz. FR-4 dielectric material is used as substrate which is commonly available but has significant losses. The SRR layers are separated by thin layer of air gap of around 7 mm and thus resulting in the low profile structure. The loss because of FR-4 can be eliminated by using low loss dielectric materials, in which case the performance of CP bandwidth will be further enhanced. This low cost, easy to fabricate MPA loaded with subwavelength metamaterial structure can be efficiently utilized in applications like WLAN and RFID respectively.

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DESIGN OF RECONFIGURABLE AND TUNABLE MULTIBAND PATCH ANTENNA FOR WIRELESS DEVICES

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ABSTRACT

This paper presents the design of a low-profile reconfigurable and tunable multiband patch antenna. The antenna implemented for C band in Electromagnetic Spectrum and can be used for long distance radio telecommunication and NATO applications. Nowadays, different antennas are preferred/ devised for different wireless applications. This increases the complexity and size of the device. The proposed technique deals with the design of an antenna which can be used for most of the wireless applications by reconfiguring and tuning the antenna. Thus, the selection of frequency band in communication systems can be conveniently served by only one antenna. This will make an overall antenna a compact one. The Parameter that shall be considered in this work for performance analysis is Return Loss.

Keywords : Tunability, Reconfigurability, Return loss.

I. INTRODUCTION

Broadband compact antennas are highly desired nowadays for communication terminals as they occupy limited space and can interface with various communication standards [1]. Modern mobile handsets are miniature in size, and they are required to operate at multiple-frequency bands in order to provide the enhanced and multifunctional performances and due to the device convergence trend antenna structure, very limited space is available for the antenna structure [2]. The design of an efficient wide band small size antenna, for recent wireless applications, is a major challenge. Microstrip patch antenna is a resonant element [3]. Tunable multiband antennas are becoming popular for use in the multifunctional handsets due to their significant advantages in terms of weight, volume and performance [4]. Since past few decades, there have been intensive studies going on tunable antennas. Antennas can be tuned by various ways, for example by using pin diodes [3][5], varactor diodes [1], [6]-[11] and MEMs switches [12]-[14] and by varying substrate properties with ferrites [15] and ferroelectrics [16]. Microwave antennas tuned using liquid crystal (LC) substrates have been reported in [17]-[21]. Tunable multiband antennas are becoming popular for use in the multifunctional handsets due to their significant advantages in terms of weight, volume and performance [22], [23]. Another new concept called compact reconfigurable antenna is introduced for mobile communication devices [24]. A reconfigurable antenna can reuse its entire volume [13] at different operating bands so the physical size of the multiband antenna can be reduced [25]. Reconfigurable antenna is one of the effective solutions as far as miniaturization is concern in antenna design. Tunable narrow-band antennas can be advantageous if small efficient antennas are required to cover a large frequency range [6].

Different techniques that are used to design reconfigurable antennas are presented in [26], [27]-[32].

Tunability is basically tuning to different frequencies in a same band of frequencies and reconfigurability is tuning to different defined bands of frequencies using same antenna volume. The proposed technique is to combine both reconfigurability and tunability for wireless applications in a higher frequency range. It includes different wireless applications for the wireless devices such as Mobile phones, WLAN, Bluetooth, Wi-Fi, WiMax. The incorporation of tunability and reconfigurability in single antenna may lead to compact size and low cost. In this paper it is proposed to have both tunability and reconfigurability in one i.e. using single antenna. This paper is organized as follows. The proposed antenna design is described in Section II. Simulation results are given in Section III. Applications of proposed structure are presented in Section IV. Finally conclusion is presented in Section V.

II. PROPOSED ANTENNA DESIGN

Software required for simulation of antenna design is Advanced Design System (ADS). Fig. 1. shows the proposed structure for tunability for frequencies 4.8 GHz, 7.5 GHz, 8 GHz. The proposed Patch structure is placed on Dielectric Substrate called Roger Duroid having dielectric constant $\epsilon_r = 2.3$ and loss tangent $\delta = 0.001$. Coupling is realized by aperture which is a slot with 8.5mm by 4.6mm. Microstrip structure provides different frequencies of operation and by incorporating PIN diode into the structure, same antenna structure can operate on one frequency at a time for different application according to requirement. This structure designed for C band in a microwave frequency bands in Electromagnetic spectrum.

Design of frequency reconfigurable antenna covers S and C bands. Antenna includes main radiator and four sub-patches placed on FR4 substrate having $\epsilon_r = 4.4$ and height of a substrate $h = 1.57$. Structure of patch is as shown in Fig. 2. Dimensions of all patches are as shown in table II.

III. SIMULATION RESULTS

Fig. 3. shows the simulation result of proposed antenna structure for tunability for C band in terms of return loss. Return loss represents how much the power is reflected from the antenna, and hence it is also called as reflection coefficient. The return loss achieved shall be as low as for a transmission of maximum power. Return loss (S_{11}) should be less than -10 dB. This antenna structure provides different frequencies 4.8 GHz, 7.5 GHz, 8 GHz with minimum return loss.

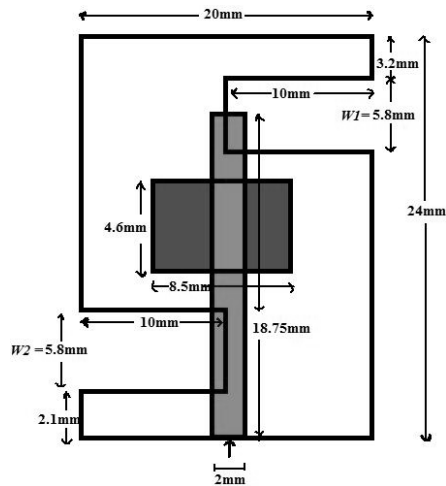


Fig. 1. Proposed structure for tunability

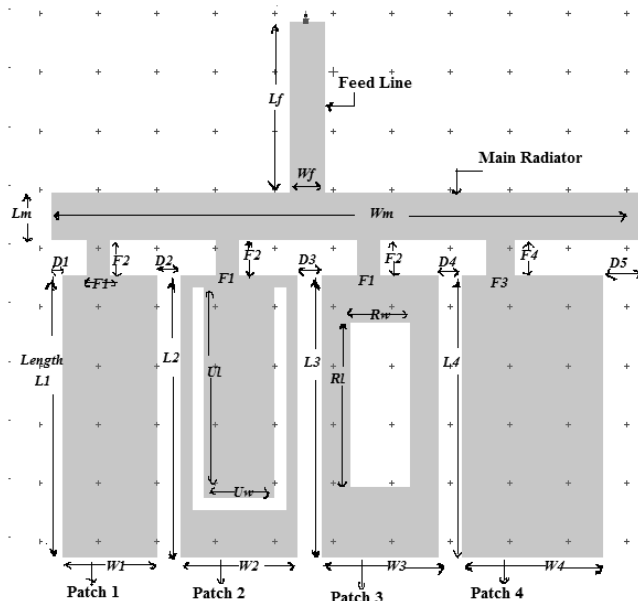


Fig. 2. Proposed structure for Reconfigurability

Table I shows various effects in terms of frequency by varying width of a slots in a structure. By varying width of slots in a structure frequency of operation can be changed and this can be achieved using tunable component such as PIN diode, varactor diode within a same C microwave band. Similarly by defining different antenna patches for different bands with the single microstrip feed line Reconfigurability can be achieved that is tuning from one band to another band.

Fig. 2. shows proposed structure for reconfigurability which covers both the bands C-band and S-band in electromagnetic spectrum. Table II provides dimensions of a patch shown in Fig. 2. and Fig. 4. shows the simulation results of the same. It provides the bands almost for all the wireless applications such as Wimax, Wi-Fi, Bluetooth, and WLAN. Tunability can be achieved by varying length of the patch. By changing length of patch 1 and patch 2 from 24 mm to 22 mm, frequencies get shifted and the results are shown in Fig. 5. Note that only those frequencies obtained by patch 1 and patch 2 are getting shifted. Similarly by changing length of patch 3 and patch 4 from 24 mm to 22 mm, the new frequencies obtained are shown in Fig. 6.

Table I. Simulation results by varying width of the slots in antenna structure

Width of slots		Obtained frequencies	Applications
$W1$ (mm)	$W2$ (mm)		
5.8	5.8	4.8GHz, 7.5GHz, and 7.9 GHz	Wi-Max, NATO and UWB
5.8	4.8	4.8 GHz	
5.8	3.8	4.8 GHz, and 7.5 GHz	
5.8	3	5 GHz, and 7.9 GHz	
4.8	5.8	7.5 GHz, and 8 GHz	
3.8	5.8	7.5 GHz	
3	5.8	7.5 GHz, and 8GHz	

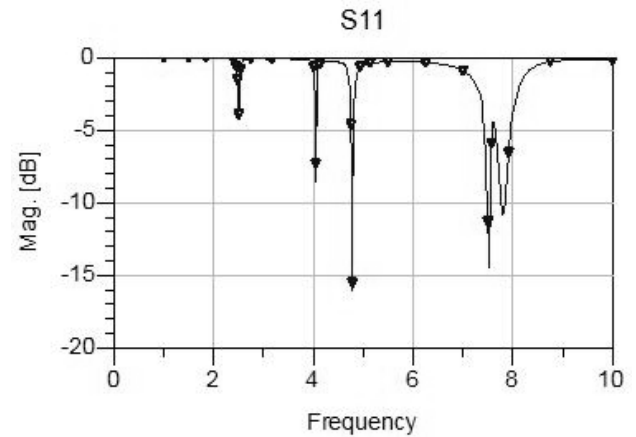


Fig. 3. Simulation Result of Proposed structure as shown in Fig. 1

Table II. Dimensions in mm of proposed antenna structure as shown in Fig. 2.

$L1$	$L2$	$L3$	$L4$	Lf	$W1$	$W2$	$W3$	$W4$	Wf
24	24	24	24	14.6	8	10	10	12	3
Lm	Wm	$F1$	$F2$	$F3$	$F4$	$D1$	$D2$	$D3$	$D4$
50	4	2	3	2.5	3	1	2	2	2
$D5$	$U1$	Uw	$R1$	Rw	h				
3	19	6	14	5	1.57				

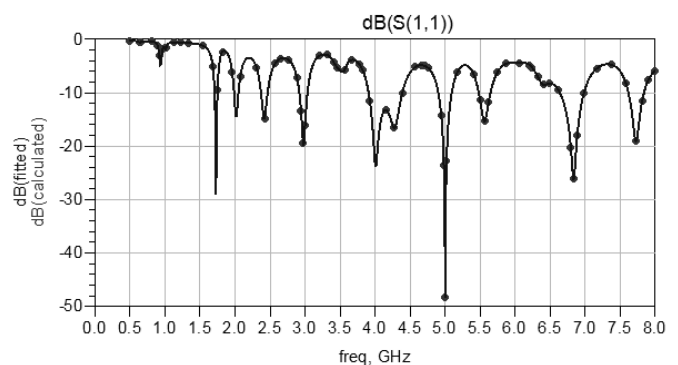


Fig. 4. Simulation results of proposed structure as shown in Fig. 2.

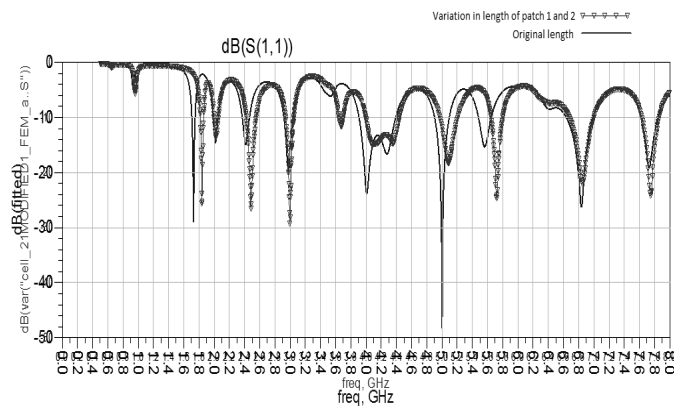


Fig. 5. Simulation results by varying length of patch 1 and 2

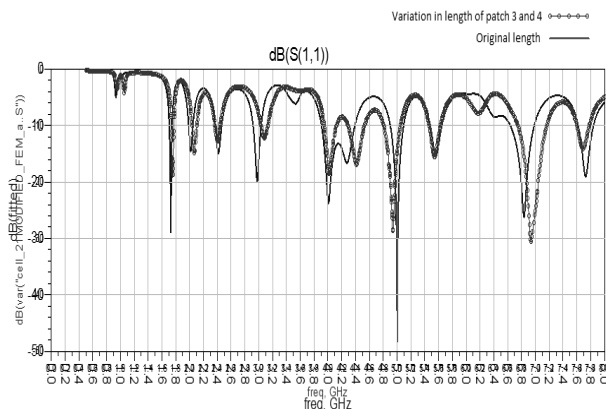


Fig. 6. Simulation results by varying length of patch 3 and 4

IV. APPLICATIONS

The proposed structure shown in Fig. 2 provides bands for Wimax, Wi-Fi, WLAN, and Bluetooth applications. It covers both S-band and C-band of electromagnetic spectrum, achieves reconfigurability.

V. CONCLUSIONS

The compact slotted patch antenna is proposed which provides different frequencies such as 1.75 GHz, 2 GHz, 2.4 GHz, 2.9 GHz, 3.9 GHz to 4 GHz, 5GHz, 5.56GHz, 6.8 GHz, 7.7 GHz with minimum return loss. The proposed antenna dimensions are 50 mm x 50 mm and provide bands for Wimax, Wi-Fi, WLAN, and Bluetooth applications. Such applications can be served by using proposed single antenna which reduces complexity and cost as well.

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COMPARATIVE STUDY OF SMART ANTENNA ADAPTIVE BEAM ALGORITHMS

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ABSTRACT

Smart antenna is one of the most promising technologies that will enable a higher capacity in wireless networks by effectively reducing multipath and co-channel interference used in mobile, WLAN communication. Adaptive beamforming is the main technique of smart antenna system in which an array of antennas are exploited to achieve maximum reception in a specified direction (in the presence of noise) while signals of the same frequency from other directions are rejected. Different beam forming algorithms are used as per application & performance requirement. In this proposed work relative comparison of adaptive algorithms such as Sample Matrix Inversion (SMI), Least Mean Square (LMS), Recursive Least square (RLS) & Constant Modulus Algorithm (CMA) is made, also analyzed the performance of LMS algorithm using MATLAB.

Keywords : LMS, RLS, SMI, CMA, Beamforming, Smart Antenna.

I. INTRODUCTION

Smart antennas employ a set of radiating elements arranged in the form of an array. The signals from these elements are combined to form a movable or switchable beam pattern that follows the desired user [1]. Smart Antenna uses DSP where algorithms are embedded. Smart antenna systems are customarily categorized, as either switched beam or adaptive array systems.

Switched beam antenna systems form multiple fixed beams with heightened sensitivity in particular directions. These antenna systems detect signal strength, choose from one of several predetermined, fixed beams, and switch from one beam to another as the mobile moves throughout the sector.

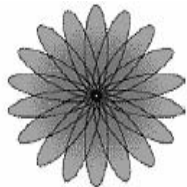


Fig1. Switched beam system Antenna Pattern

Adaptive system takes advantage of its ability to effectively locate and track various types of signals to dynamically minimize interference and maximize intended signal reception [2].

The optimization is based on algorithms for updating and computing the optimum weights such as LMS, RLS etc.

In next sections we will make comparative study of various beamforming algorithms & as a case study we will have more insight of LMS.

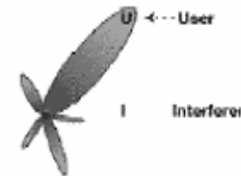


Fig 2. Adaptive Array Coverage

Both systems attempt to increase gain according to the location of the user, however, only the adaptive system provides optimal gain while simultaneously identifying, tracking, and minimizing interfering signals [2].

Unlike switched beam systems, the adaptive array systems are really smart because they are able to dynamically react to the changing RF environment. An Adaptive arrays are controlled by signal processing. This signal processing steers the radiation beam towards a desired mobile user, follows the user as he moves, and at the same time minimizes interference arising from other users by introducing nulls in their directions [2].

Consider a typical adaptive digital beamforming network shown below in Fig. 3.

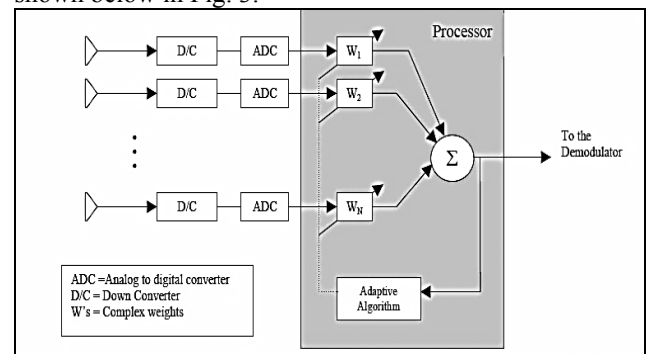


Fig 3. Block diagram of Adaptive Array System

In a beamforming network typically the signals incident at the individual elements are combined intelligently to form a single desired beam-formed output. Before the incoming signals are weighted they are brought down to baseband or intermediate frequencies (IF's). Adaptive antenna array systems use digital signal processors (DSP's) to weight the incoming signal. Therefore it is required that the down-converted signal be converted into digital format before they are processed by the DSP. The processor interprets the incoming data information, determines the complex weights (amplification and phase information) and multiplies the weights to each element output to optimize the array pattern.

II. BEAMFORMING ALGORITHMS

The adaptive algorithms can be classified into categories based on different approaches.

Based on adaptation:

1. *Continuous adaptation*: algorithms based on this approach adjust the weights as the incoming data is sampled and keep updating it such that it converges to an optimal solution. This approach is suitable when the signal statistics are time varying. e.g. Least Mean Square (LMS) algorithm, and the Recursive Least square (RLS) algorithm.
2. *Block adaptation*: algorithms based on this approach compute the weights based on the estimates obtained from a temporal block of data. This method can be used in a non-stationary environment provided the weights are computed periodically. e.g. The Sample Matrix Inversion (SMI) algorithm

Based on information required:

1. *Reference signal based algorithms*: These types of algorithms are based on minimization of the mean square error between the received signal and the reference signal. Therefore it is required that a reference signal be available which has high correlation with the desired signal. e.g. LMS, RLS.
2. *Blind adaptive algorithms*: These algorithms do not require any reference signal information. They themselves generate the required reference signal from the received signal to get the desired signal. [6,7]. e.g. Constant Modulus Algorithm (CMA).

A. Least Mean Square (LMS) Algorithm

The design of this algorithm [2] was stimulated by the Wiener-Hopf equation. The algorithm contains three steps in each recursion: the computation of the processed signal with the current set of weights, the generation of the error between the processed signal and the desired signal, and the adjustment of the weights with the new error information as shown in Fig. 4

The signal $x(n)$ received by multiple antenna elements is multiplied with the coefficients in a weight vector ' w '. This weighted signal is summed up, resulted in the array output, $y(n)$. An adaptive algorithm is then employed to minimize the error $e(n)$ between a desired signal $d(n)$ and the array output $y(n)$. The LMS algorithm can be described by the following three equations,

$$y(n) = w^H \cdot x(n) \quad \text{---- (1)}$$

$$e(n) = d(n) - y(n) \quad \text{---- (2)}$$

$$w(n+1) = w(n) + \mu \cdot x(n)e^*(n) \quad \text{---- (3)}$$

where the step - size μ , governs the stability, convergence time and fluctuation of LMS adaption process.

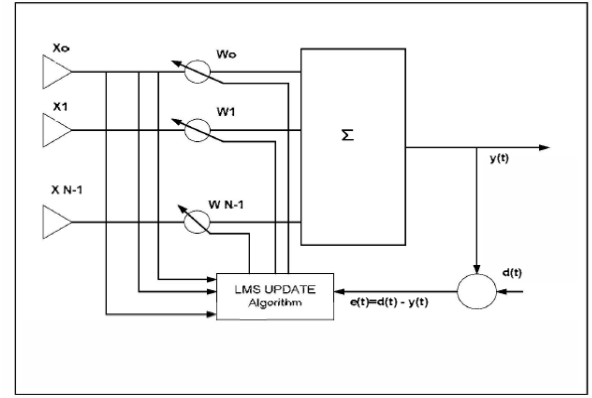


Fig.4 LMS Block Diagram

B. Recursive least-squares (RLS) algorithm

Instead of minimizing the mean square error (MSE) as in the LMS algorithm, the sum of the squared errors of different set of inputs is the subject of minimization.

Although it is intended to be used in a multi-tap transversal filter where the squared error information is sampled over a varying time frame, this method also works in our system where input information originates from different elements. The following equations illustrate the update procedures in each recursion with the RLS algorithm.[4]

$$k(n) = \frac{\lambda^{-1} P(n-1) u(n)}{1 + \lambda^{-1} u^H(n) P(n-1) u(n)} \quad \text{---- (4)}$$

$$\xi(n) = d(n) - w^H(n-1) u(n) \quad \text{---- (5)}$$

$$w(n) = w(n-1) + k(n) \xi^*(n) \quad \text{---- (6)}$$

$$P(n) = \lambda^{-1} P(n-1) - \lambda^{-1} k(n) u^H(n) P(n-1) \quad \text{---- (7)}$$

The P in the above equations is first initialized to $\delta^{-1} I$ where δ is a small positive constant and I is an identity matrix. k is a vector called the Kalman gain factor. λ is the forgetting factor and is supposed to weight the error value differently depending on the ages of the received signals in a transversal filter.

C. Constant Modulus Algorithm (CMA)

The constant modulus algorithm (CMA)[4] is used for blind equalization of signals that have a constant modulus, i.e. it does not use reference signal. The constant modulus algorithm is Godard Algorithm. The algorithm contains three steps in each recursion: the computation of the processed signal with the current set of weights (Initial weight $w(1)$ are chosen), the generation of the error, and the adjustment of the weights with the new error.

The following equations summarize the above three steps.

$$y(k) = W^H X(k) \quad \text{---- (8)}$$

$$e(k) = (y(k) - \frac{y(k)}{|y(k)|}) \quad \text{---- (9)}$$

$$W(k+1) = W(k) + \mu e(k) X(k) \quad \text{---- (10)}$$

In equation first above W represents weight vector of the arrays. Here, each weight vector contains number of elements of weight. In second equation e(k) is error at kth iteration. The symbol 'μ' in third equation is called the Step size parameter. The value of this parameter affects the settling time and the steady state error of the CM algorithm.

D. Sample Matrix Inversion (SMI)

It uses a block of data to estimate the adaptive beam-forming weight vector. For a N-element antenna array, the baseband received signal vector X is given by

$$x(t) = \sum_{i=1}^M s_i(k) a_i(\theta_i) + n(k) \quad \text{---- (11)}$$

The co-channel transmitted signals are represented by, Si(k) for i= 1...M.

The array output is expressed as

$$y(k) = \sum_{i=1}^N w_i(k) x_i(k) = x(k) w(k) \quad \text{---- (12)}$$

The weight vector that minimizes the mean squared error is given by $W = R^{-1}P$ where

$$R = E[x^H(k)x(k)] \text{ and } P = E[x^H(k)d(k)] \quad \text{---- (13)}$$

The Sample Matrix inversion (SMI)[2] method is a technique used to approximate the solution to the minimum mean square error (MMSE) problem.

This sample is used to form an estimate of the N×N covariance matrix

$$\hat{R}(k) = X_k^H(k) X_k(k) \quad \text{---- (14)}$$

$$\hat{P}(k) = X_k^H(k) d(k) \quad \text{---- (15)}$$

The approximation to the solution of MMSE problem is calculated as:

$$\hat{w}(k) = \hat{R}(k)^{-1} \hat{P}(k) \quad \text{---- (16)}$$

III. COMPARATIVE STUDY OF ALGORITHMS

The SMI adaptive beam-former uses a block of code to get optimum weight; therefore it is not suitable for *non-stationary* environment. Since the sample-by-sample adaptive beam-former alter its weight with each new sample, it can dynamically update its response for such a changing scenario. The constant modulus algorithm (CMA) converges slower than least mean square (LMS) algorithm. This also limits the usefulness of CMA when channel conditions are rapidly changing. The CMA algorithm is *less stable* than the LMS algorithm. The CMA seems to be more sensitive to gradient constant 'μ'.

An important feature of the recursive least square (RLS) algorithm is that its *rate convergence* is typically an order of magnitude faster than that of the simple least square algorithm (LMS). This improvement, however, achieved at the expense of an increase in *computational complexity* of the recursive least square (RLS) algorithm.

The LMS algorithm is the *least demanding* in computational complexity. But the LMS algorithm has a *slow convergence* rate. Moreover in all cases the step- size, governs the stability, convergence time and fluctuation of LMS adaption process.

To overcome this dependency, Normalized Least Mean Square (NLMS) algorithm introduced. NLMS is used to achieve stable calculation and faster convergence.

The final weight vector in NLMS can be updated by,

$$w(n+1) = w(n) + \frac{\mu}{\|x(n)\|^2} x(n) e^*(n) \quad \text{---- (17)}$$

where the NLMS algorithm reduces the step size 'μ' to make the large changes in the update weight vectors. This prevents the updated weight vectors from diverging and makes the algorithm more *stable and faster converging* than when a fixed step size is used like LMS. But when large number of array elements used, the convergence rate is really poorer.

IV. LMS SIMULATION AND ANALYSIS

LMS algorithm works as follows.

1. Take input parameters from User such as
 -Number of Array elements
 -Spacing $d(\lambda)$ between adjacent elements
 -Pilot signal (SOI) amplitude & direction
 -Amplitude & direction of Interference signal (SNOI)
 -Mean & variance of noise
 -Number of data samples
 -μ of LMS algorithm
 -AF threshold
2. To compute weight coefficient as

$$e(n) = d(n) - y(n)$$

$$w(n+1) = w(n) + \mu x(n) e^*(n)$$
3. To form signal SOI and SNOIs
4. To compute the array factor (AF) & generate output

$$y(n) = w^H x(n)$$

Simulations are made to analyze LMS.

TYPE (I)

As 'N' increases from N=8 to N=14 beam becomes 'sharp' at desired direction (30°) also 'Side-lobes diminishes' in interference direction (0° & 60°) which result in reduction in interference.

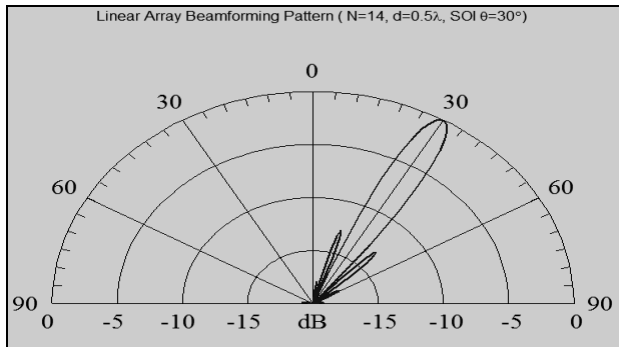
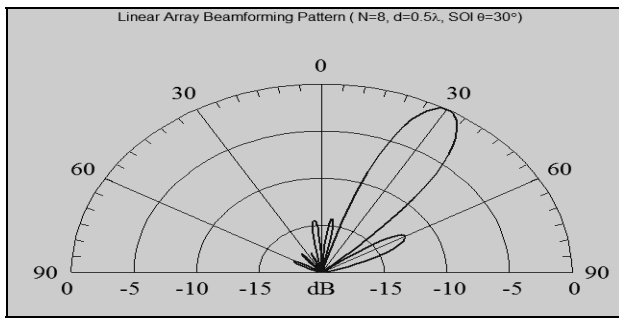
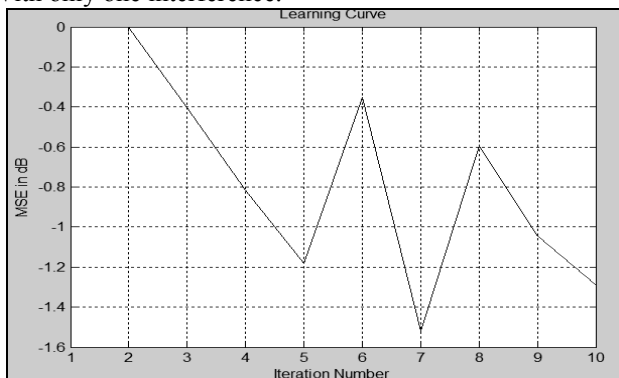


Fig.5 Beam sharpness.

TYPE (II)

As Number of Interfering signal increases more iteration are required to form beam.

With only one interference.



With three interferences(30°,60°,0°)

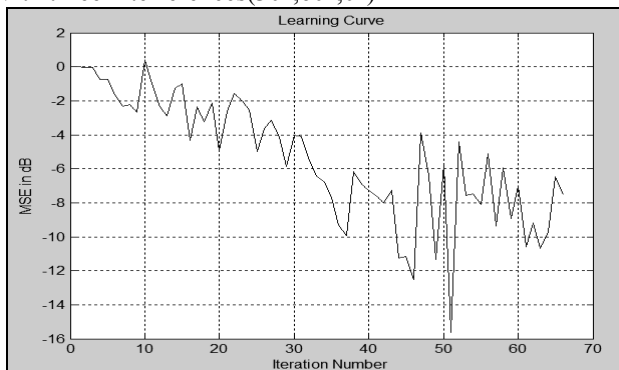
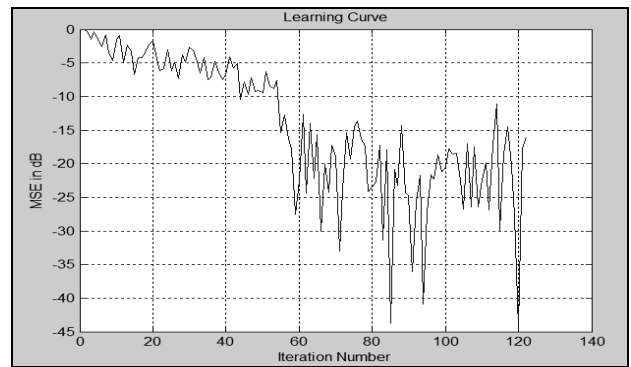
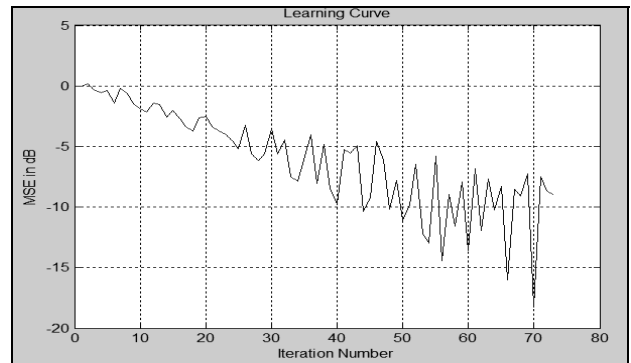


Fig.6 MSE by varying Number of Interferences

TYPE (III)

By decreasing ' μ ' beam forming become faster i.e. in less iteration.

MSE for $\mu = 0.002$ MSE for $\mu = 0.001$ Fig.7 Variation due to μ **V. CONCLUSION**

The LMS algorithm is the least demanding in computational complexity & produces exact beam shaped. But the LMS algorithm has a slow convergence rate. Moreover in all cases the step- size, governs the stability, convergence time and fluctuation of LMS adaption process. NLMS can be used to achieve stable calculation and faster convergence. For faster convergence RLS is preferred at cost of computational complexity.

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MODIFIED KOCH CURVE ANTENNA: ELECTRICALLY LARGE BUT PHYSICALLY SMALL PRINTED DIPOLE MULTIBAND FRACTAL

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ABSTRACT

The resonant frequency of a dipole antenna is an inverse function of the length. Hence it is difficult to embed a dipole antenna resonating at lower frequencies in a smaller area. This difficulty is being answered with the help of Koch fractal curve which is a highly convoluted curve and can be packed up in smaller areas. Modified Koch geometry is being used for achieving lowest possible resonating frequency without affecting the overall size of the dielectric slab. The paper also focuses on the radiation characteristics of the modified Koch curve dipole antenna. It has been observed that the antenna along with lower resonant frequency provides multiband due to its self-similar nature.

Keywords : Fractals, Iterative function systems (IFS), modified Koch curve, resonant length, etc.

I. INTRODUCTION

Microstrip dipole is a printed version of wire dipole antenna with width of antenna equal to the radius of the wire antenna [1]. Printed dipole antennas are famous amongst the low range wireless communication applications like Bluetooth, wireless sensor network nodes. It is also used in long range communication like mobile. Printed dipole is an attractive option for such applications because of its following advantages: planar geometrical construction, low profile, easily embeddable on the application PCB, ease of fabrication, light weight, low cost and easy handling [1]. But the printed dipole antenna persist almost all disadvantages of microstrip patch antenna [1]. Two parameters i.e. size of the antenna and the radiation efficiency are of great concern while designing an antenna for such applications. These constraints lead us to a new path way in designing antenna, which invoked new class of radiators that look very random and irregular but can be created in a deterministic manner. These radiators are called as fractal radiators [12].

Section II enlightens new class of geometrical shapes which are very irregular and random in nature. But their construction is very simple and deterministic. Section III describes the background of dipole antenna and motivation of study of fractal dipole antennas. While in section IV historical background of convoluted curve fractal omnidirectional antennas is discussed. The theory of fractal antennas is verified using simulations through FEM approximation method in section V. Finally observations and conclusion are discussed in section VI and VII respectively.

II. FRACTAL GEOMETRY

The baptism of fractals was done by a French mathematician B. B. Mandelbrot in the year 1975 at IBM labs, USA [2]. Fractal is a Latin adjective of fractus means to break: create irregular fragments [2]. Even though the birth of name fractal came into existence in 1975, Fractal geometrical structures have been studied far before this time. But until 1975 these curves were called as monstrous curves because they do not fit into the rules of classical geometry [2]. An object can be classified as fractal if it possess following properties: [2]

- Self-Similarity: Zooming into a Euclidean object gives more and more smoother curve. Whereas looking into fractal object repeats scaled copies of the whole object itself at very little scale. This repetitive self-copied property is called as self-similarity.
- Infinite Details: When a crooked curve is being analyzed using Euclidean geometrical rules, the smaller segment of the curve is analyzed and integrated over the end limits. But if at every smaller level of segment new details are reproduced then it becomes impossible to find the exact tangent to the curve and hence integration fails. This forms one of the basic properties of fractal object. That at every level of zoom we find new details.
- Discordant Dimension: Dimension is intuitively suggested as the freedom of motion. For example 3-Dimension means the object can feel the space in three directions. This also referred to as topological dimension. Fractal dimension was given by Hausdroff-Besicovitch in 1919.

Even though these curves look very crooked, irregular and random there is a deterministic way to develop such curves through predetermined function system called Iterative function system. These functions are applied on an initiator, which is nothing but a Euclidean geometrical such as a line, circle, square, triangle, etc. with certain rule (initiator) e.g. middle third cantor set. [2] The irregularity of the curve depends on iterative application of the rule. Figure 1 shows the flow chart of the process discussed above. Table 1 tabulates different geometrical structures with their initiators and generators. [2] The dimension of such curves is also the function of number of iterations applied.

Table 1: Iterative Function system procedure of generating fractal structures for various geometrical Euclidean structures.

Sr. No.	Geometry Name	Euclidean Geometry (Initiator)	Euclidean Geometry (Generator)	Iterative Function System (Rule of Generation)	Iteration 1	Fractal Geometry	Dimension of Fractal Geometry
1	Koch curve	Unit length Line 	Equilateral Triangle 	Erase middle one third region of line segment and replace it with open triangle			1.2619
2	Sierpinski Gasket	Unit area equilateral triangle 	Equilateral triangle 	Remove one third triangular area of unit triangle.			1.5850
3	Sierpinski Carpet	Unit area square 	Square 	Remove one third area of Unit square			1.893
4	Cantor Set	Unit Length Line 	Line 	Remove middle one third part			0.6309
5	Hilbert curve	Unit Square 	Line 	Divide the square in equal number of parts and draw line passing through each sub-square without repetition			1.87

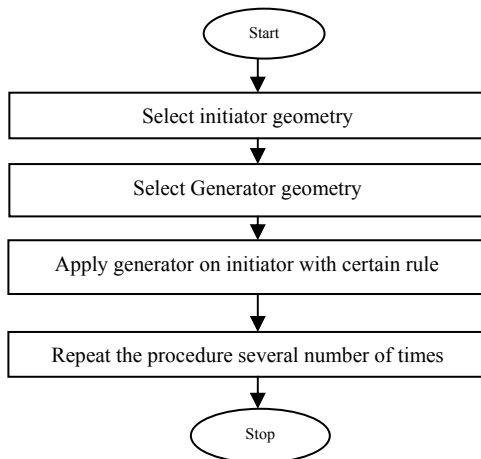


Figure 1. Flow chart of generation of fractal curves from Euclidean geometrical curves.

III. BACKGROUND OF PRINTED DIPOLE AND MOTIVATION OF STUDY

The printed microstrip patch antenna has a very narrow width as compared to the microstrip patch antenna [1]. The typical value of width of dipole antenna is $W < 0.05\lambda_0$ [1]. There are various techniques to feed a dipole antenna amongst coplanar feed technique is used very often [1]. In this literature we are using center feed antenna (figure 2), which is also a very popular feed configuration of dipole antenna [1]. The feed gap is insignificant, if it is smaller compared to the wavelengths [1].

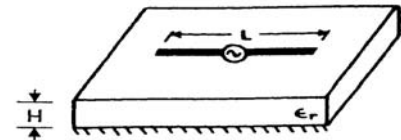


Figure2. Center Feed printed dipole antenna [1].

It should be noted that the only difference between the printed dipole and patch is the width to height ratio leading to compact size [1]. As a result microstrip dipole antenna finds applications in various areas. The resonant length of the dipole is given by equation (1) [1].

$$L = \frac{c}{2f_{TE} \sqrt{\epsilon_{eff}}} - 2\Delta l_{oc} \quad (1)$$

Where c is the velocity of light, ϵ_{eff} effective dielectric constant, Δl_{oc} is extended length due to open circuits; the length of the dipole element is also a function of width of the line, dielectric permittivity, and height of the substrate [1]. From equation (1) it is apparent that "the length of the dipole is an inverse function of frequency" and as the frequency decreases the length increases. This is the main motif of designing different shaped antennas. The length of the antenna cannot be increased arbitrarily even though it provides enhancement in the performance, because it can affect the size of the application device using this antenna. Another parameter which grabbed the attention of many researchers since long back is Q (quality factor) of such small antenna. This leads to another view as to how far can the size of the antenna be shrunk. The question arises because the antenna is used to

couple the energy from transmission line to free space and vice versa [5-9]. And since the waves in the free space are not shrinking with the size of antenna, the coupling efficiency degrades indicating the reactive behavior of antenna. The Q of the omnidirectional antenna derived in [5-6] gives its relation with the size of the antenna. The radiation efficiency of small antenna is depicted in [7].

IV. HISTORICAL BACKGROUND OF FRACTAL OMNIDIRECTIONAL ANTENNAS

The first traces of fractal radiators are observed in the year 1993-94 [10-12]. But the actual application of fractal geometry to wire antenna was first demonstrated and stated by N. Cohen [10]. He also proved that not only self complimentary structures produce frequency independent antennas but self similarity too produces frequency independent antenna [13]. The rigorous analysis of Koch monopole shows the relation between the iterative process of fractal curve generation and the antenna parameters [9]. Also various literatures are being produced in [10] which show the rigorous work in the development of fractal dipole and monopole antennas.

V. SIMULATION AND RESULT ANALYSIS

This section is split up into two parts first part defines the considerations and assumptions used for simulations and second part explains the results and behavior of modified Koch curve fractal antenna.

A. SIMULATION ASSUMPTION AND CONSIDERATION

The resonant frequency of classical Euclidean printed dipole antenna is considered from an unlicensed band i.e. ISM band which is 2.4GHz. This frequency is selected since many standard wireless applications use this frequency. The dipole antenna is center feed with a spacing of 2 mm between the arms. The width of the line is selected according to the criteria (typically $0.05\lambda_0 \geq w$) [1]. The resonant physical length of the antenna for 2.4 GHz is optimized to 2.1 cm which is PEC placed on a dielectric substrate of size 2cm x 6cm x 1.6mm. The detailed structure is shown in figure no. 3

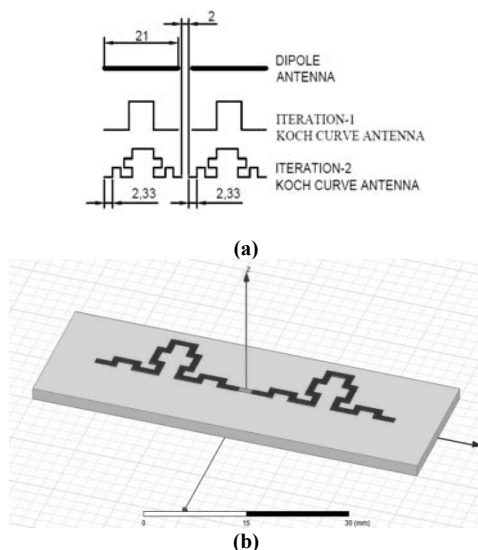


Figure 3 (a) Modified Koch curve generation mechanism with center feed dipole antenna coplanar structure. (b) Centre feed 2nd iteration modified Koch curve dipole antenna.

Figure 3 shows the geometrical structure of modified Koch curve. This structure is created using IFS system explained in section II. Here the generator and the initiator are straight lines. At each iteration the generator line is divided into three equal parts and the center part is replaced by four straight lines with a rule shown in figure 3 a. The final geometrical structure constructed in HFSSv10 is shown in figure 3 b. Figure 5 and 6 shows the impedance and radiation characteristics of the modified Koch dipole antenna with increasing iterations of curve.

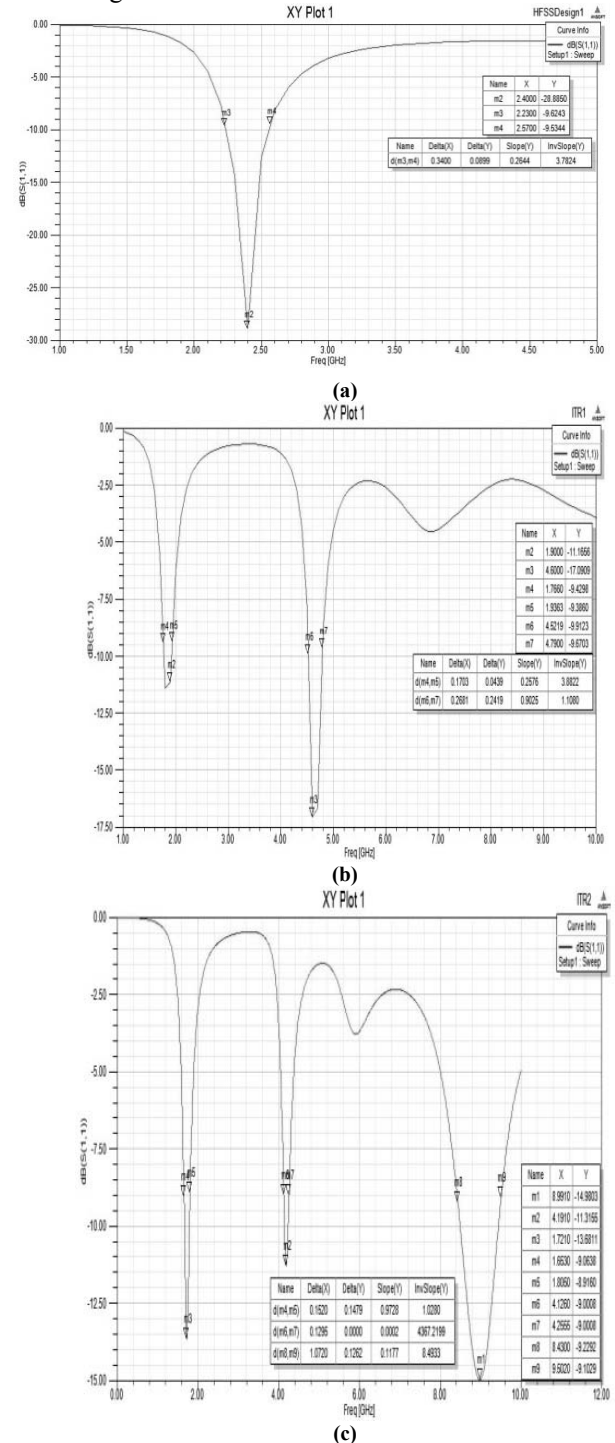


Figure 5 (a) S parameter (S11) of dipole antenna resonating at 2.4 GHz. (b) S-parameter (S11) of 1st iteration modified Koch curve dipole antenna resonating at two different frequencies viz. 1.9 GHz and 4.6 GHz. (c) S-parameter (S11) of 2nd iteration modified Koch curve dipole antenna resonating at three different frequencies viz. 1.7210GHz, 4.191GHz, and 8.991GHz.

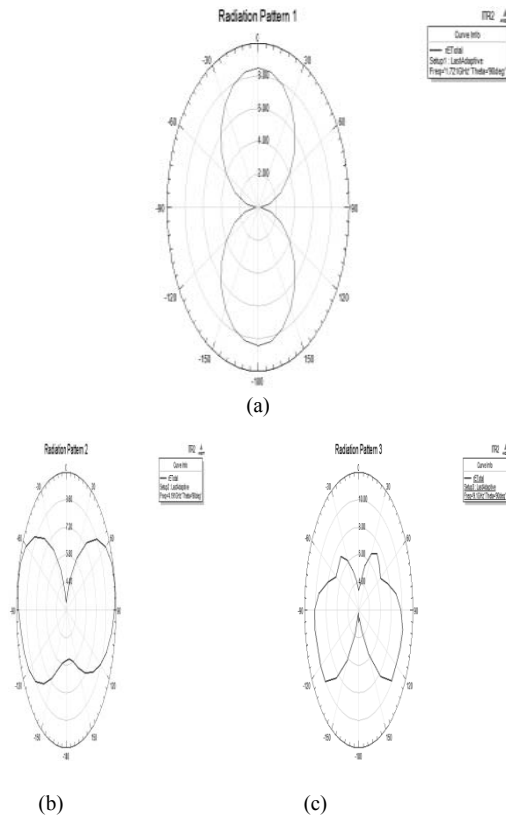


Figure 6(a) Radiation pattern of Euclidean dipole antenna with resonating frequency 1.7GHz. (b) Radiation pattern for resonating frequency 4.7GHz (c) Radiation pattern for resonating frequency 9.1GHz

Table 1 and 2 gives the brief comparison and also setup a relation between the performances of dipole antenna with number of iteration.

Table1. Resonant frequency characteristics of modified Koch curve dipole antenna.

Sr. No.	Order of curve	length of curve ($\lambda_g/4$)	Number of resonant frequencies	Resonant frequencies (GHz)	Min value of S11 at resonant frequencies in dB
1	0	2.1cm	1	2.4	-28.885
2	1	3.5 cm	2	1.9 4.6	-11.1656 -17.0909
3	2	4.89cm	3	1.71 4.191 8.99	-13.68 -11.31 -13.68

Table2. Far field radiation characteristics at different frequencies.

#	Freq. GHz	Gain in dB	Directivity in dB/ at angle in deg.	Pattern	Radiation Efficiency
1	2.4	2.1958 at 180°	2.1958 at 180°	Omni	0.97
2	1.9	1.109/180° 1.12/0°	1.440/180° 1.452/ 0°	Omni	0.9266

	4.6	-1.2418/180° 1.8004/ 70°	-0.425/180° 2.62/70°	Dir.	0.8273
3	1.72	0.916/180° 0.9823/360°	1.2118/180° 1.2781/360°	Omni	0.9342
	4.19	-2.58/180° 2.5354/80°	-1.56/180° 3.5571/80°	Dir.	0.7940
	8.99	-8.39/180° 2.6115/100°	0.15/180° 1.97/100°	Dir.	0.9251

B. RESULT ANALYSIS

The simulation results shows the benefits and drawbacks of using fractal structure for designing a microstrip dipole antenna. It can be seen that as the number of iterations increases the length of the dipole antenna increases. As the total length increases the frequency of resonance is shifted to the lower side of the spectrum according to equation 1. To achieve this frequency with normal Euclidean antenna the overall size of the complete structure has to be increased. Hence we can say that physically the fractal antenna is small with respect to the volume used by normal Euclidean shaped antenna.

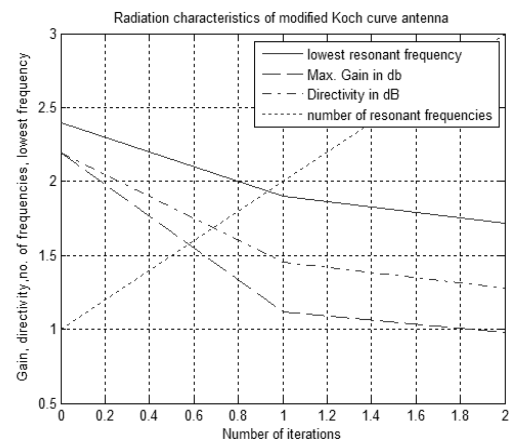


Figure 7 Graphical representations of effects on antenna parameters with change in no. of iteration.

The results also show that due to irregularities of the structure there are various sharp edges which helps in radiation. But as these edges are not at same length hence we achieve multiple bands due to the structural characteristic properties (Self-Similar) of fractal. These structure have drawn the attention of authors to a very special phenomena, which is portrait in figure 6 (b) and (c) it indicates the radiation pattern at different frequencies are different. Finally we would like to go through the drawbacks of the structure, simulations show that the reactive nature of the antenna at different resonance frequency is different and it is observed to be increasing making the antenna narrow band. Also the coupling of the EM energy is less in case of fractal structures.

VI. CONCLUSION

The above discussion can be concluded that the property of highly convoluted fractal curves can be used to produce electrically large but physically small dipole antenna. The results also show the advantages of having multiple bands and multi directionality properties of fractal structures. This phenomenon is very helpful in applications where multiple bands and various modes of directionality are of a major concern. The major drawback of this structure is the efficiency and bandwidth i.e. Q of the structure is high making the efficiency of antenna poorer, but tolerable for faithful radiation and energy coupling.

VII. FUTURE SCOPE OF WORK

The work is thoroughly done through simulations and further backing of practical results need to be performed. Also the multiple band and multi directionality phenomenon need to be modeled and rechecked with other configuration of Koch curve. The efficiency of the antenna degrades which is due to the increase in the length inductance hence further modifications in the geometry is required to compensate this access reactance; this is authors view and need to be verified.

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REVIEW OF BACKGROUND SUBTRACTION METHODS USED FOR MOVING OBJECT DETECTION

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ABSTRACT

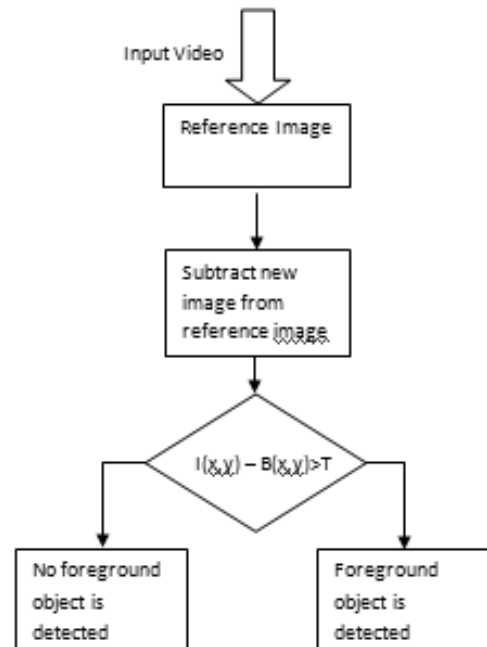
In many vision based application identifying moving objects is important and critical task. For different computer vision application Background subtraction is fast way to detect moving object. Background subtraction separates the foreground from background. Now days many methods are available for background subtraction. The core of background subtraction is background modeling. This paper is comparative study of several background subtraction methods. Comparison is based on type of background, speed, computational complexity and application requirement. This study will help which method is suitable for particular application. (Abstract)

Keywords : Background subtraction, Gaussian mixture model, Pixel based, Block based, Approximate median filter, Kernel density estimation.

I. INTRODUCTION

In many computer visions application background subtraction is fast way to detect moving object from video by static camera. Moving object detection applications are normally car detection, person identification or wild life monitoring. Therefore it is required that background subtraction method should be fast and simple. Background subtraction methods are divided into parametric and non parametric background subtraction. Background model is also classified as static or dynamic. Dynamic background model consist of moving background mostly in outdoor environment.

Any good background algorithm must have the following characteristics (1) should adapt to various levels of illuminations at different times of the day (2) It must handle different weather condition such as fog or snow that modified the background. (3) It must handle the moving objects that first merge into background and then become foreground at a later time. The basic idea behind background subtraction is to separate the foreground and background from incoming image. In the simple method like frame difference current frame is subtracted from reference image. If $| \text{frame } i - \text{background } i | > \text{threshold}$, then the pixel i is foreground. Although such techniques are very fast, the segmentation performance can be quite poor, especially with fluctuating illumination conditions. In order to manage the change in background several complex background methods have been developed.



II. BACKGROUND SUBTRACTION METHODS

Background subtraction techniques have to classify each pixel as part of foreground or background. If there is a too much variation in pixel value then it is considered as moving object. According to Cheung and Kamath [11] Background subtraction techniques are categorized as: 1) non-recursive and 2) recursive. Non recursive techniques are adaptive to scene changes depending on the buffer size. But for adapting slow moving objects or transient stop these techniques require large memory. Recursive technique do not require buffer. They try to update the background model recursively using either a single or multiple model(s) as each input frame is observed.

Non recursive technique :

A non-recursive technique uses a sliding-window approach for background estimation. It stores a buffer of the previous L video frames and estimates the background image based on the temporal variation of each pixel within the buffer.

Frame Difference Algorithm:

Frame differencing is the simplest method in Background subtraction. A background image without any moving objects of interest is taken as the reference image.

Pixel value for each co-ordinate (x, y) for each color channel of the background image is subtracted from the corresponding pixel value of the input image. If the resulting value is greater than a particular threshold value, then that is a foreground pixel otherwise background [6].

Median Filter :

Median filter is most widely used in many applications. Background estimation is done as the median of all the pixel value stored in the buffer. Here one assumption is made that the pixel stays in the background for more than half of the frames in the buffer.

Recursive technique

Recursive technique do not require buffer for background estimation. Compared with non-recursive techniques, recursive techniques require less storage.

Single Gaussian:

Many authors have modeled background pixel with probability density function learned over sequence of frames. Here with PDF thresholding a pixel with low probability is considered as foreground moving object. This algorithm requires t frames to estimate the mean μ and the standard deviation σ in each color component separately. After computing the parameters, a pixel is considered as a part of the foreground object based on the following formula:

$$|\mu(x,y,t) - p(x,y,t)| > c \cdot \sigma(x,y,t) \quad (1)$$

Where c is a constant. Even though this method is capable of adapting to indoor environments with gradual illumination changes, it's not able to handle moving background objects like trees, flags, etc.

Approximation Median algorithm:

In this method the output is difference of current pixel value and median of some recent pixel values. *AMF* apply the filtering procedure by simply incrementing the background model intensity by one, if the incoming intensity value (in the new input frame) is larger than the previous existing intensity in the background model. It uses a buffer of size n , where n is the number of last frames whose pixel values are considered for calculating the median value for background model. The algorithm is implemented without sub sampling frames for creating an adequate background model. Equation used is as follows. $|I(i,j,k) - \text{Med}(i,j,k)| > Th$ then it is classified as foreground. The median value is updated for last n recent pixel values. 'I' represents the current frame and 'Med' is the median of last n frames. For each pixel (i, j) , the difference of current frame pixel value with pixel value of median of last n frames decides whether it is foreground or background [11].

Mixture of Gaussian model:

The Mixture of Gaussians technique was first introduced by Stauffer and Grimson in [8]. This method represents each pixel of the scene by using a mixture of normal distributions to handle multimodal background images from video. In this method each pixel is modeled as mixture of k normal distribution. Values for k vary from 3 to 5.

This method uses a Gaussian probability density function to evaluate the pixel intensity value. It finds the difference of the current pixel's intensity value and cumulative average of the previous values. So it keeps a cumulative average (μ_t) of the recent pixel values. If the difference of the current image's pixel values and the cumulative pixel value is greater than the product of a constant value and standard deviation then it is classified as foreground. That is, at each t frame time, the I_t pixel's value can then be classified as foreground pixel if the inequality:

$$|I_t - \mu_t| > k \sigma \quad \text{holds;} \quad (2)$$

otherwise, it can be considered as background, where k is a constant and σ is standard deviation [8]

Here background is updated as the running average:

$$\mu_{t+1} = \mu_t * I_t + (1 - \alpha) * \mu_t \quad (3)$$

$$\sigma_{t+1}^2 = \alpha (I_t - \mu_t)^2 + (1 - \alpha) \sigma_t^2 \quad (4)$$

where α , the learning rate, is typically 0.05, I_t is the pixels current value and μ_t is the previous average.

Kernel Density Estimation:

An approximation of the background PDF can be given by the histogram of the most recent values classified as background values. However, as the number of samples is necessarily limited, such an approximation suffers from significant drawbacks: the histogram, as a step function, might provide poor modeling of the true, unknown PDF, with the "tails" of the true PDF often missing. In order to address such issues, Elgammal et al in [7] have proposed to model the background distribution by a non-parametric model based on Kernel Density Estimation (KDE) on the buffer of the last n background values. KDE guarantees a smoothed, continuous version of the histogram.

In [7], the background pdf is given as a sum of Gaussian kernels centered in the most recent n background values, x_i :

$$p(xt) = \frac{1}{n} \sum_{i=1}^n \eta(xt - x_i, \Sigma t) \quad (5)$$

Based on (5), classification of X , as foreground can be straightforwardly stated if $P(X_i) < T$.

Model update is obtained by simply updating the buffer of the background values in fifo order by selective update: in this way, "pollution" of the model (5) by foreground values is prevented.

QR Decomposition based algorithm:

Mahmood Amintoosi, Farzam Farbiz, Mahmood Fathy, Morteza Analoui, Naser Mozayani [3].proposed QR decomposition is method of linear algebra in which they split the image into small blocks and according to the R values they select the background blocks with the weakest contribution. This method can distinguish the foreground object from background object with the scene having moving object during initialization.

In this technique, N different blocks are obtained by splitting the input image frame. Now to identify the background part in image we apply QR decomposition method on each block .Consider the time series of intensity values of pixel (x_i, y_i) of block a at time t as follows:

TABLE I. Summary of all the methods

Methods	Basic Method	Single	Approximate	Gaussian	Kernel	QR	Pixel wise
Parameters	Frame Difference	Gaussian	Median Filter	Mixture model	density Estimation	Decomposition	local information based
Background Model	Static	Static	Static	Dynamic	Dynamic	Initialization with moving objects	NA
Robustness	Non Robust	Non Robust	Non Robust	Robust for illumination	Robust for illumination	NA	Robust
BGS Approach	Pixel based	Pixel based	Pixel based	Pixel based	Pixel based	Block based	Pixel based
Advantages	1 Simple 2 Fast speed 3 Less memory	1 Fast speed 2 Less memory	1 Fast speed 2 Increases stability of background model.	1 Accuracy 2 Handle multimodal background	1 Accuracy 2 Simple	Apply GMM only for Background	1 Detect closely moving cars And sudden illumination change
Disadvantage	Need continuously moving object	1 Light sensitive 2 No multimodal background	computation requires buffer with the recent pixel values	Computational-ly intensive	Memory requirement high (n * size(frame))	Effect with sudden illumination change	Selection of Gabor filters scales and orientation
Applications	1 Indoor 2 noise free static background	1 Indoor 2 Gradual illumination changes	1 Best for indoor 2 Real time application	1 Indoor / outdoor 2 low quality camera and in dark area	can use with low quality camera and in dark area	1 Outdoor application 2 Moving car detection	1 Highway video surveillance 2 Indoor application

Pixel wise local information based approach:

Zhong Wei, Shuqiang, Qingming Huang [4]. Proposed a new background subtraction method in which they use neighboring spatial distribution for each pixel. There are three problems that cannot be simultaneously solved by either method: the robustness to illumination changes, the effectiveness in suppressing shadows, and the smoothness of foreground's boundary. In order to solve these problems, here, Gabor filters are performed to extract the spatial feature vectors for each pixel from the source image sequence. Then, the spatial feature vectors are modeled by Gaussian Mixture Model, and then moving objects are detected.

Let $F(x, y)$ be the input image, its convolution with a Gabor filter $\phi_{u,v}(z)$ is defined as

$$G(x, y, u, v) = F(x, y) * \phi_{u,v}(z) \quad (9)$$

$$X_{i,1}, X_{i,2}, X_{i,3}, \dots, X_{i,t} \quad (6)$$

Now construct a matrix M for a^{th} block. QR decomposition of matrix M is given by:

$$M\pi = QR \quad (7)$$

Where π = Permutation matrix Q = orthogonal matrix R = upper triangular method.

The diagonal values of matrix R is called R - values which are in decreasing order. The R -values of background data will be smaller than moving object [2]. Suppose the intensity values of i^{th} pixel at a^{th} block $\{X_{i,1}^a, X_{i,2}^a, \dots, X_{i,t}^a\}$ which are in sorted order according to R -values, where $\{f_1, f_2, \dots, f_t\}$ is ordered frame number indices. We consider according to R values.

$$P(B|X_{i,j}^a) = 1, \quad \text{if } j > (1-\alpha) \\ 0 \quad \text{otherwise} \quad (8)$$

α shows the percentage of blocks belongs to background[8].

where $*$ denotes the convolution operator. Gabor filters with m scales $v = \{0, 1, \dots, m-1\}$ and n orientations $\mu = \{0, 1, \dots, n-1\}$ are used. Convolving the image with each of the $m \times n$ Gabor filters can generate Gabor features. Thus spatial feature vector for pixel (x, y) can be generated as follows:

$$SFV(x, y) = (G(x, y, 0, 0), \dots, G(x, y, 0, m-1), G(x, y, 1, 0), \dots, G(x, y, n-1, m-1))^T \quad (10)$$

where $SFV(x, y)$ means the spatial feature vector for pixel (x, y) in one frame. Thus each pixel is spatially described[8].

Block based background subtraction:

Dorra Riahi, Pier-Luc St-Onge and Guillaume-Alexandre Bilodeau [5] proposed background subtraction technique based on blocks of image.

The reference image is divided into blocks of size $N \times M$ depending on the image ratio. For each block, a color histogram (64 bins for each RGB channel) and the variance of the pixels of the block are calculated. These two statistical measures captures the statistics of the pixels in the blocks and thus of the background. $N \times M$ blocks are then grouped together and their statistics are merged until a minimum number R_c (user defined) of blocks are obtained. Four blocks at the finest scale gives one block at the next scale, and so on. This gives background image B_R . The background is updated by substituting blocks that are labeled as background during motion detection.

Consider I_r is new frame and the background image B_R . The corresponding blocks in I_r and B_R at the coarsest scale are first compared. And only if they are different, blocks at a finer scale are compared and so on until the finest scale is reached. Blocks are compared using the color histograms and their variance. For each block of I_r and B_R , their histograms H_M and H_I , respectively, are compared using the MDPA (Mean distance of pair assignment) distance SH . Two histograms are similar if SH is less than a threshold T . where T is threshold value change for each scale.

A pixel is part of the foreground if:

$$|X_t - \mu_t| > T_g \sigma_t \quad (11)$$

Where σ_t is the variance and T_g is a threshold [8].

III. LIMITATIONS AND FUTURE WORK

Numerous BGS algorithms have been proposed. Since it is only practical to evaluate a small subset of these, we have selected state-of-the-art algorithms that cover a range of popular methodologies. We plan to extend our comparative study to include other methodologies in the future. A thoughtful reviewer has also indicated that a statistical test, such as McNemar's test, could be used to determine if the performance between BGS algorithms or post processing stages is significant. A diverse set of video sequences for comparing BGS algorithms has not been established. We overcome this by performing our comparative study on a collection of previously used test sets [1, 9]. Nevertheless, the BGS community would benefit from establishing a standard test set which demonstrates canonical problems and facilitates easy quantitative comparisons. Such a test set would also allow parameter values to be determined in a more structured manner (e.g., cross-validation).

All the considered post-processing techniques have a computational complexity that is linear in the number of foreground pixels. This suggests that applying techniques which remove significant numbers of false positive foreground pixels at low computational cost should be applied early in order to reduce the overall computational complexity of the pipeline. The post-processing pipeline we propose reflects this insight and significantly improves the quality of foreground masks.

IV. CONCLUSION

After studying various methods from the literature results indicate that critical tradeoffs are always present between the accuracy of estimated background model and the real time performance of the method. The choice of algorithm for background modelling should be made according to the required application. For instance if it is desired to monitor an indoor scene environment, one of the most suitable choices would be the Approximated Median Filtering, however, the same algorithm is not a proper choice when we have to use it for outdoor surveillance. Mixture of Gaussian Model is one of the most reliable background estimation methods in the literature because of its capability of handling multi-modal background scenes. However, these kinds of algorithms fail in the case of illumination changes and transient stops of moving objects. Histogram based approaches seemed to be robust to transient stops but they are still too sensitive to illumination changes and required larger storage spaces. Each of above mentioned techniques has its own merits and demerits. Table shows the comparative analysis of reviewed techniques based on some parameters. This paper will help the newcomers to choose the appropriate technique to their research work.

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IMAGE DENOISING BY INDEPENDENT COMPONENT ANALYSIS (ICA)

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ABSTRACT

Visual information transmitted in the form of digital images is becoming a major method of communication in the modern age, but the image obtained after transmission is often corrupted with noise. The images usually bring different kinds of noises in process of receiving, coding and transmission. Removing noise from digital images is a big challenge for researchers. The received image needs processing before it can be used in applications. Denoising of natural images is the fundamental and challenging research problem of Image processing. This problem appears to be very simple however that is not so when considered under practical situations, where the type of noise, amount of noise and the type of images all are variable parameters, and the single algorithm or approach can never be sufficient to achieve satisfactory results. Independent Component Analysis (ICA) is a higher order statistical tool for the analysis of multidimensional data with inherent data adaptiveness property. The noise is considered as Gaussian random variable and the image data is considered as non-Gaussian random variable. Specifically the Natural images are considered for research as they provide the basic knowledge for understanding and modelling of human vision system and development of computer vision systems.

Index Terms : Denoising techniques, Median filter, Independent component analysis

I. INTRODUCTION

A very large portion of digital image processing is devoted to image restoration. This includes research in algorithm development and routine goal oriented image processing. Image restoration is the removal or reduction of degradations that are incurred while the image is being obtained. Degradation comes from blurring as well as noise due to electronic and photometric sources. A noise is introduced in the transmission medium due to a noisy channel, errors during the measurement process and during quantization of the data for digital storage. Image denoising is often used in the field of photography or publishing where an image was somehow degraded but needs to be improved before it can be printed. For this type of application we need to know something about the degradation process in order to develop a model for it. When we have a model for the degradation process, the inverse process can be applied to the image to restore it back to the original form. Image denoising finds applications in fields such as astronomy where the resolution limitations are severe, in medical imaging where the physical requirements for 2 high

II. DENOISING AND TECHNIQUES

Various denoising techniques have been proposed so far and their application depends upon the type of image and noise present in the image. Image denoising is classified in two categories:

1. Spatial domain filtering:

This is the traditional way to remove the noise from the digital images to employ the spatial filters. Spatial domain filtering is further classified into linear filters and non-linear filters.

A. Linear Filters

A mean filter is the optimal linear for Gaussian noise in the sense of mean square error. Linear filters tend to blur sharp edges, destroy lines and other fine details of image. It includes Mean filter and Wiener filter.

B. Non- Linear Filters

With the non-linear filter, noise is removed without any attempts to explicitly identify it. Spatial filters employ a low pass filtering on the group of pixels with the assumption that noise occupies the higher region of frequency spectrum. Median filter is the non-linear filter.

2. Transform domain filtering

The transform domain filtering can be subdivided into data adaptive and non-data adaptive filters. Transform domain mainly includes wavelet based filtering techniques which is non-data adaptive

A. Wavelet Transform

Filtering operations in the wavelet domain can be subdivided into linear and nonlinear methods.

a. Linear Filters

Linear filters such as Wiener filter in the wavelet domain yield optimal results when the signal corruption can be modelled as a Gaussian process and the accuracy criterion is the mean square error (MSE).

b. Non-Linear Filters

The most investigated domain in denoising using Wavelet Transform is the non-linear coefficient thresholding based methods. The procedure exploits sparsity property of the wavelet transform and the fact that the Wavelet Transform maps white noise in the signal domain to white noise in the transform domain.

3. Data-Adaptive Transforms

Recently a new method called Independent Component Analysis (ICA) has gained wide spread attention. The ICA method was successfully implemented in denoising Non-Gaussian data. One exceptional merit of using ICA is it's assumption of signal to be Non-Gaussian which helps to denoise images with Non-Gaussian as well as Gaussian distribution.

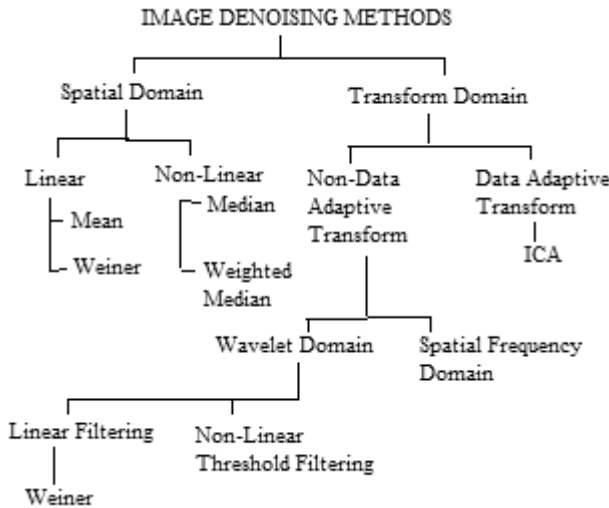


Fig. 1. Image denoising methods

III. ICA MODEL

1. System Model:

In case of image denoising methods, the characteristics of the degrading system and the noises are assumed to be known. The image $s(x, y)$ is blurred by a linear operation and noise $n(x, y)$ is added to form the degraded image $w(x, y)$. This is convolved with the restoration procedure $g(x, y)$ to produce the restored image $z(x, y)$.

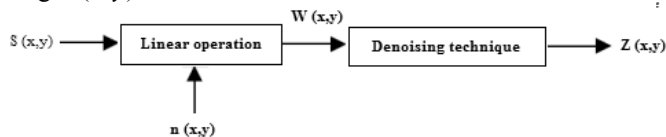


Fig. 2 Denoising concept

The "Linear operation" shown in Figure 2 is the addition or multiplication of the noise $n(x, y)$ to the signal $s(x, y)$. Once the corrupted image $w(x, y)$ is obtained, it is subjected to the denoising technique to get the denoised image $z(x, y)$.

2. Proposed Method:

• Independent Component Analysis (ICA) Model :

Let us denote by x the random vector whose elements are the mixtures $x_1, \dots, x_n$, and likewise by S the random vector with elements $s_1, \dots, s_n$. Let us denote by A the matrix with elements a_{ij} . Generally, bold lower case letters indicate vectors and bold upper-case letters denote matrices.

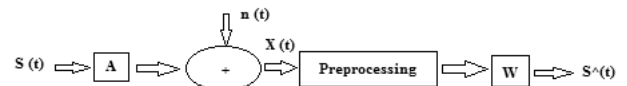


Fig. 3. The ICA model

All vectors are understood as column vectors; thus x^T , or the transpose of x , is a row vector. Using this vector-matrix notation, the above mixing model is written as

$$x = As + n \quad (1)$$

Sometimes we need the columns of matrix A ; denoting them by a_j the model can also be written as

$$x = \sum_{j=1}^n a_j s_j \quad (2)$$

The statistical model in Eq. (1) is called independent component analysis, or ICA model. The ICA model is a generative model, which means that it describes how the observed data are generated by a process of mixing the components s_j . Also the mixing matrix is assumed to be unknown. All we observe is the random vector x , and we must estimate both A and s using it. This must be done under as general assumptions as possible.

The starting point for ICA is the very simple assumption that the components s_j are statistically *independent*. It will be seen below that we must also assume that the independent component must have *non gaussian* distributions. For simplicity, we are also assuming that the unknown mixing matrix is square. Then, after estimating the matrix A , we can compute its inverse, say W , and obtain the independent component simply by:

$$s = Wx \quad (3)$$

A 'source' means here an original signal, i.e. independent component.

IV. RESULTS

1. Salt and Pepper noise added with cameraman image at different variance (σ) and denoised using median filter, the results are shown in fig. below.



Fig. 4. Original image



Fig. 5(a). Cameraman ($\sigma = 0.01$)



Fig. 5(b). Filter image



Fig.5(c). Median filtered image



Fig. 6(a). Cameraman ($\sigma = 0.03$)



Fig. 6(b). Filter image

Fig. 6(c). Median filtered image Fig. 7(a). Cameraman ($\sigma=0.06$)

Fig. 7(b). Filter image



Fig. 7(c). Median filtered image

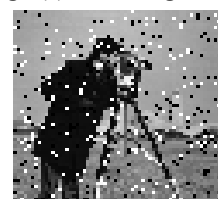
Fig. 8(a). Cameraman ($\sigma=0.09$)

Fig. 8(b). Filter image

Fig. 8(c). Median filtered image Fig. 9(a). Cameraman ($\sigma=0.12$)

Fig. 9(b). Filter image

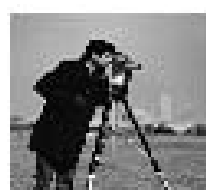


Fig. 9(c). Median filtered image

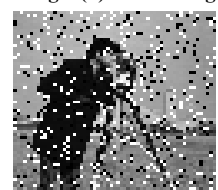
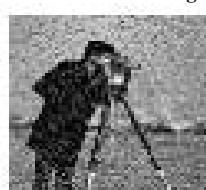
Fig. 10(a). Cameraman ($\sigma=0.12$)

Fig. 10(b). Filter image

Fig. 10(c). Median filtered image Fig. 11(a). Cameraman ($\sigma=0.2$)

Fig. 11(b). Filter image



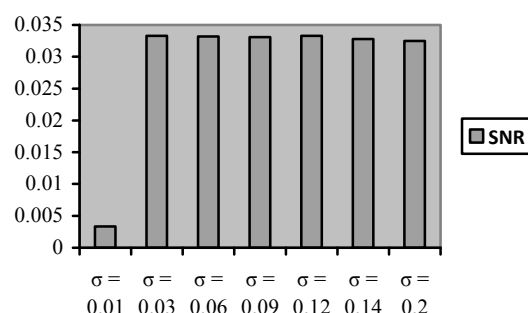
Fig. 11(c). Median filtered image

Salt and pepper noise added to the image (cameraman.tif) at different variance ($\square$) then different image quality measurement parameters are calculated which is shown in table below.

Table 1. Image quality parameters at various σ

Variance($\square$)	MSE	PSNR	MAE	SNR	SSIM
$\square = 0.01$	237.851	24.3678	118.1581	0.0334	0.0101
$\square = 0.03$	237.851	24.3678	118.1599	0.0333	0.0103
$\square = 0.06$	237.851	24.3678	118.161	0.0332	0.0106
$\square = 0.09$	237.8506	24.3678	118.1627	0.0331	0.0109
$\square = 0.12$	237.8495	24.3678	118.1664	0.0333	0.0111
$\square = 0.14$	237.8503	24.3678	118.1691	0.0328	0.0112
$\square = 0.2$	237.8454	24.3679	118.1846	0.0325	0.0118

Salt & pepper noise added to the same image (cameraman.tif) then SNR is calculated at various variance ($\square$) and plotted which is shown in fig. 12. below.

Fig. 12. SNR V/s Variance (σ)

- Gaussian noise added to the same image (cameraman.tif) at different variance ($\square$) and denoised using median filter, the results are shown in fig. below.

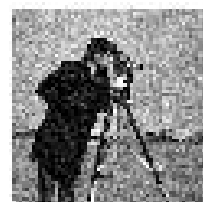
Fig. 13(a) Cameraman ($\sigma=0.02$)

Fig. 13(b). Filter image



Fig. 13(c). Median filtered image

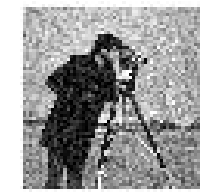
Fig. 14(a) Cameraman ($\sigma=0.06$)



Fig. 14(b). Filter image



Fig.14(c). Median filtered image

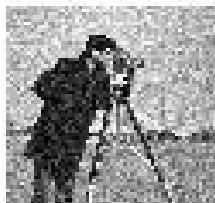
Fig. 15(a) Cameraman ($\sigma = 0.1$)

Fig. 15(b). Filter image



Fig.15(c).Median filtered image

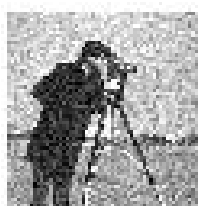
Fig.16(a). Cameraman ($\sigma=0.14$)

Fig.16(b). Filter image



Fig.16(c). Median filtered image

Fig. 17(a) Cameraman ($\sigma = 0.2$)

Fig.17(c).Median filtered image

Fig.18(a) Cameraman ($\sigma=0.24$)

Fig.19(b). Filter image



Fig.19(c). Median filtered image

Fig. 20(a) Cameraman ($\sigma = 0.3$)

Fig. 20(b). Filter image



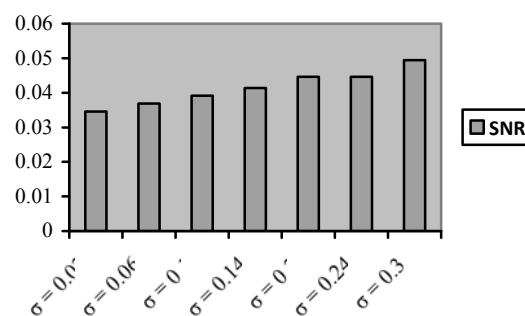
Fig.20(c). Median filtered image

Gaussian noise added to the image (cameraman.tif) at different variance (σ) then different image quality measurement parameters are calculated which is shown in table below.

Table 2. Image Quality parameters at various σ

Variance(σ)	MSE	PSNR	MAE	SNR	SSIM
$\sigma = 0.02$	237.851	24.3678	118.1199	0.0346	0.0109
$\sigma = 0.06$	237.851	24.3678	118.0591	0.0369	0.0118
$\sigma = 0.1$	237.8497	24.3678	118.0223	0.0391	0.0127
$\sigma = 0.14$	237.8492	24.3678	117.999	0.0414	0.0138
$\sigma = 0.2$	237.8452	24.3679	117.9777	0.0446	0.0153
$\sigma = 0.24$	237.8284	24.3682	117.9649	0.0446	0.0164
$\sigma = 0.3$	237.7713	24.3692	117.9414	0.0494	0.0179

Salt & pepper noise added to the same image (cameraman.tif) then SNR is calculated at various variance (σ) and plotted which is shown in fig. 21. below.

Fig. 21. SNR V/s Variance(σ)

3. Salt and Pepper noise added to the image (cameraman.tif) at different variance ($\square$) and denoised using ICA method then results of that images are shown in figures below.



Fig.22. Original image

Fig. 23(a)
Cameraman ($\sigma = 0.01$)Fig. 23(b)
Output ICAFig. 24(a)
Cameraman ($\sigma = 0.02$)Fig. 24(b)
Output ICAFig. 25(a)
Cameraman ($\sigma = 0.06$)Fig. 25(b)
Output ICAFig. 26(a)
Cameraman ($\sigma = 0.09$)Fig. 26(b)
Output ICAFig. 27(a)
($\sigma = 0.12$)Fig. 27(b) Cameraman
Output ICAFig. 28(a)
Cameraman ($\sigma = 0.14$)Fig. 28(b)
Output ICAFig. 29(a) Cameraman ($\sigma = 0.2$)

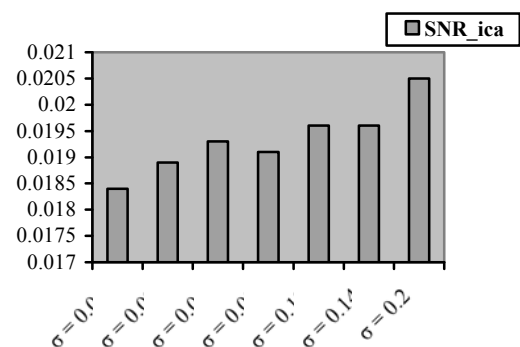
Fig. 29(b) Output ICA

By changing the variance different results of image quality parameters which are given in table below.

Table.3. Different image quality parameters at various σ

Variance ($\square$)	MSE_ica	PSNR_ica	MAE_ica	SNR_ica	SSIM_ica
$\square = 0.01$	237.851	24.3678	118.6781	0.0184	0.0096
$\square = 0.03$	237.8506	24.3678	118.666	0.0189	0.0099
$\square = 0.06$	237.8469	24.3678	118.6536	0.0193	0.0103
$\square = 0.09$	237.8464	24.3678	118.6469	0.0191	0.0103
$\square = 0.12$	237.836	24.368	118.6373	0.0196	0.011
$\square = 0.14$	237.8332	24.3681	118.6397	0.0196	0.0112
$\square = 0.2$	237.7826	24.369	118.6124	0.0205	0.012

The salt & pepper noise added to the same image then SNR_ica is plotted at different variance ($\square$) which is shown in fig.30 below.

Fig.30. SNR_ica V/s Variance (σ)

4. Gaussian noise added to the same image (cameraman.tif) at different variance (σ) then denoised images by using ICA method, the results are shown in figures below.



Fig. 31(a)
Cameraman ($\sigma = 0.02$)



Fig. 31(b)
Output ICA



Fig. 32(a)
Cameraman ($\sigma = 0.06$)



Fig. 32(b)
Output ICA



Fig. 33(a)
Cameraman ($\sigma = 0.1$)



Fig. 33(b)
Output ICA



Fig. 34(a)
Cameraman ($\sigma = 0.14$)



Fig. 34(b)
Output ICA



Fig. 35(a)
Cameraman ($\sigma = 0.2$)



Fig. 35(b)
Output ICA



Fig. 36(a)
Cameraman ($\sigma = 0.24$)



Fig. 36(b)
Output ICA



Fig. 37(a) ($\sigma = 0.3$)



Fig. 37(b) Cameraman Output ICA

By changing the variance different results of image quality parameters calculated which are given in table below.

Table 4. Different Image Quality Parameters at Various σ

Variance (σ)	MSE_ica	PSNR_ica	MAE_ica	SNR_ica	SSIM_ica
$\sigma = 0.02$	237.851	24.3678	118.6327	0.0192	0.0097
$\sigma = 0.06$	237.851	24.3678	118.6003	0.0199	0.0096
$\sigma = 0.1$	237.851	24.3678	118.5727	0.0211	0.01
$\sigma = 0.14$	237.851	24.3678	118.5368	0.0221	0.0103
$\sigma = 0.2$	237.851	24.3678	118.432	0.0251	0.0105
$\sigma = 0.24$	237.851	24.3678	118.3687	0.0278	0.0109
$\sigma = 0.3$	237.851	24.3678	118.3145	0.0301	0.0111

The gaussian noise added to the same image then denoised images by using ICA method and calculated SNR_ica at different variance (σ) which is plotted shown in fig.38 below.

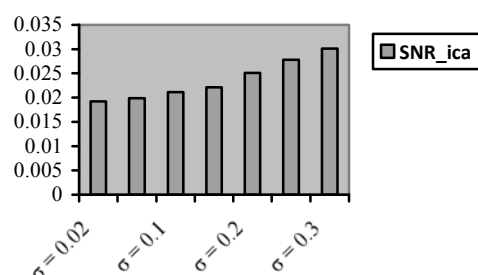


Fig.38. SNR_ica V/s Variance (σ)

V. CONCLUSION

In this paper different noises added to the original images and denoised using median filter and ICA method. Comparison of SNR, SNR_ica at different variances are given to measure image quality. Degraded images recovered by using image denoising technique i.e. ICA implemented and compared with median filter.

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DIGITAL WATERMARKING USING SPATIAL AND FREQUENCY DOMAIN

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ABSTRACT

Digital Watermarking is a technique in which an individual can add hidden messages to digital image, video or audio signals and documents. In our proposal, for Audio Watermarking, a watermark is encrypted using RSA Algorithm and is embedded using LSB substitution technique. For Image Watermarking, DCT and DWT techniques have been implemented. The performance was evaluated using parameters such as MSE and PSNR for both audio and image watermarking.

Keywords: Audio Watermarking, Image watermarking, RSA algorithm, LSB substitution, DCT technique, DWT technique, MSE and PSNR.

I. INTRODUCTION

Digital watermarking is a technique in which a secret message can be hidden in a digital file without the detection of the user. Watermark information is primarily used to identify the owner of a digital file, i.e. a picture, a song, or text. In digital watermarking an indiscernible signal “mark” is embedded into the host image, which uniquely identifies the ownership. After embedding the watermark, there should be no perceptual degradation in the host file. The unauthorized person should not be able to detect or expunge the watermark intentionally. The decoder needs to correlate the extracted watermark with original file and if the correlation matches a predefined threshold value then the watermark is detected. Watermarking is an exciting field and there is scope for researchers to do pioneering work. Watermarking can be used by entertainment companies, museums and libraries because it helps in protecting the multimedia data from piracy[1]. The proposed techniques are for invisible watermarking and designed to exploit some aspects of the human auditory system and human visual system[2]. Watermark can also be used for copyright protection.

II. AUDIO WATERMARKING

Audio Watermarking is a kind of digital watermarking in which a marker is embedded in an audio signal typically to identify ownership of audio. Digital audio watermarking involves the concealment of data within a discrete audio file[3].

The proposed technique is Least Significant Bit (LSB) Manipulation. Here, we are embedding the encrypted text in the audio file. The text is encrypted using RSA algorithm to increase the security and make the watermark robust to attacks.

2.1 Encryption using RSA algorithm

RSA algorithm is a Public Key Cryptosystem. It involves a public key and a private key. The public key can be known to everyone and is used for encrypting messages. Messages encrypted with the public key can only be decrypted using the private key. This algorithm does not require the distribution of the secret key prior to the establishment of communication as in the case of Private Key Cryptosystems[3]. The private key is known only to intended users. This reduces possibility of attacks further.

2.1.1. Algorithm

- Choose any two prime numbers p and q .
- Compute $n = p * q$.
- Compute $\phi(n) = (p - 1) * (q - 1)$. $\phi(n)$ is called the Euler's totient.
- Choose e such that $1 < e < \phi(n)$ and e and ϕ are co-prime.
- Compute a value for d such that $(d * e) \% \phi(n) = 1$.
- Public Key is (e, n) .
- Private Key is (d, n) .
- The encryption of m is $c = m^e \bmod n$.
- The decryption of c is $m = c^d \bmod n$ [3].

2.2 LSB Technique

The Least Significant Bit (LSB) substitution is the most straight-forward method of watermark embedding. In this technique the watermark signal is embedded directly into the least significant bits of the host object. In this technique of LSB manipulation a huge amount of data can be embedded without much impact on the host audio file[1].

2.3 Watermark Embedding

The watermark used is a text. This text to be embedded is first encrypted using RSA algorithm. Public key (e, n) is used for the encryption.

This encrypted text is embedded in an audio file using LSB substitution technique. The audio file is converted into 16 bit binary and then LSB substitution is carried out. The resultant is the watermarked audio file. This audio file is played to check for any perceptual differences between the original audio file and watermarked audio file. If this watermarked audio is very much similar to the original audio then the watermarked audio is acceptable[1].

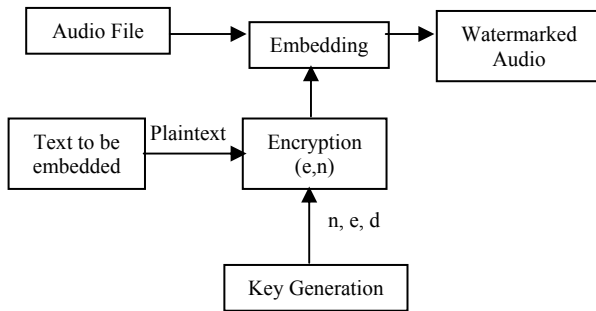


Fig. 1 Audio Watermark Embedding[1]

2.4 Watermark Extraction

The watermarked audio file is passed through an extraction algorithm in which the LSBs are extracted from the watermarked audio file to get back the ciphertext. This ciphertext is then decrypted using RSA algorithm. The private key (d,n) is used. If the decrypted text matches the original text then the watermark is considered to be unchanged[1].

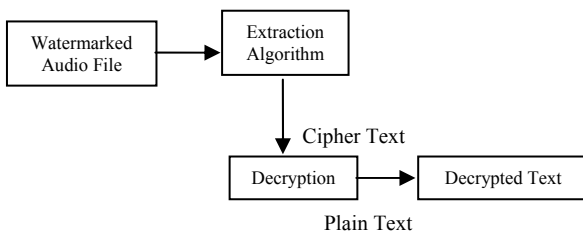


Fig. 2 Audio Watermark Extraction[1]

III. IMAGE WATERMARKING

Digital Image Watermarking can be defined as a process of embedding information in a certain digital image that acts as a host or cover signal. The owner of the multimedia object can be revealed from the watermark which can be considered as a kind of signature in the host signal. There are various methods used for image watermarking. They are classified into spatial domain and frequency domain. Spatial domain include LSB substitution and frequency domain includes Discrete Cosine Transform (DCT), Discrete Wavelet Transform (DWT), and Discrete Fourier Transform (DFT) etc. The techniques proposed are DCT and DWT.

3.1 Discrete Cosine Transform

DCT being a real transform, transforms real data into real spectrum and therefore avoids the difficulty of redundancy. The two-dimensional DCT is used in digital image processing. For an image of size NxN, the DCT of the image is defined as[1]:

$$F(u,v) = \sum_{n=0}^{N-1} \sum_{m=0}^{N-1} C(u)C(v)f(n,m) \cos\left[\frac{\pi(2n+1)u}{2N}\right] \cos\left[\frac{\pi(2m+1)v}{2N}\right] \quad (1)$$

And the inverse DCT is given as:

$$f(n,m) = \sum_{u=0}^{N-1} \sum_{v=0}^{N-1} C(u)C(v)F(u,v) \cos\left[\frac{\pi(2n+1)u}{2N}\right] \cos\left[\frac{\pi(2m+1)v}{2N}\right] \quad (2)$$

where,

$$C(u)C(v) = \begin{cases} \sqrt{1/N}, & u,v = 0 \\ \sqrt{2/N}, & u,v = 1,2,\dots,N-1 \end{cases} \quad (3) [4]$$

where F(u,v) is the DCT coefficient of the image.

3.1.1 Algorithm

- Select the image in which watermark is to be embedded.
- Separate the R,G and B frames.
- Divide each frame into 8x8 blocks.
- Take DCT for each block and embed the watermark coefficient.
- Take inverse DCT of watermarked coefficients.
- Extract the watermark from the watermarked image.
- Determine the performance measures such as MSE and PSNR.

3.1.2 Block Diagram

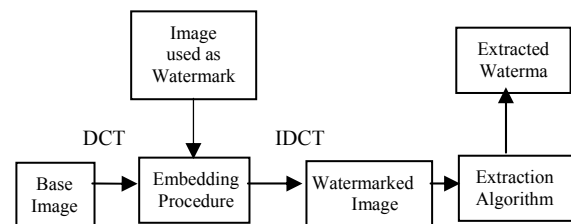


Fig. 3 Image Watermarking[2]

3.2. Discrete Wavelet Transform

Wavelets are functions that satisfy certain mathematical requirements and are used in representing data or other functions. DWT has an advantage over other transforms that it captures both frequency and location information (location in time). Wavelet transform uses wavelets as basis and is a tool that cuts up data or functions or operation into different frequency components, and then studies each component with a resolution matched to its scale. The original image is decomposed by the low pass (LP) and high pass (HP) filters followed by down sampling first of rows and then of columns.

The result of wavelet decomposition is approximation of original image and three detail signals(horizontal, vertical and diagonal). Process of wavelet decomposition can be expressed in the following form[4]:

$$cI_j = cI_{j+1} + cD_{j+1}^{(H)} + cD_{j+1}^{(V)} + cD_{j+1}^{(D)} \quad (4)[4]$$

The next step is decomposition of cI_{j+1} and so on. Discrete Wavelet Transformation is very appropriate to identify the areas in the cover image where a secret image can be embedded effectively. This property allows the exploitation of the masking effect of the human visual system such that if a DWT co-efficient is modified, it modifies only the region corresponding to that coefficient. The embedding watermark in the lower frequency sub-bands may degrade the image as generally most of the Image energy is stored in these sub-bands. However it is more robust. The high frequency part contains information about the edge of the image so these frequency sub-bands are usually used for watermarking since the human eye is less sensitive to changes in edges[4].

3.2.1. Algorithm

- Read the desired base image and the image to be watermarked.
- Resize both these images to a fixed and equal size.
- Separate the R, G and B frames of both base image and the watermark.
- Take DWT of the base image. This decomposes the base image into sub-bands ca , ch , cv and cd . Take DWT of ca coefficient.
- Calculate the new sub-bands by embedding the watermarked coefficient into the desired sub-band.
- Take inverse dwt to get the watermarked image.
- To extract the watermark calculate the dwt of the watermarked image and subtract the sub-bands of original image from the sub-bands of the watermarked image to retrieve the watermark.
- Determine the performance parameters like MSE and PSNR.

3.2.2. Block Diagram

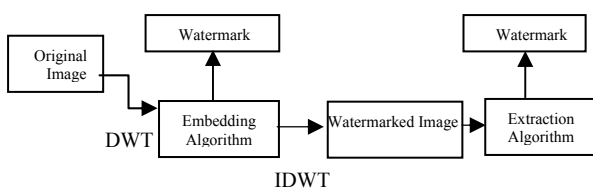


Fig. 4 : Image Watermarking using DWT

IV. PERFORMANCE MEASURES

The performance of various watermarking techniques can be assessed using various techniques. Evaluating the Mean Square Error (MSE) and the Peak Signal to Noise Ratio (PSNR) the original and watermarked files can be compared. MSE is a technique in which the similarity between files is calculated. Ideally MSE should be zero. PSNR is a better measure since the signal strength is considered and not just the error. PSNR should be as high as possible. MSE is given by,

$$MSE = \frac{1}{n} \sum_{i=1}^n (X_i - X_i^*)^2 \quad (5)$$

where X_i is the original file, X_i^* is the watermarked file and n is the length of the file. PSNR is given by,

$$PSNR = 10 \cdot \log_{10} \left(\frac{MAX^2}{MSE} \right) \quad (6)$$

where MAX^2 is the maximum value of the watermarked file (i.e. the maximum pixel value of the watermarked file).

V. EXPERIMENTAL RESULTS

The following results have been obtained using MATLAB 7 software. The results for audio watermarking are observed by replacing up to 10 LSB bits out of 16 of the audio file. The MSE and PSNR are evaluated for each case. This process is repeated for several audio files. For the Image watermarking, the watermarking is carried out for several images acting as watermark signals. The MSE and PSNR are evaluated for the same. For this entire work the GUI is also implemented.

Table 1. Audio Watermarking

File name and Size	Water mark Size	No. Of LSB bits replaced	MSE	PSNR (dB)	Audio Quality*
test_1 (52kB)	250 characters	5	4.09e-8	70.27	Good
test_2 (92kB)			2.39e-8	76.21	
test_3 (96kB)			2.36e-8	76.26	
test_4 (9.39kB)			1.144e-8	67.87	
test_1 (52kB)		8	1.668e-6	54.17	Acceptable
test_2 (92kB)			8.55e-7	60.67	
test_3 (96kB)			9.46e-7	60.39	
test_4 (9.39kB)			4.19e-6	52.13	
test_1 (52kB)	250 characters	10	2.85e-5	41.84	Not Acceptable
test_2 (92kB)			1.216e-5	49.15	
test_3 (96kB)			1.159e-5	49.54	
test_4 (9.39kB)			5.44e-5	41.33	

*The audio quality results are obtained by presenting the results to ten physically fit subjects.

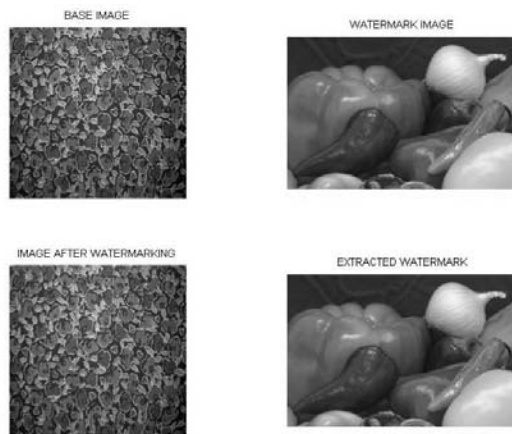


Fig 5. Image Watermarking using DCT

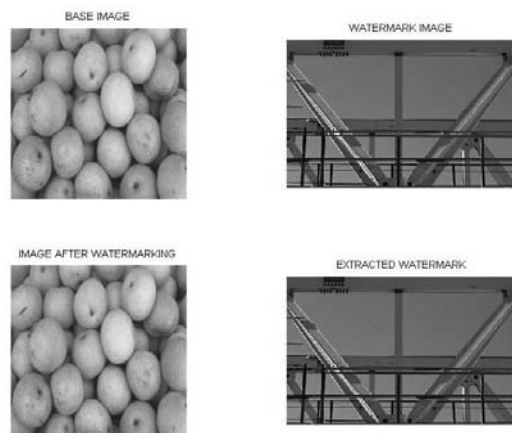


Fig. 6 : Image Watermarking using DCT

Table 2. DCT Results

Sr. No	Base Image	Watermark Image	MSE	PSNR (dB)
1.	fabric.png (611kB)	onion.png (43.5kB)	30.9249	76.5097
2.	pears.png (541kB)	gantrycrane.png (130kB)	11.6636	86.2605

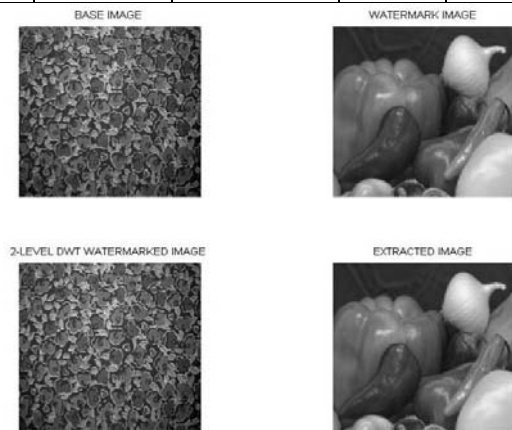


Fig. 7 Image Watermarking using DWT

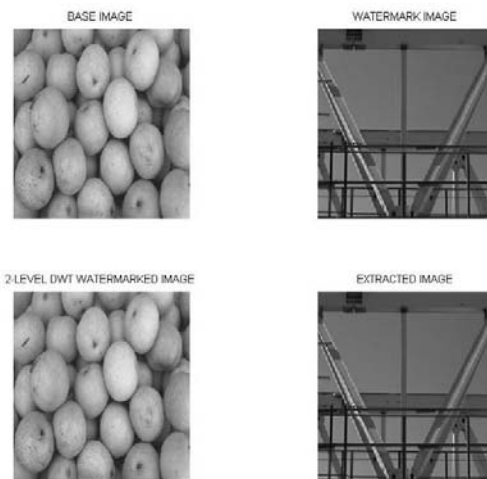


Figure 8. Image Watermarking using DWT

Table 3. DWT Results

Base Image	Watermark Image	MSE	PSNR (dB)
fabric.png (611kB)	onion.png (43.5kB)	0.32354	122.1096
pears.png (541kB)	gantrycrane.png (130kB)	0.35334	121.0709



Fig 9. GUI for Image Watermarking using DCT

VI. CONCLUSION

The paper describes the techniques used for audio and image watermarking. The audio watermarking done using LSB substitution and encryption of text ensures security and maintains watermark unintelligible. This is done to overcome the vulnerabilities of spatial domain techniques. The results obtained for audio watermarking imply that the audio quality of the watermarked file is not disturbed and is very much similar to the original audio.

For image watermarking the watermark is inserted in such a way that it is imperceptible. The MSE and PSNR results are better for DWT as compared to DCT hence DWT is a better choice as compared to complexity in DCT technique. The quality of watermarked images using DCT and DWT is not disturbed. The DWT technique can be further modified to improve the embedding ratio by decomposing up to three levels.

ACKNOWLEDGMENT

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IMAGE STEGANOGRAPHY USING KARHUNEN-LOÈVE TRANSFORM AND LEAST BIT SUBSTITUTION

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ABSTRACT

As communication channels are increasing in number, reliability of faithful communication is reducing. Hacking and tempering of data are two major issues for which security should be provided by channel. This raises the importance of steganography. In this paper, a novel method to encode the message information inside a carrier image has been described. It uses Karhunen-Loève Transform for compression of data and Least Bit Substitution for data encryption. Compression removes redundancy and thus also provides encoding to a level. It is taken further by means of Least Bit Substitution. The algorithm used for this purpose uses pixel matrix which serves as a best tool to work on. Three different sets of images were used with three different numbers of bits to be substituted by message information. The experimental results show that algorithm is time efficient and provides high data capacity. Further, it can decrypt the original data effectively. Parameters such as carrier error and message error were calculated for each set and were compared for performance analysis.

Keywords : *Steganography, Karhunen-Loève Transform, Least Bit Substitution, pixel matrix, eigenvectors.*

I. INTRODUCTION

With the advent of various communication techniques, its applications are also on the rising scale. They include browsing, E-mailing, file transfer and remote login. Though the first three need not have utmost level security, remote login does include some kind of security breach. Number of eavesdroppers has increased since communication mediums are also employed to convey highly sensitive and confidential information. Information prone to such attacks can be secured by encoding it using various practices, mainly by adding redundant data. This gave rise to branch of cryptography namely steganography. It has been proposed as a new, alternative method to enforce intellectual property rights and protect digital media from tampering. The methods used in steganography are characterized as imperceptible, robust and secure communication of data related to the host signal, which includes embedding into and extraction from the host signal. In historic times when data was encoded, it dealt with more physical methods such as hiding the information inside password-protected case. Nevertheless, they served the purpose.

As times followed, more concise methods were followed which dealt with obscuring the data itself. This marked the era of digital steganography.

Generally, steganography should meet the few imperative requirements as described below:

1. Imperceptibility to a Human Visual System:

Whenever an image is subjected to watermarking process, its watermarked version should look similar to the one which is not watermarked. There should not be any palpable distinctions so that third party person might learn about watermarking. If this condition is fulfilled then it serves the primary purpose of watermarking.

2. Robust to various kinds of distortions

The watermarked image should be robust and sturdy against distortions such as lossy compressions or any types of modifications. It should produce the original image after reversal of processes. This makes sure that the message to be hidden remains safe even if it gets attacked and manipulated.

3. Simplicity of detection and extraction

For an individual who possesses the private key to retrieve the message, it should be easy to extract it. For others who don't have a key, it should be very complicated to unlock its contents. This ensures that the watermarking is perfect and can be only deciphered by rightful individual.

4. High information capacity

The watermarked image should be able to carry large information without burdening the channel or the original image. This property describes how much data should be embedded for proper carriage.

In this paper, Karhunen-Loève Transform (KLT) has been employed for performing steganography. In order to acquire better image quality, sub-matrix of specific size of original pixel matrix message has been used. Readjustment will be executed to extract secret data exactly and to minimize the perceptual distortion resulted from embedding. The experimental results show that proposed method provides a large embedding capacity, and the quality of the steganographically hidden image is improved as well.

The paper is organized as follows: section II gives idea of proposed solution and section III gives implementation steps. Section IV shows experimental results and section V provides conclusion.

II. IDEA OF PROPOSED SOLUTION

In this algorithm the data information are initially compacted utilizing the KLT so as to accomplish a higher hiding limit, then afterward packed into LSBs of carrier image, which is in the RGB spatial domain. This combination will be useful in expanding the limit for hiding large messages, accomplishing a high caliber steganographically hidden image so it is essentially intangible and enhancing the execution time of the algorithm.

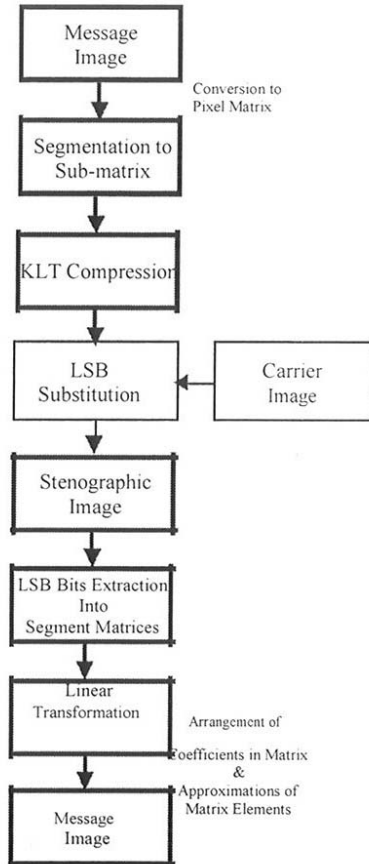


Fig. 1 Block diagram of proposed algorithm

2.1 Karhunen-Loève Transform

The aim of image compression is to store an image in a more compact form, i.e., a representation that requires lesser bits for encoding than original image. As images have a definite structure, there is some correlation between neighboring pixels. If reversible transformation that removes the redundancy by decorrelating the data, then an image can be stored more effectively. Karhunen-Loève Transform (KLT) is a linear transformation which achieves this goal.

$$\therefore (r, c) = \frac{1}{n} \sum_{i=0}^{n-1} \{f_i(r) - \overline{f}(r)\} \{f_i(c) - \overline{f}(c)\} \quad (2)$$

Therefore,

$$\overline{f} = \frac{1}{n} \sum_{i=0}^{n-1} f_i \quad (3)$$

and

$$\sum_f(r, c) = \frac{1}{n} \sum_{i=0}^{n-1} (f_i - \overline{f})(f_i - \overline{f})^T \quad (4)$$

Now $\overline{f}$ is M -dimensional vector and $\sum_f$ is $M \times M$ matrix.

Since $\sum_f$ is a real symmetric matrix, M eigenvectors

$$T = \begin{bmatrix} e_0 \\ e_1 \\ e_2 \\ \vdots \\ e_{M-1} \end{bmatrix} \quad (5)$$

Then it can be written as $T^{-1} = T^T$, and

$$T \sum_f T^T = \begin{bmatrix} \lambda_0 & 0 & 0 & 0 & 0 \\ 0 & \lambda_1 & \dots & \dots & 0 \\ \vdots & \vdots & \lambda_2 & \vdots & \vdots \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \dots & \dots & \lambda_{M-1} \end{bmatrix} \quad (6)$$

The K-L transform pair is then defined as

$$g = T^T (f - \overline{f}) \quad (7)$$

$$f = Tg + \overline{f} \quad (8)$$

Since the covariance matrix of transformed vector is a diagonal matrix, it is evident that the elements of the transformed vector g are uncorrelated [8].

The Karhunen-Loève Transform (KLT), also known as the Hotelling Transform, Eigenvector Transform or sometimes Principal Component Analysis is widely considered to achieve optimal signal processing for data representation, compression and analysis [1]-[4]. This transform is used in many domains in which random processes or sequences are encountered.

Consider a set of n one or multi-dimensional discrete signals represented as column vectors $f_0, f_1, f_2, \dots, f_{n-1}$ each having M elements. Let us denote the mean vector and covariance matrix of f_i ($i=0,1,2,\dots,n-1$) by $\bar{f}$ and Σ respectively.

Then the r^{th} element of mean vector is given by

$$\bar{f}(r) = \frac{1}{n} \sum_{i=0}^{n-1} f_i(r) \quad (1)$$

2.2 Least Significant Bit (LSB) Substitution

LSB substitution method for hiding images is a very simple and easy method to implement. Suppose s is the image to be hidden in host image H . Both are grayscale images with each pixel having n bits. Suppose S is to be embedded in rightmost k -bits of each pixel in H . First, S will be converted to S' . In this process, each pixel of S is decomposed into several small k -bit units to form the k -bit image S' [6].

Consider an 8-bit grayscale bitmap image where each pixel is stored as a byte representing a grayscale value. Suppose the first eight pixels of the original image have the following grayscale values [7]:

```
10010111 10001100 11010010 01001010 00100110
01000011
00010101 01010111
```

To hide the letter A whose binary value is 01000001, we would replace the LSBs of these pixels to have the following new grayscale values:

```
10010110 10001101 11010010 01001010 00100110
01000010
00010100 01010111
```

As from above example, only half the LSBs need to change. The difference between the host image and the hidden image will be hardly noticeable to the human eye. Figure 1 shows the flowchart for intended operation.

2.3 Message Segmentation

The original matrix of size $m \times n$ is subdivided into smaller sub-matrix of size $s \times n$. As each pixel is divided into R, G and B pixels, the matrix has increased into the size, three times the original. Hence size of this matrix is $3m \times n$. Segregation of larger matrix into smaller matrix reduces time required for intended operation. This makes the process efficient in time domain. Also, reducing matrix size in turn demotes reducing image size, i.e., removing data redundancy. This brings about effect of compression.

Thus concealing the secret image can be achieved through this type of compression. This makes procedure efficient in increasing the capacity of image to hide the data.

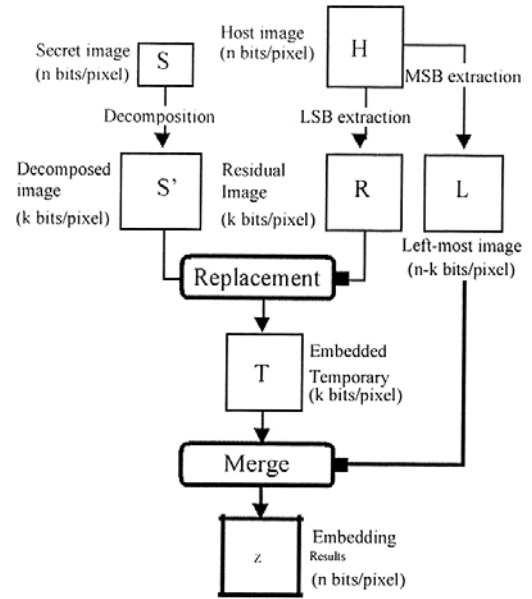


Fig 2: The flowchart of the embedding process in the simple LSB substitution method

To segment the image matrix, iterative approach is taken in which classification decision about each pixel can be taken in parallel [8]. Decisions made at neighboring points in the current iteration can be then used to make decision in next iteration.

Suppose a set of pixels $\{g_1, g_2, \dots, g_n\}$ is to be classified into m classes $\{C_1, C_2, \dots, C_m\}$. To keep class assignment of pixels independent, it is assumed that for each pair of class assignment $f_i \in C_j$ and $f_h \in C_k$, there exists a quantitative measure of compatibility $C(i, j; h, k)$ of this pair.

Let $p_{i,j}$ represent the probability that

$$f_i \in C_j, \quad 1 \leq i \leq n \quad (9)$$

$$1 \leq j \leq m,$$

with $0 \leq p_{i,j} \leq 1$ and $\sum_j p_{i,j} = 1$.

If $p_{h,k}$ is high and $C(i, j; h, k)$ is positive, $p_{i,j}$ is increased since it is compatible with high probability event $f_h \in C_k$. Similarly, if $p_{h,k}$ is high and $C(i, j; h, k)$ is negative, $p_{i,j}$ is reduced as it is incompatible with $f_h \in C_k$. On the other hand, if $p_{h,k}$ is low or $C(i, j; h, k)$ is nearly zero, $p_{i,j}$ is not changed as either $f_h \in C_k$ has a low probability or is irrelevant to $f_i \in C_j$.

III. STEPS OF IMPLEMENTATION

Considering an image as carrier image and another as message image, all the steps were carried out. Carrier image was converted to HSV format initially.

3.1 Representation of Secret Message into Corresponding Pixel of Image

The secret message to be hidden is represented as $m \times n$ RGB matrix of pixels, where m represents height of image and n represents width of image. Hence, an image A can be shown as follows:

$$A = \begin{bmatrix} P_{1,1} & P_{1,2} & \cdots & P_{1,n} \\ \vdots & \vdots & & \vdots \\ \vdots & \vdots & \ddots & \vdots \\ P_{m,1} & P_{m,2} & \cdots & P_{m,n} \end{bmatrix} \quad (10)$$

To achieve efficient processing, the pixels were segregated into three distinct pieces of information R,G and B. The matrix A thus becomes of size $3m \times n$, which is represented by A' .

$$A' = \begin{bmatrix} R_{1,1} & R_{1,2} & \cdots & R_{1,n} \\ G_{1,1} & G_{1,2} & \cdots & G_{1,n} \\ B_{1,1} & B_{1,2} & \cdots & B_{1,n} \\ \vdots & \vdots & \ddots & \vdots \\ R_{m,1} & R_{m,2} & \cdots & R_{m,n} \\ G_{m,1} & G_{m,2} & \cdots & G_{m,n} \\ B_{m,1} & B_{m,2} & \cdots & B_{m,n} \end{bmatrix}$$

3.2 Segmentation of Image in Sub-Matrix

The result of image segmentation is a set of segments that collectively cover the entire image, or a set of contours extracted from the image. It separates out foreground and background in meaningful way [9]. Each of the pixels in a region is similar with respect to some characteristic or computed property, such as color, intensity, or texture. Maximum Likelihood Classification (MLC) method is used for this purpose. The iterative clustering algorithm first computes the cluster mean values and covariance matrices, adjusting these values while reading the image data set.

The assignment to the class is based on image statistics. A clustering algorithm groups pixel values with similar statistical properties according to user definition of number of classes [10]. The idea is to identify pixel clouds from the feature space which have similar reflectance values. Each pixel cloud, grouped into clusters, characterizes spectral signature of that object. The cluster information is used to perform spatial assignment of the individual pixels to the derived clusters.

The MLC determines to which spectral class each cell in the image has the highest probability of belonging.

3.3 Application of KLT

KLT helps in compressing the image matrix further to increase hiding capacity of image. Consider that image has been divided in segments of size s . The matrix A^* corresponds to the first of these segments.

$$A^* = \begin{bmatrix} x_{1,1} & x_{1,2} & x_{1,3} & \cdots & x_{1,n-1} & x_{1,n} \\ x_{2,1} & x_{2,2} & x_{2,3} & \cdots & x_{2,n-1} & x_{2,n} \\ x_{3,1} & x_{3,2} & x_{3,3} & \cdots & x_{3,n-1} & x_{3,n} \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots \\ x_{3s-2,1} & x_{3s-2,2} & x_{3s-2,3} & \cdots & x_{3s-2,n-1} & x_{3s-2,n} \\ x_{3s-1,1} & x_{3s-1,2} & x_{3s-1,3} & \cdots & x_{3s-1,n-1} & x_{3s-1,n} \\ x_{3s,1} & x_{3s,2} & x_{3s,3} & \cdots & x_{3s,n-1} & x_{3s,n} \end{bmatrix}$$

where $x_{3i-2,j} = R_{i,j}$, $x_{3i-1,j} = G_{i,j}$ and $x_{3i,j} = B_{i,j}$ for all $i \in \overline{1,s}$ and $j \in \overline{1,n}$ [11].

The next step is to calculate eigenvalues and eigenvectors of covariance matrix. The distribution of the processed matrix's A^* energy (information) among the eigenvectors is indicated by the eigenvalues. Jacobi Eigenvalue Algorithm is used for this purpose. The value of each eigenvalue is proportional to the quantity of energy stored by the corresponding eigenvector. The matrix is same as equation (6).

Since covariance matrix is symmetric, it has orthonormal basis of eigenvectors. These eigenvectors constitute a $(3s) \times (3s)$ orthogonal matrix $V = [v_1 v_2 v_{3s}]$, which has the property (11)

$$V \cdot V^T = V^T \cdot V = I_{3s} \quad (12)$$

3.4 Concealing the Message

The entries of matrix A^* are integer and hence can be accommodated in single byte. But this is not the case with entries of projection matrix as the values are real. Hence they need at least 4 bytes to store. In terms of computer bytes, the compression rate would be $\frac{4K}{3S}$, providing no compression. To achieve

original compression rate, a linear transform is applied on P_j values as follows.

$$P_j'_{i,j} = (P_{j,i,j} - \min P_j) / (\max P_j - \min P_j) \cdot 255 \quad (13)$$

The similar problem is encountered with matrix V^* , the entries are real which need at least 4 bytes to be stored. To round them, following formula can be used :

$$V^*_{i,j} = V^*_{i,j} \cdot 32767 \quad (14)$$

After this, information can be hidden using LSB substitution. The number of bits used for hiding will decide the capacity of image to hide the data. Depending on how many of these bits we use for hiding the message, we get three versions of the same algorithm: one bit, two bits and three bits. The more bits we use for hiding, the more information we will be able to hide, at the expense of a greater Carrier Error.

3.5 Extraction of Message

The extraction of hidden message is exact reverse process of above procedures. First, the hidden information is extracted from LSBs of steganographically hidden image. For each segment, we get the linearly processed projection and eigenvector matrix for each segment and their dimensions. The next step is to reverse the process of linear transformation using following formulas:

$$aP_{i,j} = \frac{P_{i,j}' \cdot (\max P_j - \min P_j)}{255 + \min P_j} \quad (15)$$

$$aV^*_{i,j} = \frac{V^*_{i,j}}{32767} \quad (16)$$

$$aA^* = aV^* \cdot aP_j \quad (17)$$

Approximating the RHS,

$$aV^* \cdot aP_j \cong V^* \cdot P_j \quad (18)$$

From equation (14),

$$V^* \cdot P_j = V^* \cdot (V^*)^T \cdot A^* \quad (19)$$

from equation (12),

$$V^* \cdot (V^*)^T \cdot A^* \cong I_{3s} \cdot A^* = A^* \quad (20)$$

IV. EXPERIMENTAL RESULTS

To implement the algorithm, three sets of carrier and message images were used. For each set, different values of LSB bits were used. The algorithm was tested on PC with Intel® Core i5 Quad-Core with 4GB RAM.

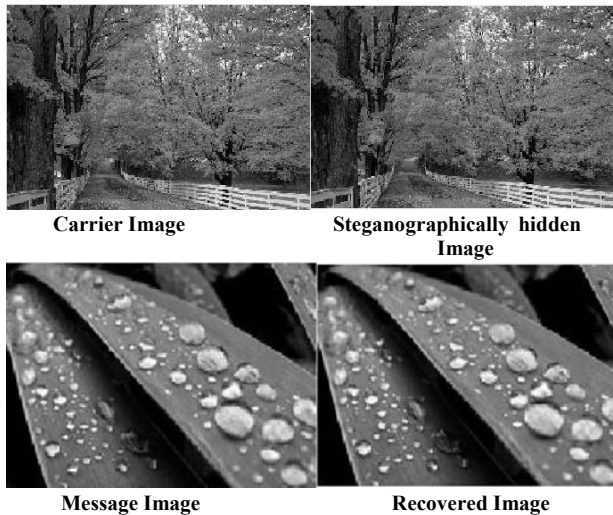


Fig.3: Set 1 images

For the first set of images, one bit was used in LSB. The carrier error is the least 0.395667. It can also be seen from the image that steganographically hidden image is of high quality. The recovered image is too of high quality with message error 1.1348. The hiding time is 3.59876 second and recovery time is 1.63255 seconds.



Carrier Image

Steganographically hiddenImage



Message Image

Recovered Image

Fig.4: Set 2 images

For the second set of images, two bits were used in LSB. The carrier error is 0.638335, almost double of carrier error of set 1. steganographically hidden image is of average quality. The recovered image has message error 2.50727. The hiding time is 3.10416 seconds and recovery time is 1.317215 seconds.



Carrier Image

Steganographically hidden Image



Message Image

Recovered Image

Fig.5: Set 3 images

For the third set of images, four bits were used in LSB. The carrier error is maximum, 1.76675. Steganographically hidden image is of poorest quality. The recovered image has message error 1.61832. The hiding time is 7.41073 seconds as the image size was larger and recovery time is 2.59556 seconds.

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Table 1: Parameters calculated during processing

Image	Data can be embedded	Compression Rate	Hiding Time	Recover Time	Carrier Error	Message Error
Set1	25311	0.493827	3.59876	1.63255	0.395667	1.1348
Set2	9125	0.333333	3.10416	1.31721	0.638335	2.50727
Set3	15160	0.444444	7.41073	2.59556	1.76675	1.61832

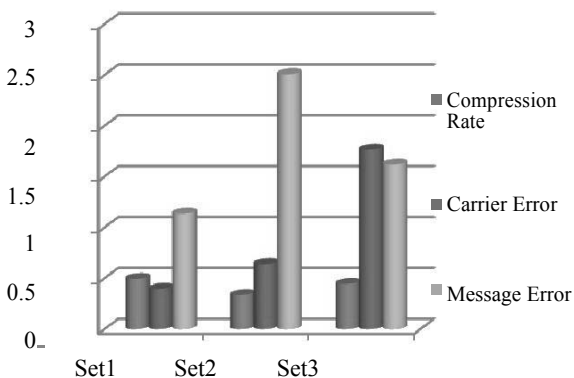


Fig.6: Graphical representation of parameters

Table 1 shows different parameters calculated for all three sets of images. It can be seen that carrier error and message error is maximum for third set, i.e., when four LSB bits were used for encoding. As number of bits used for encoding increases, the resemblance of steganographically hidden image with message image starts increasing. Whereas only one bit used for encoding provides no resemblance meaning proper masking. It is evident from table 1 that value of carrier error and message error is the least for this situation.

Fig.6 shows graphical representation of compression rate, carrier error and message error. Above results can be verified from this graph.

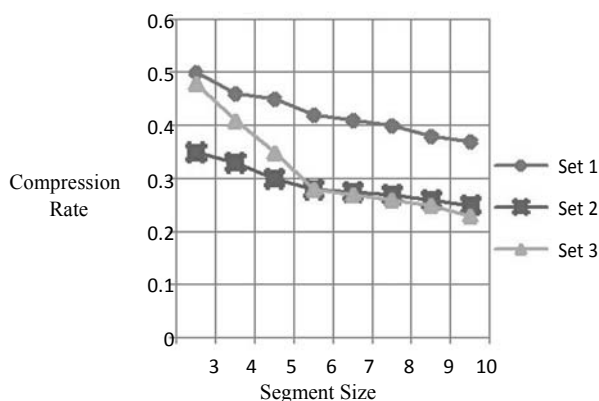


Fig.7: Plot of segment size vs. compression rate for three sets

Fig.7 shows plot of segment size vs. compression rates. It can be observed that rate depends largely on number of segments. As number of segments increases, compression rate decreases. The compression rate is poor for less segmented images, implying that compressed message will not “fit” inside the carrier [13].

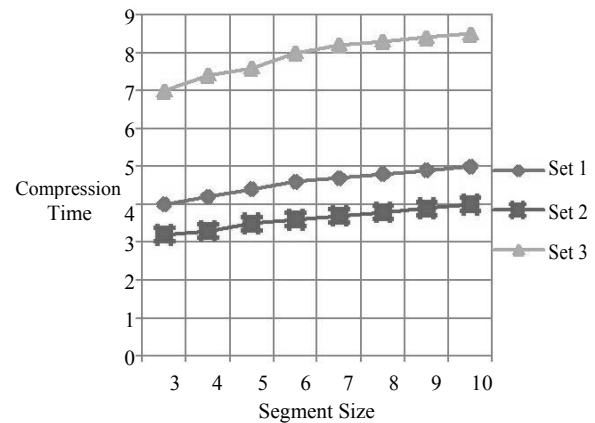


Fig.8: Plot of segment size vs. compression time for three sets

Fig.8 shows plot of segment size vs. compression time. It is clear that as number of segments increases, time required will also more. Smaller is the size of segments, faster will be compression meaning lesser time will be required.

V. FUTURE WORK

The method can be extended to hiding of various media inside image such as pure text, audio file etc. The capacity of data hiding can be increased more so that multimedia files can be hidden. The algorithm can be made stronger by reviewing recent stego-systems and considering how they can be attacked.

Additional steganalytic functions can be used so that the system is prepared to operate on a wider range of images. This could be done by implementing some more breaching techniques.

VI. CONCLUSION

The primary aim of this paper was to implement a robust and secure method for steganography which would offer optimum performance. All the three systems have been simulated on three different sets of carrier and message images. From the parameters it was found that encoding with two bits for set 2 type images offers best results as size of carrier image and data hiding capacity of provided are exactly equal. Other systems also provide optimum results with carrier and message errors. By virtue of KLT, the compression is high which adds up to capacity of image to hide the data. It also satisfies the basic rules of data concealing that hidden image should not be detectable. From the results it can be seen that it fulfils this requirement. Thus it can be concluded that algorithm gives a proper way to hide the data with minimum errors and optimum image quality.

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IRIS RECOGNITION SYSTEMS – A BRIEF REVIEW FOR PROPOSING NEW ALGORITHMS FOR RESEARCH WORK

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ABSTRACT

This paper gives a brief review of the various types of iris recognition systems that could be used as a survey paper for proposing new algorithms.

Keywords : Iris, Recognition, Matlab.

I. INTRODUCTION TO THE RESEARCH WORK WITH PROBLEM IDENTIFICATION

Identifying or verifying one identify using biometrics is attracting considerable attention in this modern day automated world, one the main reason being the security issues. Biometrics is the beautiful science of automatic identification of individuals that uses the unique physical or behavioral traits of individuals to recognize them. A variety of traits can be used, including the finger-print biometric, Iris {Fig. 1 (a) and (b)}, face geometry, palm print, gait, retina, hand geometry, utterance and the voice recognition & identification concepts. In the work considered, iris is the trait that has been used for identification.

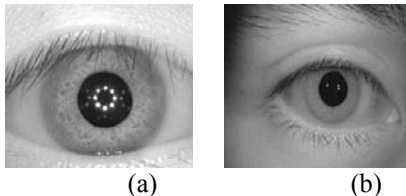


Fig. 1: (a) and (b) An orthogonal (taken at 0°) view of the human eyes.

Among the biometrics, the Iris has been shown to be one of the most accurate traits for human identification due to its stability and high degree of freedom in texture [1], [7]. Iris, which is the study, considered here in the research work, is a thin circular diaphragm which lies between the cornea and the lens of the human eye. The iris is perforated close to its center by a circular aperture known as the pupil. The human iris is rich in features which can be used to quantitatively and positively distinguish one eye from another.

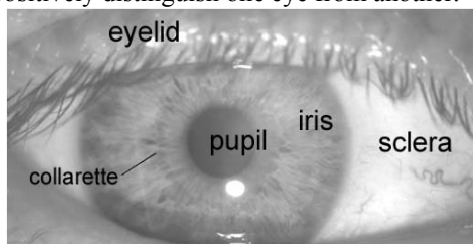


Fig. 2 : Human iris and its texture

The Iris contains many collagenous fibers, contraction furrows, coronas, crypts, color, vasculature, striations, freckles, rifts, and pits as shown in the Fig. 2. Measuring the patterns of these features and their spatial relationships to each other provides other quantifiable parameters useful to the identification process. Many algorithms have been developed by various researchers to measure these various characteristics so that they can be compared to a database of stored information for identification purpose. These techniques eliminate the need for password and token based identification & of course has certain drawbacks. Application of biometric technology increases confidence that only those people who are authorized to gain access to a particular resource or secured facility are able to do so. The major applications of biometrics are verification, identification & security. Verification is determining a one-to-one comparison and identification are of 2-fold, viz., determining if an individual is one of a number of known people in a database, to allow permission or access to a secure facility in the system of interest.

Currently, most biometric identification occurs when a subject knowingly approaches a biometric data collecting device, such as an Iris or fingerprint scanner, and purposely presents the data necessary for identification, whether it be staring straight into a camera (0°, i.e., without parallax) from a distance of only several centimeters or placing a finger on a fingerprint scanner.

Currently, the data collection takes a noticeable amount of time as well, so the subject must also keep the observed biometric in proximity to the sensor until identification is completed effectively. Once the biometric is collected, it also takes time for the collected data to be processed and compared to the database before a decision is made. Today's biometrics applications require a cooperative subject and many controlled parameters, such as illumination, distance to the sensor, positioning of the camera, the angle of positioning and many more, for positive identification of an individual to occur. In the case of iris recognition we can't have control over the unconstrained environment [10], [11], whether the collected image is orthogonal or non-orthogonal to the camera, light illumination images [10], half opened eyes, blurred iris image, out of focus, images captured on a move, wearing glass and also the orientation from an off-axis angle. Literature survey was done extensively on the iris recognition for unconstrained environments.

It was found that not much of research work was done in this field as a number of factors (some of them being the tilt, angle of presentation, scaling, perspective views, partially occluded, bad illumination, squint eyes, etc) have to be taken into consideration during the recognition process. Further, there were lot of drawbacks & dis-advantages. All these problems are going to be considered in our research work & efficient algorithms are going to be developed. This has led us to take up the work in this exciting field of biometric identification using the human iris. Identification based on iris images under unconstrained environment {Fig. 3 (a), (b), (c), (d), (e), (f)} is the problem that has been considered as a part of this proposed work. This includes use of database of such iris images and developing efficient algorithms to recognize the iris images under different unconstrained environments.

It was observed that, partial iris recognition [6] can work and the results show how likely a person is of being recognized when only a certain percentage of the iris is being used for recognition. The Institute of Automation, Chinese Academy of Sciences database images of Irises were used to test the feasibility of partial iris recognition [6]. The results show that when only 50 % of the iris is being used for recognition and positive results have been obtained. These results make it reasonable to assume that iris images under unconstrained environments will achieve similar results because it has the same problem of not having the entire iris available for template generation and comparison.

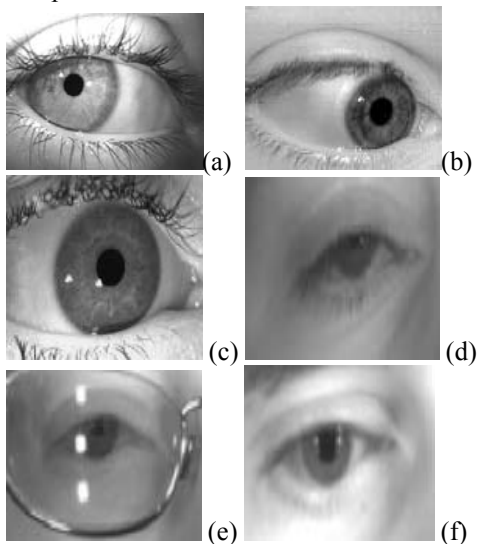


Fig. 3 : Images of Iris in different unconstrained environments --
(a) Impose of Eye Lids (b) Looking at different direction (c)
Light Illuminated (d) Half opened eye, (e) Wearing glass (f) Out
of focus

After completing the coursework (all the 4 subjects successfully), research work on the identified problem was started with the collection of work done by the various researchers in this field from the survey papers, books, articles, etc... Thousands of related research papers were collected from various sources such as internet, library, several IITs, NITs, IISc., Deemed Universities, Different college libraries, Research Center of VTU-Belgaum, VTU Belgaum Library, HKBK College of Engineering, from friends, other colleges and in STJIT libraries. Extensive research is being carried out on the iris recognition issues in the world @ various research centres till date. A number of researchers have worked on the topic so far, some of them have advantages & some of them dis-advantages. A brief exhaustive review of the research work done in the relevant chosen research field by different authors is summarized as follows.....

II. ANALYSIS OF THE SURVEY PAPERS TILL DATE....

2.1 Daugman. J., "New method in iris recognition", *IEEE Trans. on systems, man, and cybernetics - part-B*, vol. 37, no. 5, pp. 1167-1175, Jun. 2010

This methodology is clearly the most cited in iris recognition literature. It is licensed to Iridian Technologies who turned it into the basis for 99.5% of the present-day commercial iris recognition systems. Proposed in 1992, it was the first methodology effectively implemented in a working biometric system. Segmentation of iris highly depends on assumed parameters and accuracy of images. Daugman assumed both pupil and iris with a circular form and applied an integral differential operator. However; we observed that it frequently fails when images do not have sufficient intensity separability between iris and sclera regions. As possible optimizations, we implemented two pre-process operations that enhanced image contrast and contributed to the improvement of the results. Histogram equalization: This operation improves the contrast between each eye's regions, thus contributing to the correct algorithm segmentation. Binarization: Applying a threshold on an image before the operator's execution enables the maximization of the contrast between the regions belonging to the iris and the remaining ones. This process has, however, one major disadvantage it is highly dependent on the threshold chosen and as image characteristics may change, the results may seriously deteriorate. Apart from this fact, the binarization Compromises one of this methodology's biggest advantages: the inexistence of user-defined parameters for the segmentation task. Segment the iris by applying a threshold on an image before the operator's execution enables the maximization of the contrast between the regions belonging to the iris.

2.2 Proenca, H., Alexandre, L.A., “Iris segmentation methodology for non-cooperative Recognition”, *IEEE Proc. of Vision, Image and Signal Processing*, vol. 153, no. 2, pp. 199-205, 2006.

Segmentation has small tolerance to image noise and thus is in appropriate for the application on non-cooperative recognition systems. The main focus is on the analysis of the ability of segmentation algorithms to process images with heterogeneous characteristics, simulating the dynamics of a non-cooperative environment. The accuracy of the four selected methodologies on the UBIRIS database is tested and, having concluded about their weak robustness when dealing with non-optimal images regarding focus, reflections, brightness or eyelid obstruction, the authors introduce a new and more robust iris image segmentation methodology. This methodology could contribute to the aim of non-cooperative biometric iris recognition, where the ability to process this type of image is required. Describe the problems associated with the segmentation of iris images with poor quality. Presented some of the most cited methodologies in the iris segmentation literature and used the UBIRIS database to show that they are dependent on the specific image capture conditions, yielding a low robustness level. On the basis of this fact, proposed a new iris segmentation methodology that consists of the selection of three discrete features followed by the application of the well-known fuzzy-clustering algorithm.

This produces an intermediate image that tends to be more homogeneous even on images with very different focus, brightness or contrast characteristics. Results showed that for these non-optimal images, the creation of an intermediate labelled image improves the segmentation accuracy and is therefore adequate for the application on a non-cooperative iris recognition system.

2.3 Sanchez-Avila, C., Sanchez-Reillo, R., De Martin-Roche, D., “Iris-Based Biometric Recognition using Dyadic Wavelet Transform”, *IEEE Trans. on Aerospace & Electronics Systems Magazine*, vol. 17, issue 10, pp. 3 - 6, 2002

Segmentation has small tolerance to image noise and thus is inappropriate for the application on visible light images. In order to use the iris pattern for identification, it is important to define a representation well-adapted for extracting the iris information content from iris signatures. In this way, introduce an algorithm for extracting unique features from iris signatures and representing these features using a discrete dyadic wavelet transform. A fast discrete wavelet transform algorithm and its inverse have been utilized. This methodology proposed based on dyadic wavelet transform Zero crossing as Iris nature, where images were preprocessed by histogram stretching to

aid the limbic boundary detection. Wavelet is the first derivative of a cubic spline will used to construct the representation. Image acquisition and preprocessing users samples are captured using high resolution camera thus a photograph is taken covering whole eye of the user. After the capture, the location inside the image is performed first the image of the eye is converted to grayscale and its histogram is stretched then throughout a guiding process, the center of the iris as well as the stretched then throughout a guiding process, the center of the iris as well as Once detected, the outer boundary is suppressed and the same process is performed in order to find inner boundary In the last step of the preprocessing the dimensions of the iris in the image will be scaled to have the same constant diameter regardless of the original size of the image. A biometric identification system, based on the processing of the human iris by the dyadic wavelet transform, has been introduced. The procedure to obtain an iris signature of 256 bits has been described, as well as the feature extraction block and the verification system. The results have shown that the system can achieve high rates of security.

2.4 Milena Bueno Pereira Carneiro, Antônio Cláudio P. Veiga, Edna Lúcia Flôres and Gilberto A. Carrijo, “Solutions for Iris Segmentation”, *Biometric Systems, Design and Applications - Book edited by Mr Zahid Riaz*, ISBN 978-953-307-542-6, pp. 111 – 129, Nov. 2011

Segmentation have small tolerance to image noise and thus are inappropriate for the application on non-cooperative recognition systems. They proposed a moment-based texture segmentation algorithm, using the moments in small windows of the image as texture features and then applying a clustering algorithm to segment the image. The second-order regular geometric moments for each pixel in the image were computed. Tuceryan concluded that these regular moments did not have sufficient discriminant capacity and proposed the application of the hyperbolic tangent as a non-linear transducer followed by an averaging step. Segmentation algorithm : The essential point consists in making the edge-map construction less dependent on the specific image characteristics. A normalized (clustered) intermediate image is produced that will be used for the edge-map construction. The process begins with the image-feature extraction where three discrete values are extracted for each image pixel, followed by the application of a clustering algorithm that will label (classify) each pixel and produce the intermediate image. This image is then used by the edge-detector algorithm and, as it has more homogeneous characteristics, facilitates the tuning of the parameters required by the edge-detector algorithm. A more accurate edge map enables a higher accuracy of the circular Hough transform in its circumference detection task. Feature extraction: We did several tests to select the best feature set and evaluate which set could simultaneously and clearly identify the iris

regions and minimize the noisy information related to eyelashes and eyelids. We concluded that three discrete components f_x , y , z_g , being (x, y) the coordinates of the pixel position on the image and z the correspondent pixel image intensity, can characterize each pixel and enable a correct segmentation. This feature set, hereinafter named 'Pixel position p '. The moments F20 and F02 proved to correctly identify the iris border but also produced considerable noise regarding the eyelid regions. This noise is an important obstacle to the posterior circumference detection stage. Clustering algorithm: For the clustering (classification) algorithm, the most important feature is its capacity to classify, in the same class, all the pixels belonging to the iris and all the remaining ones in a distinct one. For this purpose, we evaluated four unsupervised clustering and classification algorithms: Kohonen's self-organizing maps: Also called topological ordered maps, the goal of this algorithm is to represent all points in the source space by points in the target space, such that distance and proximity relationships are preserved as much as possible. The task is this: having an input space and a sequence of input points, to create a mapping from the source space x to the target space y such that points neighboring in the source space are mapped to points that are neighboring in y .

The map is usually learned by a fully connected neural network where each cell represents a point in the target space. When a pattern from x is presented, each cell in the target space computes its net activation and one of the cells is activated. All weights from this cell and its neighbors are then adjusted in relation to the input pattern. K-means: Having a predefined number of k clusters and n data points, each one with dimension d , the algorithm begins by randomly initializing each coordinate of the k clusters. The distance between data points and clusters is computed and each input corresponds to one activated cluster. The weights of this cluster are adjusted in relation to the input so that at the end of each iteration. Segmentation method based on Mometric Algorithm that is an evolutionary algorithm was proposed and evaluated, the basic concepts of Mometric Algorithms were described and then, the implementation of the proposed method was carefully detailed. The experimental results indicate that the proposed method is efficient at localizing the iris region in an image of an eye. The innovation related to the use of evolutionary algorithms to localize the iris region can be further explored in order to achieve even better result.

2.5 Daugman, J., "High confidence visual recognition of persons by a test of statistical independence," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 15, no. 11, pp. 1148 - 1161, Nov. 1993.

Generate a compact code for the iris (of minuscule length compared with image data size), and render a

decision about individual identity with high statistical confidence, all within less than one second of computation time on a general purpose processor. This approach is regarded as one of the most cited approach in the survey of iris recognition. Daugman uses an integro-differential operator for segmenting the iris. It finds both inner and the outer boundaries of the iris region. The outer as well as the inner boundaries are referred to as limbic and pupil boundaries. The parameters such as the center and radius of the circular boundaries are being searched in the three dimensional parametric space in order to maximize the evaluation functions involved in the model. Statistical decision theory generates identification decision from exclusive OR comparisons of complete iris codes, also includes calculation of decision confidence levels using integro-differential operator. This algorithm achieves high performance in iris recognition. It is having a drawback that, it suffers from heavy computation.

2.6 R.P. Wildes, "Iris recognition: An emerging biometric technology", *Proc. of the IEEE*, Vol. 85, issue 9, pp. 1347, Sep. 1997

Major challenges involved in the taken image are in terms of image resolution and also in the focus using some standard optics. Here, an extant system has been used in order to provide a remedy to these challenges. Next issue is the iris localization, i.e., is the image capture during the image acquisition will be a very larger image which contains iris as a part of it. Wildes had proposed an iris recognition system in which iris localization is completed by detecting edges in iris images followed by use of a circular Hough transform to localize iris boundaries. In a circular Hough transform, images are analyzed to estimate the three parameters of one circle (x, y, r) . Where (x_i, y_i) is an edge pixel and i is the index of the edge pixel. The localization of the part that corresponds to the iris from taken image is very much important. The edge detection has been performed through the gradient-based canny edge detector, which is followed by the circular Hough transform, which is used for iris localization. After the localization of the region of the taken image which corresponds to the iris. The advantage of this method is that it provides segmentation accuracy up to an extent. The drawback of this approach is that, it does not provide any attention to eyelid localization (EL), reflections, eyelashes, and shadows.

2.7 L. Masek, "Recognition of Human Iris Patterns for Biometric Identification", *M.S. Thesis Dissertation*, The University of Western Australia, 2003

Open iris recognition system for the verification of human iris uniqueness and also its performance as the biometrics. Segment multiple objects simultaneously; they mitigate some of the concerns associated with

traditional iris segmentation models. The iris recognition system consists of an automated segmentation system, which localise the iris region from an eye image and also isolate the eyelid, eyelash as well as the reflection regions. Masek's implementation automatic segmentation was achieved through the utilization of the circular Hough transform in order to localise the iris as well as the pupil regions, and the linear Hough transform has been used for localizing the eyelid occlusion. The drawback is that localization of the circular iris as well as the pupil region, occlusion of eyelids as well as the eyelashes, and also the reflection occurs. In order to achieve localizing the eyelid occlusion, as well pupil and Sclera region they have used Hough transform. The drawback of this approach is that the iris segmentation is not that much accurate and also the speed of the system is low.

2.8 Z. He, T. Tan, Z. Sun, and X. Qiu, "Toward accurate and fast iris segmentation for iris biometrics", *IEEE Trans. Pattern Anal. Machine Intelligence*, vol. 31, no. 9, pp. 1670 - 1684, Sep. 2009

Iris image captured in a uncontrolled environment produces a non-ideal images with different quality this increase the false rejection rate decrease the performance of the recognition system. Moreover iris orientation depends upon large number of internal and external factors including torsional eye rotation tilt. A perfect (accurate) as well as a rapid iris segmentation algorithm for iris biometrics has been developed in this. There are mainly five major contributions in this. Firstly, a novel reflection removal method has been developed in order to exclude the specularities involved in the input images, also an Adaboost-cascade iris detector has been used in order to detect the iris in them and also to exclude the non-iris image parts before further processing such that redundant computations can be avoided. In addition to this, a rough iris center has been extracted in the iris images. Second contribution is that, beginning from the rough iris center, a novel pulling and pushing (PP) procedure has been developed in order to accurately localize the circular iris boundaries. The PP method directly finds the shortest path to the valid parameters. Third is that, a cubic smoothing spline has been adopted in order to deal with the noncircular iris boundaries. Fourth contribution is that, an efficient method for the localization of the eyelids has been developed. The main difficulties of eyelid localization difficulties such as sharp irregularity of eyelids as well as the noise due to the eyelashes has been addressed proficiently by a rank filter and also a histogram filter. Finally, the eyelashes as well as the shadows have been detected with statistically learned prediction model. The advantage of PP method is the accuracy and speed. The drawback of this method is that the occurrence of the segmentation error.

2.9 N.B. Puhon, N. Sudha, A. Sivaraman Kaushalram, "Efficient segmentation technique for noisy frontal view iris images using Fourier spectral density", *Signal, Image and Video Processing*, Vol. 5, pp. 105, 2011

Images are taken with less-constrained conditions on illumination, subject's movements, poses, and head alignments, the iris images captured with the Proença's acquisition system generate much more realistic noise conditions, such as specular reflections, off-angle situation, including the wearing of glasses. Besides noise effects, the visible wavelength characteristic of iris images show substantial differences between the iris images captured by visible wavelength system and images obtained with traditional iris recognition systems. A new segmentation method for noisy frontal view iris images which is captured with minimum cooperation based on the Fourier spectral density has been proposed in this paper.

This approach computes the Fourier spectral density for each pixel with the aid of its neighborhood and then executes row-wise adaptive thresholding, and thus results in a binary image which gives the iris region in a fairly accurate manner. This segmentation method can also be used in order to calculate limbic as well as the pupil boundaries. This is having the advantage that, this has lower computations as compared. The drawback is that, limbic boundary detection should be improved. The method computes the Fourier spectral density for each pixel using its neighborhood and then performs row-wise adaptive thresholding which results in a binary image giving the iris region approximately. Further image processing operations on the binary image could compute the circle parameters for the limbic and pupil boundaries in deterministic time. From the experimental results of testing on the UBIRIS iris database containing visible spectral range iris images, the new method is found to achieve good performance in iris segmentation.

III.CONCLUSIONS

In majority of the work done by the various authors presented in the previous paragraphs (only major works shown here for the sake of convenience), there were certain drawbacks / disadvantages / lacunas such as consideration of only vertical cup-disc ratio, use of conventional methods, noisy images, dimension concepts, etc. Couple of these drawbacks was considered in our research work & new algorithms are going to be developed which will be verified through effective simulation results in Matlab. Various architectural designs by other researchers have been analyzed and the new architectural design is being planned.

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A HYBRID METHOD TO MR IMAGE SEGMENTATION

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ABSTRACT

Magnetic resonance imaging (MRI) scan can be used to produce image of any part of the body. Image segmentation is a growing field and it has been successfully applied in various fields such as medical imaging, pattern recognition, etc. Medical Image processing is one of the most challenging topics in research field. Biased field which is low-frequency and very smooth signal that corrupts MRI images produced by MRI. In the proposed method, Biased field removal method is used as pre-processing step is needed to correct for the bias field signal before submitting it to segmentation and FCM method is used for segmentation and obtaining the contour of the image which serves as initial contour for Level set Method. The final segmentation is achieved using Level set method for active control of contour. The performance of level set segmentation is subjected to appropriate initialization and optimal configuration of controlling parameters which require substantial manual invention. A fuzzy level set algorithm with bias correction is proposed in this paper to facilitate medical image segmentation. It is able to directly evolve from initial segmentation by spatial fuzzy clustering.

Keywords: Bias field, clustering, FCM, Level set, MR data

I. INTRODUCTION

Image segmentation is an important process for most of the medical analysis tasks. Having good segmentation will benefit clinicians and patients as they provide important information for 3-D visualization, surgical planning and early disease detection. The main objective of the medical image segmentation is to extract and characterize anatomical structures with respect to some input features or expert knowledge. Several common approaches that have appeared in the literature on medical image segmentation.

Computerized medical image segmentation is a challenging problem [1] [2], due to poor resolution and weak contrast.

Moreover the task is often made more difficult by the presence of noise and artifacts, due to instrumental limitations, reconstruction algorithms and patient movement. There are two well-established concepts in image segmentation: pixel classification and tracking variational boundary. The first one assumes that the pixels in each subclass have nearly constant intensities, which is true for the anatomical structures with similar physiological properties. Such algorithms may detect multiple components

concurrently, but they are susceptible to environmental noise and image inhomogeneity. In contrast, methods that track variational boundaries make use of both intensity and spatial information. Therefore, a subclass has to be homogeneous and enclosed in a specific variational boundary. When applied to medical image segmentation, neither of them is universally robust due to intrinsic noise and artifacts.

Zexuan Ji, Yong Xia [1], proposed the fuzzy local gmm (flgmm) algorithm for automated brain MR image segmentation. This algorithm estimates the segmentation result that maximizes the posterior probability by minimizing an objective energy function, in which a truncated Gaussian kernel function is used to impose the spatial constraint and fuzzy memberships are employed to balance the contribution of each GMM. Haili Zhang, YunSmei Chen, Xiaojing Ye [2], says that present a multiphase segmentation model for MR images in the presence of strong intensity inhomogeneity. The problem is formalized as a constraint min-max optimization problem that consists both primal and dual variables. They used the primal dual hybrid gradient (PDHG) algorithm to alternately solve for the optimal solutions. G. Evelin Sujji, Y.V.S. Lakshmi, G. Wiselin Jiji [3], stated thresholding method but it is sensitive to noise and intensity homogeneities. U. Vovk, F. Pernus, and B. Likar [4] have given the Review of Methods for Correction of Intensity Inhomogeneity in MRI the methods are classified according to the inhomogeneity correction strategy.

Number of important issues has been emphasized, indicating that intensity inhomogeneity correction is still not a completely solved problem. Kaihua Zhang, Lei Zhang, and Su Zhang [9] Presented a novel level set approach to simultaneous tissue segmentation and bias correction of Magnetic Resonance Imaging (MRI) images. They first model the distribution of intensity belonging to each tissue as a Gaussian distribution with spatially varying mean and variance. Then a sliding window is used to transform the intensity domain to another domain, where the distribution overlap between different tissues is significantly suppressed. A maximum likelihood objective function is defined for each point in the transformed domain, which is then integrated over the entire domain to form a variational level set formulation. H. Permuter, J. Francos, and I. Jermyan

Stated, brain MR images can be segmented by using the Gaussian mixture model (GMM), where the voxel intensities in each target region are modeled by a Gaussian distribution. The GMM parameters are usually estimated by maximizing the likelihood of the observed image via the EM algorithm.

Healthy brain tissue can generally be classified into three broad tissue types on the basis of an MR image. These are grey matter (GM), white matter (WM) and cerebra-spinal fluid (CSF). This classification can be performed manually on an image, by simply selecting suitable image intensity ranges which encompass most of the voxel intensities of a particular tissue type. However, this manual selection of thresholds is highly subjective. Thus we proposed modified fuzzy with bias field and level set method for medical segmentation and the will be applied on clinical brain MR images for the experiment.

II. CURRENT WORK

A. Bias Field Estimation

It is low frequency smooth undesirable signal that corrupts MRI images, blurs it and reduces the high frequency contents of images and changes the intensity value of image pixels which degrades performance of image processing algorithms. A pre-processing step is needed to correct effect of bias field [5] before performing image processing through segmentation and classification algorithms. It can be modelled as a multiplicative component of an image as shown [1]

$$I = bJ + n$$

where I is the observed image, J is the true image to be restored, b is an unknown bias field, and n is the additive zero-mean Gaussian noise.

Bias field removal is an ill-posed problem and some implicit or explicit assumptions are required for the removal of it.

There are some Methods to Remove the Bias Field Signal [6] like high-pass filtering, parametric surface fitting, and an iterative removal of bias field based on modifying the objective function of the fuzzy c-means algorithm. The goal of bias field is to calculate and remove bias field b from an observed image I . Without loss of generality the bias field b is assumed to be slowly varying in the entire image domain. The intensity J in each tissue should take a specific value v_i , reflecting the physical property being measured, e.g., the proton density in MR images. This property, in conjunction with the spatially coherent nature of each tissue type, implies that the true signal J is approximately a piecewise constant map.

A. Algorithm Fuzzy- C Means

In hard clustering, data is divided into distinct clusters, where each data element belongs to exactly one cluster. In fuzzy clustering (also referred to as soft clustering), data elements can belong to more than one cluster, and associated with each element is a set of membership levels. These indicate the strength of the association between that data element and a particular cluster. Fuzzy clustering is a process of assigning these membership levels, and then using them to assign data elements to one or more clusters.

Fuzzy c-means [5] has been a very important tool for image processing in clustering objects in an image. Mathematicians introduced the spatial term [10] into the FCM algorithm to improve the accuracy of clustering under noise.

One of the most widely used fuzzy clustering algorithms is the Fuzzy C-Means (FCM) Algorithm introduced by Bezdek in 1981.

For a given image data set $X = (x_1, x_2, x_3, \dots, x_n)$ with n pixels, based on pixels characteristics, pixels to be partitioned into c clusters. The objective cost function [1] [5] is given by

$$J = \sum_{j=1}^n \sum_{i=1}^c U_{ij}^m |x_j - c_i|^2 \quad (1)$$

where U_{ij} represents the membership of an image pixel x_j in the i th cluster, c_i is the i th cluster center. $\|\cdot\|$ is a norm metric, and m is a constant that usually equals to 2 and controls the fuzziness of the partitioned clusters. The value of cost function J is minimum, i.e. membership values are high when image pixels are close to the centroid of their clusters. Similarly, the value of function J is maximum, i.e. membership values are low when image pixels are far from the centroid of their clusters. The membership function provides the probability of belonging of a pixel to a specific cluster. The membership value of a pixel is dependent on the distance between the pixel and centroid of its cluster. The updated values for membership function and cluster centers is given by equation (2) and equation (3) respectively

$$U_{ij} = 1 / (s/t)^p \quad (2)$$

$$\begin{aligned} \text{Where } s &= x_i - c_i \\ t &= x_j - c_k \\ p &= 2 / (m-1) \end{aligned}$$

$$c_i = \frac{\sum_{j=1}^n U_{ij}^m x_j}{\sum_{j=1}^n U_{ij}^m} \quad (3)$$

Each cluster center is assumed initially and then U and C are updated through iterations. When there is no change in either membership function or the cluster centers at two successive iterations, the procedure stops. This iteration will stop when $\max_{ij} \|U^{(k+1)} - U^{(k)}\| < \epsilon$ where ϵ is a termination criterion between 0 and 1, whereas k are the iteration steps.

The algorithm is composed of the following steps:

Step 1 .Initialize $U = [u_{ij}]$ membership matrix

Step 2 Find the cluster centers using

$$c_i = \frac{\sum_{j=1}^n U_{ij}^m x_j}{\sum_{j=1}^n U_{ij}^m}$$

Step 3 Update $U^{(k)}, U^{(k+1)}$

$$U_{ij} = 1 / (s/t)^p$$

$$\begin{aligned} \text{Where } s &= x_i - c_i \\ t &= x_j - c_k \\ p &= 2 / (m-1) \end{aligned}$$

Step4. If $\|U^{(k+1)} - U^{(k)}\| < \epsilon$ then STOP; otherwise return to step 2.

For example consider some data values

we have initial centroid 3 & 11 (with $m = 2$)

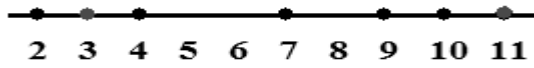


Fig. 1 Data Values

And U_{ij} is the degree membership of x_i in the cluster j .

From equation (2)

For node 2 (1st element):

$$U_{11} = \frac{1}{\left(\frac{2-3}{2-3}\right)^{\frac{2}{2-1}} + \left(\frac{2-3}{2-11}\right)^{\frac{2}{2-1}}} = \frac{1}{1 + \frac{1}{81}} = \frac{81}{82} = 98.78\%$$

The membership of first node to first cluster

$$U_{12} = \frac{1}{\left(\frac{2-11}{2-3}\right)^{\frac{2}{2-1}} + \left(\frac{2-11}{2-11}\right)^{\frac{2}{2-1}}} = \frac{1}{81 + 1} = \frac{1}{82} = 1.22\%$$

The membership of first node to second cluster.

For node 3 (2nd element):

$$U_{21} = 100\%$$

The membership of second node to first cluster.

$$U_{22} = 0\%$$

The membership of second node to second cluster.

For node 4 (3rd element):

$$U_{31} = \frac{1}{\left(\frac{4-3}{4-3}\right)^{\frac{2}{2-1}} + \left(\frac{4-3}{4-11}\right)^{\frac{2}{2-1}}} = \frac{1}{1 + \frac{1}{49}} = \frac{49}{50} = 98\%$$

The membership of first node to first cluster

$$U_{32} = \frac{1}{\left(\frac{4-11}{4-3}\right)^{\frac{2}{2-1}} + \left(\frac{4-11}{4-11}\right)^{\frac{2}{2-1}}} = \frac{1}{49 + 1} = \frac{1}{50} = 2\%$$

The membership of first node to second cluster.

With diagram we can show

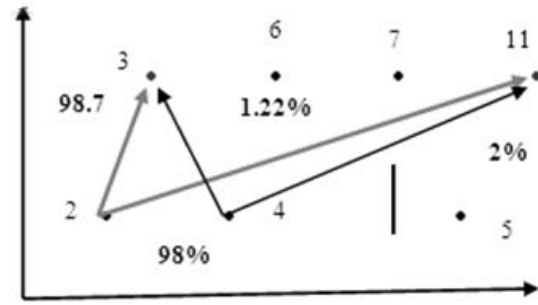


Fig. 2 Nodes with Degree of Membership to Cluster

Then by calculating centers by using equation (3), we will get new centroid again for next iteration. One of the problems of standard FCM algorithm [12] in an image segmentation is the lack of spatial information. All the pixels of an image have co-relation with their neighboring pixels. It means if we create clusters based on image pixels features then there is a high probability of all these neighborhood pixels falling in same cluster.

A spatial function [10] is defined as

$$h_{ij} = \sum_{k \in NB(X_j)} U_{ik} \quad (4)$$

where $NB(x_j)$ represents a square window centered on pixel x_j in the spatial domain. The spatial function h_{ij} gives the probability that the pixel x_j belongs to i th cluster. Now we can join spatial function to membership function as in equation

$$U_i = u_{ij}^p h_{ij}^q / \sum_{k=1}^c u_{kj}^p h_{kj}^q \quad (5)$$

where p and q handles the relative importance of both functions u and h . In a homogenous region, the clustering results remain unaltered but, in case of regions consisting of noisy pixels, equation (5) reduces the weights of noisy clusters using the intensity level of its neighboring pixels to move it in correct cluster.

A. Level Set Method Segmentation

The level set method [14] [17] (LSM) is a numerical technique for tracking interfaces and shapes. The advantage of the level set method is that one can perform numerical computations involving curves and surfaces.

For a general curve C , can be defined as a signed distance function [14]

$$\begin{aligned} \phi &> 0 && \text{If } (x, y) \in \text{inside } C \\ \phi(X, Y) &= \phi < 0 && \text{If } (x, y) \in \text{outside } C \\ \phi &= 0 && \text{If } (x, y) \in C \end{aligned}$$

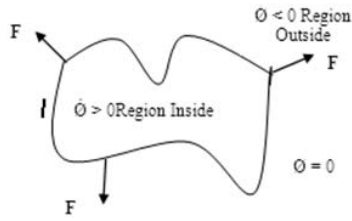


Fig. 3 Curve C

At any time, we can see from the Fig. 3, the interface is given by the zero level set of time dependent level set function $\hat{\phi}(x, y, t) = 0$. In order to find the movement of interface [14] [15], we first require that the level set value of a particle on the front must always be zero.

$$\hat{\phi}(x(t), t) = 0$$

Applying chain rule,

$$\hat{\phi}_t + \Delta \hat{\phi}((x(t), t) \cdot x(t)) = 0$$

Since F is the speed of interface in the outward normal direction n , then

$$F = n \cdot x'(t)$$

Where $n = \Delta \hat{\phi} / |\Delta \hat{\phi}|$

It gives the following interface evolution for $\hat{\phi}$

$$\hat{\phi}_t + F |\Delta \hat{\phi}| = 0$$

where F is the normal speed function. For a general curve C , $\hat{\phi}$ can be defined as a signed distance function to C .

III. PROPOSED APPROACH

The proposed approach for image segmentation is as follows :

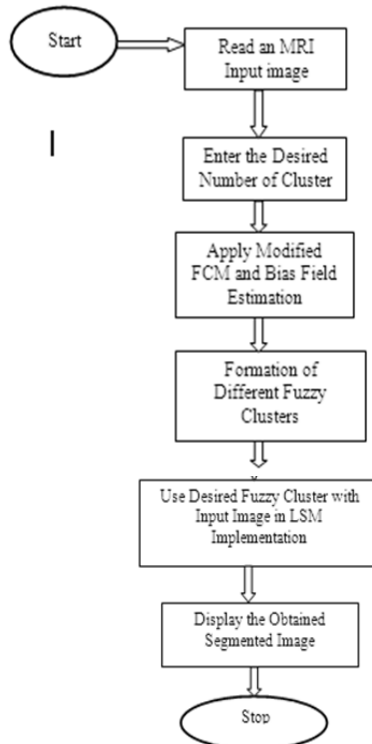


Fig. 4 Proposed Approach

IV. CONCLUSION

Segmentation of medical images is a very crucial task. There is yet no universal algorithm has been developed for medical image segmentation. An algorithm's advantages and drawbacks often vary according to the problem. In this paper we proposed pre-processing method and then applied to fuzzy clustering with level set can detect the segments of image with accuracy and can be useful to segment an image in medical and others field. This paper work is in progress and the experiment will be conducted on MR data of Brain.

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FRACTIONAL ORDER CONTROLLER DESIGN FOR NUCLEAR REACTOR MODEL

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ABSTRACT

Most of the physical phenomena can be better described using Fractional order differential equations. Fractional control model produces very good solutions to so many interesting control problems with applications in many branches of the Engineering. This paper deals with the design of Fractional order controller for Nuclear Reactor model. It has been proved that fractional order controller give robust performance compared to integer order controller.

Keywords : Fractional Calculus, Fractional differential equations, Fractional Controller.

I. INTRODUCTION

Fractional Calculus is a generalization of integration and differentiation to non-integer (fractional) order operator ${}_a D_t^\alpha$ where α and t are the limits and ($t \in \mathbb{R}$) is the order of the operation. [1]. Definition of Fractional derivatives/integrals given by Riemann-Liouville, Grunwald-Letnikov, Caputo are used by various researchers depending on applications. Fractional order can represent systems with high-order dynamics and complex nonlinear phenomena using few coefficients, since the arbitrary order of the derivatives gives an additional degree of freedom to fit a specific behavior. Therefore, Fractional Calculus finds its applications in different areas such as, long electrical lines, electrochemical processes, dielectric polarization, colored noise, viscous-elastic materials, chaos and in control theory [2-5].

Fractional Order models are more adequate for the description of dynamical systems with distributed parameters and also with concentrated parameters systems. Diffusion is the spontaneous spreading of particles in gas or liquid or inside a solid material. The neutron diffusion process is better represented by a Fractional order differential equation because of its distributed nature. [6]

New and effective methods for the time-domain analysis of fractional-order dynamical systems are required for solving problems of control theory. As a new generalization of the classical PID-controller, the idea of $PI^\lambda D^\mu$ -controller, involving fractional-order integrator and fractional-order differentiator, has been found to be more efficient control of fractional-order dynamical systems. The advantages of fractional order controllers over classical controllers have been established by many researchers. This paper deals with the design of fractional-order $PI^\lambda D^\mu$ -controller for Nuclear

Reactor model. The purpose is to take advantage of the introduction of two parameters, λ and μ , and ensure the robust performance of the controlled system with respect to gain variations. [5]

The paper is organized as follows: Section 2 deals with the concept and methods of Fractional Calculus and general definition of the Fractional Order model. Nuclear reactor system is discussed in section 3, and the design procedure of Fractional order controller of Nuclear reactor model is covered in section 4 followed by conclusion.

II. FRACTIONAL CALCULUS

The Popular definitions of fractional calculus include Riemann-Liouville definition & Caputo's definition. [2].

Riemann-Liouville:

(1)

$${}_a D_t^\alpha f(t) = \frac{1}{\Gamma(n-\alpha)} \left(\frac{d}{dt} \right)^n \int_a^t \frac{f(\tau)}{(t-\tau)^{\alpha-n+1}} d\tau$$

$(n-1) \leq \alpha < n$
where n is integer and α is real number.

M.Caputo:

(2)

$${}_a^C D_t^\alpha f(t) = \frac{1}{\Gamma(n-\alpha)} \int_a^t \frac{f^{(n)}(\tau)}{(t-\tau)^{\alpha-n+1}} d\tau$$

$(n-1) \leq \alpha < n$
where n is integer and α is real number.

(3) Laplace Transform of an n^{th} derivative ($n \in \mathbb{R}_+$) of a signal $x(t)$ relaxed at $t=0$ is given by:

$$L\{D^n x(t)\} = s^n X(s)$$

So, a fractional order differential equation, provided both the signals $u(t)$ and $y(t)$ are relaxed at $t=0$, can be expressed in a transfer function form

$$G(s) = \frac{a_1 s^{\alpha_1} + a_2 s^{\alpha_2} + \dots + a_m s^{\alpha_m}}{b_1 s^{\beta_1} + b_2 s^{\beta_2} + \dots + b_m s^{\beta_m}} \quad (4)$$

where $(a_m, b_m) \in \mathbb{R}^2$, $(\alpha_m, \beta_m) \in \mathbb{R}_+^2 \forall (m \in \mathbb{N})$. [7]. In the time domain Fractional Order system can be described by a Fractional Order differential equation as [2]:

(5)

where α, β are generally real numbers, are arbitrary constants.

To the Fractional Order differential equation (5) there corresponds, in s domain, the following Fractional Order Laplace transfer function:

(6)

III. NUCLEAR REACTOR SYSTEM

The 540MWe PHWR in Tarapur Atomic Power Plant (TAPP) is a heavy water moderated, natural Uranium fuelled reactor utilizing the pressure tube concept. The physical dimensions of the reactor core are several times larger than the neutron migration length due to which the coupling among different regions is very weak. This weak coupling causes unstable spatial oscillations of neutron flux distribution.

The control problem represents the problem of regulating Global power to match the demand and also the neutron flux distribution in the core should be regulated so that the spatial oscillations are controlled without exceeding limits on fuel.

The reactivity in the plant is controlled by adjuster rods, control rods, boron dissolved in moderator and Liquid Zone Control System (LZCS). The LZCS is used to carry out fine control of reactivity. The reactor is considered to be divided into 14 zones. Reactivity in each zone can be varied independently by varying the light water level in the Zone Control Compartment (ZCC). The level in the compartment is varied by varying the water inflow. The water outflow is kept constant.

The Global power can be controlled by varying the water level simultaneously in all ZCCs whereas the flux distribution is controlled by varying the water levels in ZCCs differentially. For small variations of bulk power from its steady state, the reactivity is controlled only by the light water levels in ZCCs. For bulk power correction, water level in all ZCCs is adjusted simultaneously and uniformly. [6].

The relation between inlet valve opening as output and the global output is represented using a state space model as follows :

$$y = Cx \quad (7)$$

System matrix A, input matrix B and output matrix C for the 540 MWe PHWR TAPP are given in Appendix 1. The global power output is given by y4. The initial conditions are assumed to be zero. The step response of the plant is given in Figure.1. [6].

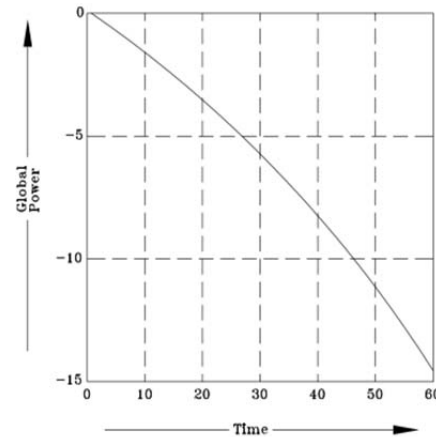


Fig.1. Global Power Variation for Bulk correction with valves fully Open for open loop system

Hence the integer order model for this plant is chosen as [6]

(8)

IV. FRACTIONAL ORDER CONTROLLER DESIGN

The fractional-order $PI^\lambda D^\mu$ -controller was proposed as a generalization of the PID controller with integrator of real order λ and differentiator of real order μ . The transfer function of such type the controller in Laplace domain has form [5]:

$$\lambda, \mu > 0 \quad (9)$$

Where K_p = proportional constant

K_i = integration constant

K_d = differentiation constant.

Taking $\lambda = 1$ and $\mu = 1$, we obtain a classical controller. If $\mu = 0$ and $\lambda = 0$, we obtain a PI^λ -controller, etc. All these types of controllers are particular cases of the $PI^\lambda D^\mu$ -controller, which is more flexible and gives an opportunity to better adjust the dynamical properties of the fractional-order control system.

For the Fractional Order Controller design the methodology adopted in [1] is used. Here, the fractional controller, which gives us a step response of feedback control loop with overshoot independent of parameter changes, has been designed.

Phase margin of controlled system is [1],

(10)

Independent phase margin implies constant phase and can be accomplished by controller of the form

$$— \quad (11)$$

Such controller gives a constant phase margin and can be obtained as,

$$— \quad (12)$$

Let the desired phase margin be 63° . We obtain a fractional controller with $\mu = 1.3$ as

$$— \quad (13)$$

where $—$

Closed loop response of integer order Nuclear reactor model using fractional controller (13) is shown in Figure.2

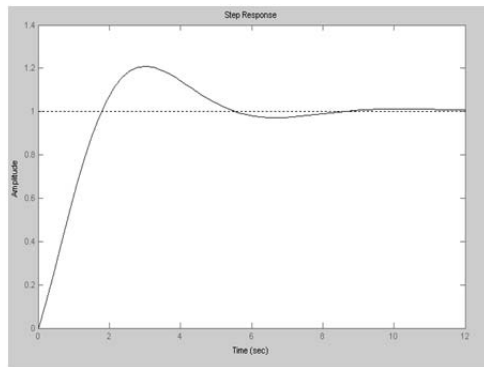


Figure.2. Closed loop response of Nuclear Reactor using fractional controller

Table 1 gives the characteristic values of the closed loop response of integer order nuclear reactor using fractional controller.

Table 1: Performance Specifications

Parameter	Value
Peak Value	1.21
Settling Time(s)	7.41
Rise Time(s)	1.35
Steady State Value	1

In theory, the Fractional PID controller is an infinite dimensional linear filter due to the fractional order of differentiation and integration. This flexibility makes fractional order controller a powerful tool in designing robust control system with less controller parameters to tune. The closed loop response in Figure.3 and Figure.4 establishes the robustness feature of the Fractional Order Controller.

Figure.3 represents closed loop response for various values of gain and Figure.4 represents closed loop performance for system with parameter changes within 10%.

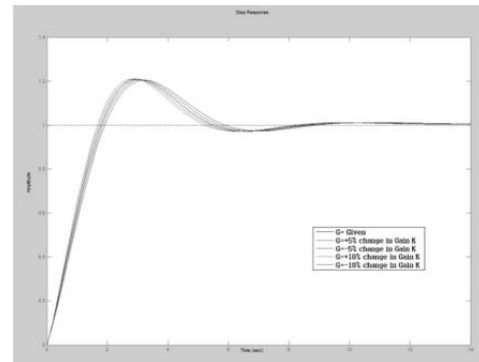


Figure.3 Step responses of controlled system with fractional controller for change in gain K_p

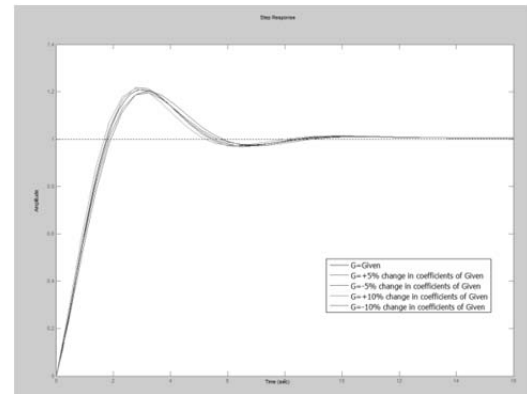


Figure.4 Step responses of controlled system with fractional controller for parameter changes of Nuclear Reactor.

In Figure.3, the simulated response for different gains using MATLAB is shown, fulfilling the robustness constraint to gain changes (within the variation range selected) and Figure.4 shows the response for 5 to 10 percentage change in coefficients transfer function of Nuclear Reactor model. From these results, the effectiveness of the fractional controller, regarding performance and robustness aspects, is evident.

V. CONCLUSION

In this paper the fractional order Controller of Nuclear Reactor model is designed using phase margin specification. It is shown that fractional controller gives robust performance of the controlled system to gain changes and percentage change in coefficients of nuclear model.

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Appendix 1

Model of Nuclear Reactor

System Matrix

$$A = \begin{pmatrix} 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ -50 & -15 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 97846 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 46389 & -0.99 & -1.99 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & -0.01 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 46378 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -0.125 & 0.125 & 0 & 0 & 0 & 0 & 0 & 39.9 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -0.159 & -2.475 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.243 & -0.121 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -0.052 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & -0.003 & 0 & 0 & -213.9 & -14.42 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0.016 & 0 & -0.007 & 0 & 0 & -6.771 & 0.185 & 1.152 & 0.972 & 2.107 & 1.113 & 0.24 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.012 & -0.012 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.03 & 0 & -0.03 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.115 & 0 & 0 & -0.115 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.301 & 0 & 0 & 0 & -0.301 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.905 & 0 & 0 & 0 & 0 & -0.905 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 2.76 & 0 & 0 & 0 & 0 & 0 & -2.76 \end{pmatrix}$$

Input Matrix

$$B = [0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ -21390 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0 \ 0]^T$$

Output Matrix

$$C = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix}$$

AN INTELLIGENT AMBULANCE FOR THE SYNCHRONIZED HEALTH CARE

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ABSTRACT

Nowadays the road accidents in modern urban areas are increased to uncertain level. The loss of human life due to accident is to be avoided. The main theme behind this scheme is to provide a smooth flow for the emergency vehicles like ambulance to reach the hospitals in time and thus minimizing the delay caused by traffic congestion. The idea behind this scheme is to implement this project which would control mechanically the traffic lights in the path of the ambulance. The ambulance is controlled by the control unit which furnishes adequate route to the ambulance and also controls the traffic light according to the ambulance location and thus reaching the hospital safely. To solve all these above problems we have come up with the solution of "An Intelligent Ambulance for the synchronized health care". Here we are tracking the ambulance and monitoring patient's health conditions continuously. The aim of this project is to develop an intelligent ambulance which will continuously monitor health of the patient until it reach the hospital without any problem of heavy traffic.

Keywords : ARM, Embedded system, Emergency vehicle, Traffic light management.

I. INTRODUCTION

In today's world health hazards are a major concern. Especially people in the older age group are the victims, and moreover the traffic conditions are worsening day by day, which results in traffic jams. Many important jobs get delayed due to these traffic jams. Ambulance service is one of the major services which get affected by traffic jams. To solve this problem we have come up with the solution of "AN INTELLIGENT AMBULANCE FOR THE SYNCHRONIZED HEALTH CARE".

Here, we are tracking the patient's health conditions. The health parameters such as Heart rate, body temperature and Blood pressure are sent to the hospital using the on board GSM unit. All these parameters are displayed in the hospital unit. Simultaneously if at all the Ambulance encounters the traffic jam in the route, the driver is provided with the remote to control the traffic signals. The particular signal is made Green for some time and by, it again regains its original flow of sequence of signaling after the ambulance passes.

II. RELATED WORK

In March 2005, the National Patient Safety Agency (NPSA) prioritisation panel strongly supported a project on ambulance design to be taken forward in the coming year in response to concerns relating to the design of vehicles and equipment that impact on patient safety. In June 2005, the Department of Health set out a vision for the provision of future ambulance services by 2010. This included providing an increasing range of quality mobile healthcare services for patients with urgent and emergency care needs.

The aims are that patients will receive improved care by consistently receiving the right response, first time, in time, and that more patients will be treated in the community, resulting in more effective and efficient use of NHS resources. It seems likely that these changes will require different vehicles and equipment for ambulance services.[1]

III. PROPOSED WORK

All developed nations have a well developed transportation system with efficient traffic control on road, rail and air.. Mismanagement and traffic congestion results in long waiting times, loss of fuel and money. In this paper taking an example of emergency vehicles as ambulance. In this paper, the first aim is to collect the information of moving emergency vehicles using GSM, GPS, ARM, RF MODULE to provide them clear path. This system can do the following, i) Minimize long waiting time, ii) Achieve smart automatic traffic signal control without human interrupt, iii) Wirelessly monitor patients health parameter through GSM technology, Ambulance will consist of Heart Beat, Temperature sensor, Blood Pressure, weight Measurement. When key is pressed, All parameter values will be sent to pre-defined mobile phone (Hospital) using GSM. On signal there will be two RF readers which will detect traffic density on two roads. When ambulance is detected on any road signal for that side will be green. And traffic on that road and other roads will be sent to ambulance through another GSM.

ARM is a 32-bit reduced instruction set computer (RISC) instruction set architecture (ISA) developed by ARM Limited. It was known as the Advanced

RISC Machine, and before that as the Acorn RISC Machine. This has made them dominant in the mobile and embedded electronics market as relatively low cost and small microprocessors and microcontrollers. The project is designed using ARM microcontroller. In this project there would be two RF systems used in the project. The RF would be used to detect the ambulance. Also the sensors are used for patient monitoring and GSM modem will be used to send the SMS to mobile. The whole setup consists of ARM, Heart Beat Sensor, Temperature sensor, Blood Pressure, Weight Measurement GSM Modem and GPS. The Systems consist of ARM microcontroller. The micro controller cannot process the analog voltages as it is a digital device; so we use inbuilt ADC to convert the raw output of sensor to digital voltage. This digital voltage is feed to controller. The ARM continuously monitors the Temperature value and display on LCD. We are also using serial communication to make connection to hospital using GSM and GPS. The RF systems will be connected to microcontroller using serial protocol. The RF will be attached to the ambulance when the ambulance passes would be read and the traffic Light will be made Green Signal. Also the body parameters will be measured using sensors and will be sent through mobile to the respective Doctor. We are using GPS to track the position of ambulance, emergency vehicles so it will help us to direct the ambulance to reach the hospital as early as possible and also reach the vehicle to their destination. [2]

IV. BLOCK DIAGRAM

This is the proposed block diagram of the project. The block diagram consists of two units Ambulance unit and Traffic Signal Unit.

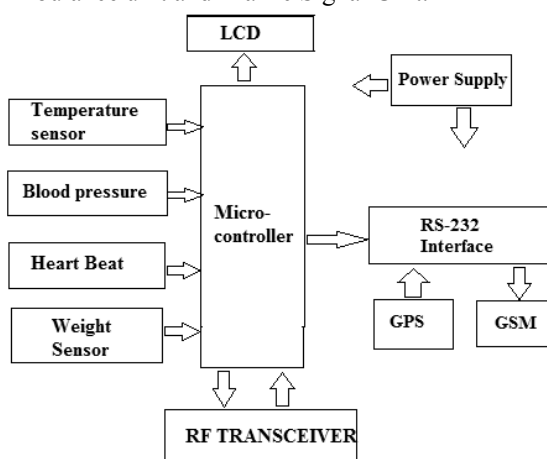


Fig.1.Block Diagram Of Ambulance Unit

The block diagram for traffic signal unit is as shown in figure below.



Fig.2.Block Diagram of Traffic Unit

The above block diagram describe about traffic control for ambulance. When RF transceiver receives the message it turns the signal green of the lane from which ambulance is arriving. It consist of microcontroller which will take RF signal from ambulance unit as input and it will give output to traffic signal to make it green. Here the RF used is CC2500.

V. HARDWARE IMPLEMENTATION

The ARM7TDMI-S is a general purpose 32-bit microprocessor, which offers high performance and very low power consumption. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles, and the instruction set and related decode mechanism are much simpler than those of micro programmed Complex Instruction Set Computers (CISC). This simplicity results in a high instruction throughput and impressive real-time interrupt response from a small and cost-effective processor core. Pipeline techniques are employed so that all parts of the processing and memory systems can operate continuously. Typically, while one instruction is being executed, its successor is being decoded, and a third instruction is being fetched from memory. The ARM7TDMI-S processor also employs a unique architectural strategy known as Thumb, which makes it ideally suited to high-volume applications with memory restrictions, or applications where code density is an issue. The key idea behind Thumb is that of a super-reduced instruction set. [3]

GSM uses Frequency Division Multiplexing AND Time Division Multiplexing. FDMA divides the frequency ranges for GSM, which are 890-915, 935-960 and some others that the book didn't have. Each is divided into 200kHz wide channels. As far as TDMA goes, each time slot is 577 micro seconds long, 8 time slices is a frame, lasting for a grand total of 4.615ms. A multi frame consists of 51 frames, 51 multi frames make up a Super frame, and 2048 Super frames make a Hyper frame which is 2715648 frames. Environmental conditions, physical size of the tags antenna and interference from other RF devices. Global Positioning System (GPS) satellites broadcast signals from space that GPS receivers, use to provide three-dimensional location (latitude, longitude, and altitude) plus precise time. GPS receivers provides reliable positioning, navigation, and timing services to worldwide users on a continuous basis in all weather, day and night, anywhere on or near the Earth. The output is serial data of 9600 baud rate

which is standard NMEA 0183 v3.0 protocol offering industry standard data messages and a command set for easy interface to mapping software and embedded devices.[4]

Heart beat sensor is designed to give digital output of heart beat when a finger is placed on it. When the heart beat detector is working, the beat LED flashes in unison with each heart beat. This digital output can be connected to microcontroller directly to measure the Beats per Minute (BPM) rate. It works on the principle of light modulation by blood flow through finger at each pulse. The sensor consists of a super bright red LED and light detector. The LED needs to be super bright as the maximum light must pass spread in finger and detected by detector. Now, when the heart pumps a pulse of blood through the blood vessels, the finger becomes slightly more opaque and so less light reached the detector. With each heart pulse the detector signal varies. This variation is converted to electrical pulse. This signal is amplified and triggered through an amplifier which outputs +5V logic level signal. The output signal is also indicated by a LED which blinks on each heart beat.

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling.

The LM35 is rated to operate over a -55° to +150°C temperature range, while the LM35C is rated for a -40° to +110°C range (-10° with improved accuracy). The LM35D is also available in an 8-lead surface mount small outline package and a plastic TO-220 package.

Features:

- Calibrated directly in °Celsius (Centigrade)
- 0.5°C accuracy guarantee able (at +25°C)
- Rated for full -55° to +150°C range
- Operates from 4 to 30 volts
- Less than 60 µA current drain
- Low self-heating, 0.08°C in still air

Blood pressure is the measure of the force of blood pushing against blood vessel walls. The heart pumps blood into the arteries (blood vessels), which carry the blood throughout the body. High blood pressure, also called hypertension, is dangerous because it makes the heart work harder to pump blood to the body and contributes to hardening of the arteries, or atherosclerosis, and to the development of heart failure.

What Is "Normal" Blood Pressure?

A blood pressure reading has a top number (systolic) and bottom number (diastolic). The ranges are:

- ✓ **Normal:** Less than 120 over 80 (120/80)
- ✓ **Pre hypertension:** 120-139 over 80-89
- ✓ **Stage 1 high blood pressure:** 140-159 over 90-99
- ✓ **Stage 2 high blood pressure:** 160 and above over 100

VI. CONCLUSION

This system will definitely help us to save life of critical patients. So, because of this system we can not only save life of patients but also can contribute towards social service. This will also help doctor in early diagnosis of the patient. So, this will be helpful for hospitals, patients & doctors. Thus we can say that we can use this system in various ambulances.

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EASY GO-AUTOMATED TOLL COLLECTION SYSTEM USING RFID BACKSCATTERING AND CLOUD BASED SERVER

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ABSTRACT

On Highways, much time is spent at the toll booth queue and some more, to pay the toll tax manually. An Automated toll Collection system would eliminate these drawbacks and facilitate a speedy transport. Our Project focuses on an automated toll collection system using radio frequency identification (RFID) technology and is based on concepts of embedded systems. RFID technology is an "Automated Data Collection" technology. The technology uses Radio Frequency to transfer data between the reader and a movable item that has been installed with a RFID tag. Each RFID tag will have a unique electronic code called as "Tag's Identification number". RFID tags consist of RFID chip along with the antennas which are required to increase the range of the RFID chip. RFID chips don't have their own source of power. Passive RFID chip harness energy from nearby radio transmitter device called as "RFID reader" which will read the unique ID of the RFID tag and store it in the computer. RFID technology is fast and does not require physical sight or contact between reader and the tagged item. In the proposed system, RFID tags will be mounted on the windshields of vehicles, these tags will be read by RFID readers which will be interfaced using Atmega64 microcontroller. Data information is exchanged between the motorists and toll authorities, thereby enabling a more efficient toll collection by reducing traffic and eliminating possible human errors. Also the proposed system will be postpaid wherein the toll tax is added to the user's account and the respective bill will be generated on a monthly basis and sent to the user, analogous to the traditional credit card system.

I. INTRODUCTION

'EASYGO' is an Automated Toll Collection System (ATCS) which enables the electronic collection of toll payments. It has been studied by researchers and applied in various highways requiring such a process. In 1959, Nobel Economics Prize winner William Vickrey was the first to propose a system of

electronic tolling for the Washington Metropolitan Area. He proposed that each car would be equipped with a transponder. The transponder's personalized signal would be picked up when the car passed through an intersection, and then relayed to a central computer which would calculate the charge according to the intersection and the time of day and add it to the car's bill [1]. The advantage of this technology is the opportunity to eliminate congestion on the tollbooths, especially during peak hours and festive seasons when traffic tends to be heavier than normal. It is also a method by which to curb inconveniences involved in manually making payments at the tollbooths.

II. BACKGROUND OVERVIEW

Existing Toll Collection System

At Present, there are two ways of collecting toll tax being practiced. First is the traditional manual toll collection method and second is the smart card system. In manual toll collection system the car arrives at the toll booth and stops for paying the toll tax to a person who then issues a receipt. The toll terminal features an embedded controller that communicates to the control computer via a digital I/O parallel interface. Vehicles passing through the lane are detected by loops installed in each lane. Axles are counted by using two-strip Traffic 2000 piezo-electric treadles. The main plaza monitor screen shows vehicle information in real time. Receipts are printed using a thermal paper receipt printer housed in a stainless steel enclosure and linked to the control computer via RS-422. Toll amounts, plaza name, lane number, vehicle class description and other variable text printed on the receipts can be easily changed by a mouse-controlled configuration utility program on each of the plaza systems [2].

A. Drawbacks of Existing System

The above mentioned methods for collecting toll tax have some major drawbacks:

1. They are generally slow and thus high compliance cost, of such a system.
2. Traffic accumulates at the Toll Booth.
3. Increased Fuel Consumption.
4. Even if the smart card system is automatic, it still needs to stop and validate the card.
5. Toll Evaders.



B. Related Work



Canada's 407 ETR for ETC

Automated Toll Collection systems are not new to the 21st Century world, in fact it marked its existence way back in 1970's in the United States of America. Easy-Go system however has different approach compared to their existing models [3].

Their technologies consist of sophisticated Image Processing algorithms which track the vehicle number plates and process the information from it. Although it serves its purpose in Canada, in the worldwide approach, it may not be feasible.

There are number of reasons for that.

1. These high-tech systems generally cost a fortune, since it requires use of high speed video cameras.
2. Extracting the informative images (Optical Character Recognition) from the video is a cumbersome process. It also increases the concept of redundant data.

3. Standardized number plates are needed for this system to work efficiently. Standard number plates are not used everywhere in every country. This reduces the efficiency of the system.

Making use of RFID technology as the heart of the project has its advantages over the existing systems. Most important of all, installing and reading a RFID tag is very easy process and uses much less time. Passive RFID tags are inexpensive and are relatively smaller in size.

III. NEW PROPOSED TOLL COLLECTION SYSTEM

C. Working of new proposed system

New proposed system consists of a Radio Frequency Identification (RFID) tag containing its unique ID. This tag emits RF signal under the proximity of Radio Frequency (RF) reader.

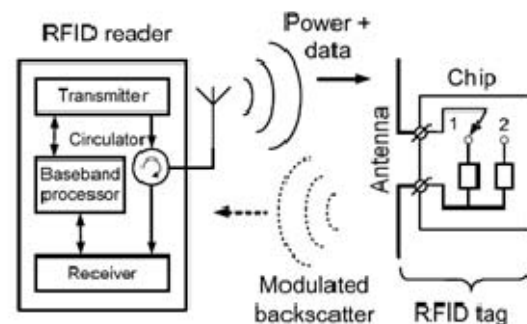
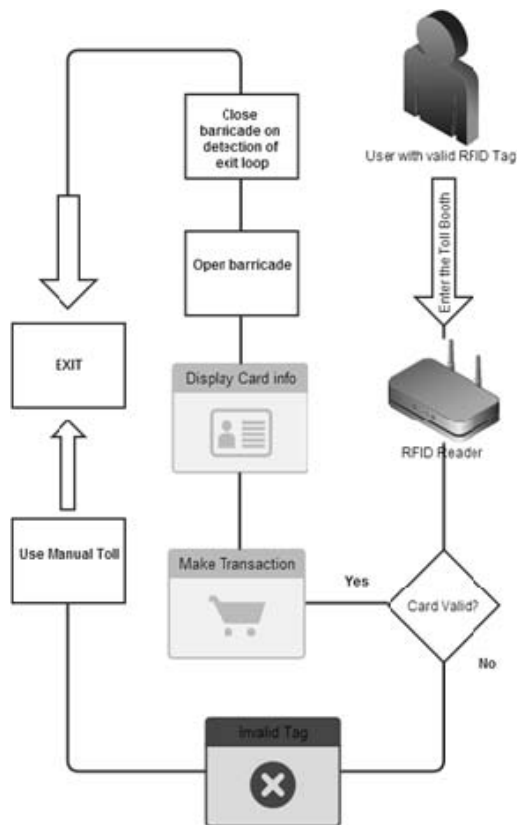


Figure 1. Passive RFID system overview.

Radio-frequency identification (RFID) is the wireless use of radio-frequency electromagnetic fields to automatically identify and track tags attached to objects. These tags usually contain electronically stored information. Tags can be broadly classified as Active and Passive Tags. Passive tags are non-powered and can be read at short ranges via magnetic fields. Active tags, on the other hand, generally use a local power source such as a battery, and may operate at hundreds of meters [4]. Unlike an infrared source or bar code, these tags do not necessarily need to be within line of sight of the reader, and may be embedded in the tracked object.

When the vehicle reaches the toll booth the RFID reader will detect these RF signals and reads the unique ID. This information is then passed to microcontroller for further processing. Microcontroller will in turn, display the information of the vehicle and the card on LCD screen. With the help of PC interface unit the data collected is passed to main server through serial port. Software developed will show all the details about the vehicle on the screen. Details like date & time of the transaction as well as the Unique ID will be stored in the database. Based on these details a bill will be prepared on monthly basis and will be sent to the user for payment.



D. Cloud Based Server

Collected data from the Toll Booths viz. vehicle identification, toll tax amount, place, time etc. all can be stored on a cloud based server. It would be possible to seamlessly transmit the secured data to the cloud based server located far from the toll plazas. Making use of cloud based server it is now possible to add multiple toll booths in cascade and at various places [5].

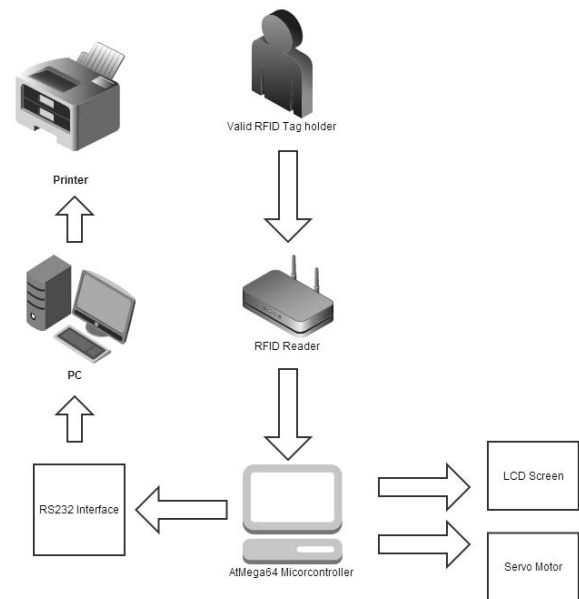
E. Advantages of New Proposed System

The following are the major advantages of this system.

1. Automatic collection of toll tax.
2. Faster and more efficient service.
3. Free flow of traffic.
4. Time saving.
5. Record maintenance.
6. Problems with pursuing toll evaders.
7. Lower the toll collection costs.
8. Low Human interference.



F. Block Diagram



The basic working of Easy-Go system starts with the entry loop. Entry loop can be usually a metal detector, to detect the entry of the vehicle. After the detection of the vehicle, RFID reader would scan the unique RFID tag of the vehicle, eliminating the need to stop the car for this process. Once the unique ID is captured, it is sent to the microcontroller to further process the information and takes the necessary actions.

Assuming a successful transaction, the microcontroller would now display a message on the LCD Screen indicating the success of payment and the validity of the tag. It would also display additional information about the tag like the User Name and License plate number. Simultaneously, the microcontroller would send this information to the server for updating the database and for maintenance of records on the server, by making use of dedicated software, it would be possible to sort the data according to Amount, Date of transaction, Place of transaction, Unique ID, License number etc. Also, barricade would open to let the vehicle move out from the toll booth. Exit loop would be installed here to indicate completion of one loop of entire process.

If for some reason, the tag is not valid or is not properly read, it would display the appropriate message indicating that the tag is not valid and the person should take the detour to make its way to manual toll tax payment.

Monthly bill would be generated automatically and would be sent to the user for payment. Additional information like the place, time, and amount of transaction etc. would be printed accordingly. By making use of various payment methods like online payment system on the website, the user can pay his toll tax. The amount paid would be segregated between various toll tax maintenance companies as per the usage.

G. Expected Result

Making use of Easy-Go system, promising results would be guaranteed. Faster commutation is the first and the most important advantage. Having no need to stop at each toll booths, commuters would save lots of their precious time which was initially wasted. Digitizing the systems has its own advantages as well – maintaining records of all the vehicles and their respective information would now be of much ease and simple to find from the records. This would speed up the

overall process of the system. Since throughput of Easy-Go system increases drastically, the running cost reduces at the same pace. Along with the preliminary advantages and results, vehicle theft would also decrease since each car is monitored at every toll booth, thus increasing the security of the vehicle.

Comparison of Easy-Go systems with existing technologies

Technology	Toll Type	System Used	Payment Method	Cost
US	Two Lanes	Two antenna	Postpaid	High
Canada	Closed Access	OCR & Laser beam	Postpaid	High
Poland	Closed Access	GSM & GPS	Postpaid	High
Easy-Go	Toll Booth	Passive RFID	Postpaid	Moderate

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DESIGN OF HUMANOID AND DRONE HYBRID BY USING ARTIFICIAL NEURAL NETWORK (ANN)

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ABSTRACT

In this we have proposed a multipurpose humanoid system which could be useful in many applications including defense, surveillance and any hazardous working environment. To have exact imitations of human body motions we have used Artificial Neural Network (ANN), which is far better than conventionally used H-bridge and clipper based systems considering such application. In this system we have used 4 accelerometers and flex sensors to imitate human hand gestures and head motions by humanoid. Software logic based mapping technique is employed in order to perform appropriate motions of humanoid with the help of different servo motors. The humanoid system is responsible for imitating fine human body motions without any physical wire connection between user and humanoid system.

I. INTRODUCTION

Recent articles suggest, military needs robots that can change the entire equation of the war as demonstrated by [1], [2]. Considering projected US military spending of \$487 billion, research in robotics has got serious attention according to [3], [4]. This has resulted in development of vast variety of robots in all kind of environment including air bots, aqua bots and ground domain robots as mentioned earlier [2], [5]. They are robust, they are obedient, they are daring, they don't have fear of death, and most important they have proved themselves in Iraq and Afghanistan. The utilization of robotics technology in military led to a new field in robotics i.e. Military Robotics as shown in [6].

In this paper we propose a novel idea of combining humanoid with drone, in order to get advantage of human accuracy and military tank to get ease in traveling on rough and uneven paths. Hence to utilize optimum working capability, it works in two different modes namely humanoid mode and infiltration mode. Such system can be optimally utilised while performing bomb defusing work, atomic radiation labs, chemical lab and in far extent as a future soldier. Basically, any situation where human existence is hazardous still requires human accuracy.

Giving war robots 'autonomy' sparks fear of independent killing machines similar to sci-fi stories and movies. Hence we are optimizing human controlled system that provides smoother and flexible use of humanoid along with achieving desired results. While employing humanoid in extreme conditions, the user wears various sensors on critical positions of his/her body such as joints which are ideal for mapping the sensor output onto the humanoid motions. Outputs of the sensors are provided to microcontroller for further processing.

Through wireless communication the humanoid functioning is performed in accordance with user.

II. WORKING

As mentioned earlier, the system works in two different modes. 1) Humanoid Mode, 2) Infiltration Mode

A. Humanoid Mode

B.

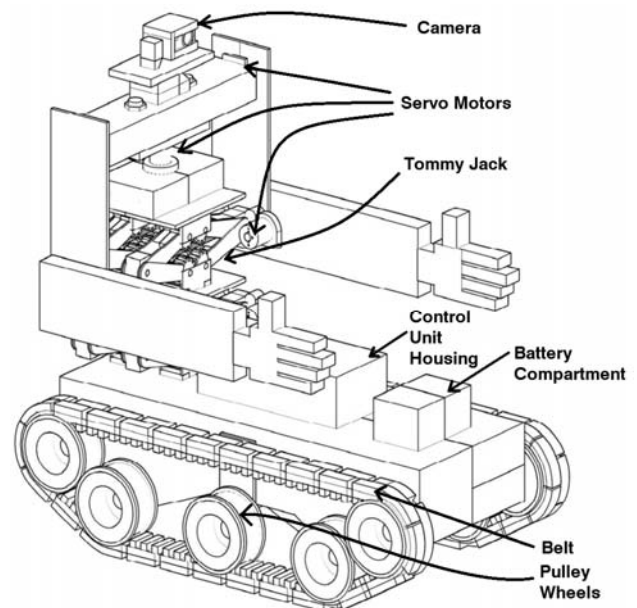


Fig.1 Cad representation of Humanoid drone hybrid

Fig. 1 is our developed cad representation of the humanoid mode. As seen from the diagram, entire humanoid assembly is unfolded to perform human resembling tasks such as picking, holding objects and after certain improvements aiming and firing through modified military guns.

System can be further divided into two distinct parts:

Transmitter (Tx) Side:

In our system, to get accurate hand motion, we have used 3 different accelerometers on three critical positions of the hand nothing but all the joints as shown in the diagram.

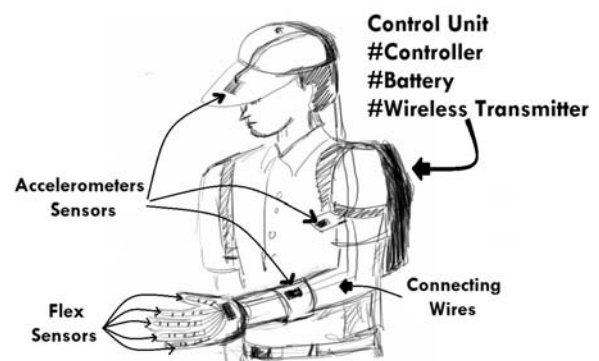




Fig.2 Position of Sensors, Xbee, Controller, Battery at user side

Hence we have placed accelerometer on shoulder, elbow and wrist each. As the accelerometers measures values against gravity, when hand is moved accelerometer output varies. Similarly, to capture the finger motions we have used flex sensors which changes its resistance when we bend them. Both the sensors used are analog sensors means provides output information in analog form. ATmega328 microcontroller takes care of converting analog signal into digital as it is mandatory for further data processing. ATmega328 works along with Arduino Uno board. It converts output analog signal into digital in the range of 0 to 1023. Processed signal is transmitted through XBee wireless module which allows high data rate transmission. As this is experimental prototype, we are using basic Series 1 XBee module. It performs QPSK modulation in order to perform efficient data transmission with baud rate of 9600/s. Further improvements in XBee communication range are described in sections ahead.

Receiver (Rx) side:

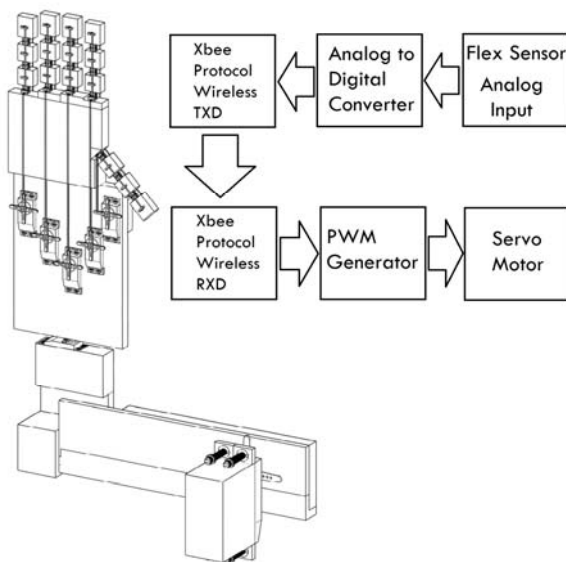


Fig.3 Receiver side working block diagram

At the Rx side, humanoid structure comprised of several servo motors to perform human hand resembling motions. Hence we have mounted servo on each joint of the arm. In addition, there exist 5 servo motors for five fingers.

Processed signal from transmitter is received via XBee receiver. Here demodulation is performed by Rx XBee.

This demodulated signal is still in the digital format and hence couldn't be recognized by the servos present. Now, we are needed to convert the received digital signal into servo understandable signal. Servo understand PWM signal to move in the angle 0-180 degrees. Receiver ATmega328 controller with Arduino Uno board is responsible for signal conversion and providing PWM signal to servos in order to perform appropriate task.

User hand motion and the humanoid motion through servo should be in synchronized with each other. This was the vital challenge faced during the mapping and programming. As the user hand moved in specific angle should match with the servo shaft angle resulting in user imitating humanoid motions.

B. Infiltration Mode

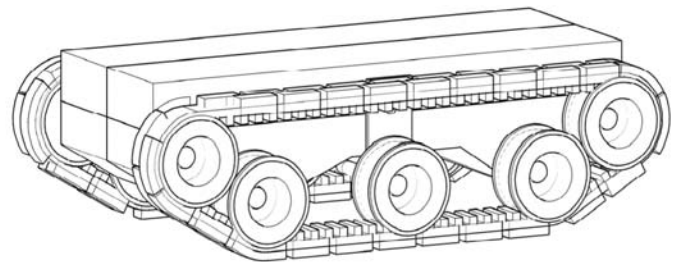


Fig.4 Drone cad representation

In travelling longer distances, which could be regular operation for applications we are looking for. Hence it is design necessity to adapt required physical structure to get ease in travelling. Hence while system is being used in infiltration mode, entire humanoid assembly folds resulting into military tank like structure. Now user can efficiently perform long distance travel.

To perform transformation into infiltration activity, we use DTMF mobile based controller. Here network signal receiving devices such as mobile phones are connected at both transmitter and receiver sides. As it uses mobile based technology inherently it has got infinite range. It means the drone can be accessed wherever mobile signal range is available.

III. MAPPING AND PROGRAMMING

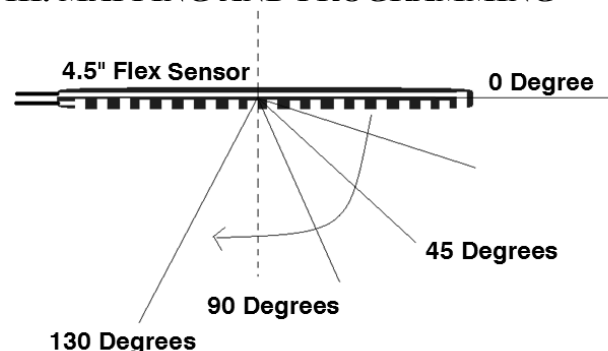


Fig.5 (a) Flex sensor and its angle deviation

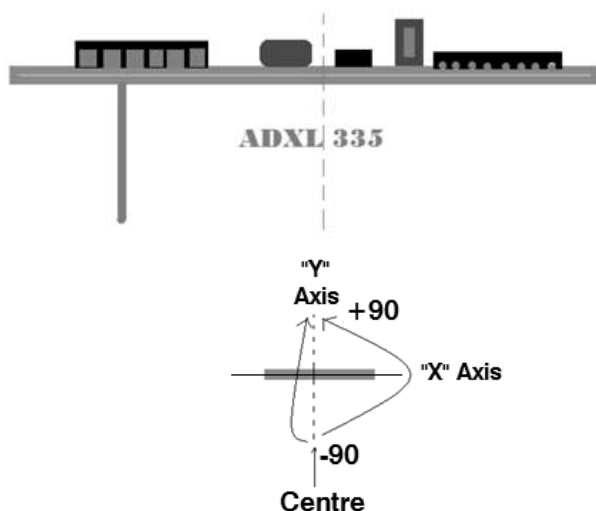


Fig.5 (b) Making use reading from Accelerometers 2 dimensions

As we discussed in prior sections of the paper, gesture glove consist of two types of sensors flex sensor and tilt sensor or accelerometer. There are five flex sensors to get data of the bend of each finger by changing its own resistance. ADXL 335 is 3 axis accelerometer, out of which we are making use of 2 axis for wrist rotation control and forearm motion control. All are analog sensors, thus we process it using ADC (Analog to Digital Converter) which is already present in Atmega 328. Since it has six channel 10 bit ADC, it gives the resolution of incoming analog data in the range of 0 to 1023. Because the all sensors are analog, it shows the large change in value for small motion. To obtain constant and uniform readings we make use of mapping technique. Mapping is a technique to change the range of data from one resolution range to another. Here, as the hand moves the sensor output varies which is mapped in order to achieve the motion through servo motors. At the very beginning performing mapping, we mapped those values in the range of 0 to 9 with the help of accelerometer sensor. Similarly head motion is performed. One accelerometer is placed on the cap of the user which is controlling the motion of robot. We provided two motions for humanoid head namely horizontal and vertical controlled with the help of X and Y axis of accelerometer.

At the receiver side this all values are obtain in the form of integers. The data which is coming in the form of range from 0 to 9 is converted in servo understandable form. Here again mapping is done in the range of 0^0 to 180^0 specified for servo. By defining the specific port the servo motor is controlled.

But in this technique there are certain drawbacks. This technique couldn't achieve fine resolution that could replicate exact human body motion. Since incoming integer values are in the range of 0 to 9, the angles of servo motor are divided into 10 parts each of 18 degree. So there was a need of improvement in coding that could generate smooth servo motion.

Servo Angle to one value of integer = Total angel in degree (180) / total range of integer.

By dividing 180 degrees into 10 equal parts, servo moves in the step size of 18^0 .

To obtain the smooth motion of robotic arm need to reduce the step size in the form of degrees, thus we find an alternative for this method. At transmitter side we mapped the incoming analog value in the range of 100 to 900 and send it in the form of three decimal values. At the receiver side by calling 3 integer values a,b,c we obtain those values. But need to apply one formula to get data in the form of single integer as d.

$$\text{Integer } d = 100 * (a-48) + 10 * (b-48) + c-48$$

Integer – 48 to obtain data values from 0 to 9 from ASCII values.

This method gives us an angle resolution of 0.225 degrees

Servo Angle to one value of integer = Total angel in degree (180) / total range of integer (800).

III. XBEE RANGE IMPROVEMENT

As far as transmission antenna is concern, there are four types of XBee modules are available. Monopole antenna, dipole antenna, pcb mounted chip antenna and RPSMA connector with U.FL connector.

In our system, we are using module with U.FL connector, here user is free to use any high gain antenna of our choice. For our system predicted applications, it needs long range access to system. It is the sole reason to design a high gain antenna for such system.

Our transmission system necessitates antenna with high directivity (high directional gain) to improve the range of the system, high bandwidth as we are considering wireless video transmission with considerably acceptable length. While shortlisting from various antennas we come across log periodic, which full filled our all requirements. Hence we decided to design a novel antenna namely Bi-Coni-Log hybrid antenna, which is modified version of log periodic antenna. Only drawback is its length. Still by optimization through simulation software, we managed to reduce the length to 910mm incorporating very large bandwidth of 1.9GHz (As length is dependent on BW). With this sized length, it is only possible to mount such antenna at the transmitter side where space is not our concern.

Designed antenna hybrid is a combination of log periodic and bow-tie antenna. Designing is performed on WIPL-D Antenna Simulation software licenced from GMRT, TIFR institute.

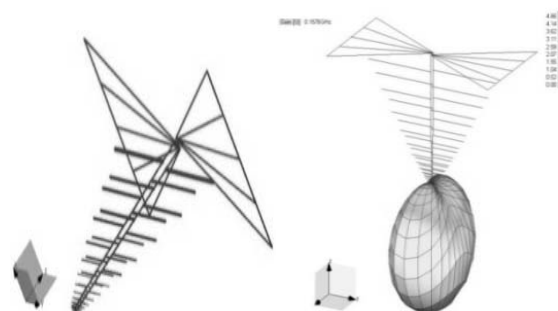


Fig.6 Optimization of Antenna through simulation software WIPL-D



Fig.7 Practical Implementation of the designed antenna

Mathematical expression for improvement of communication range by improving gain of the antenna: Radiated power density at distance R would be:

$$W_0 = \frac{P_t}{4\pi R^2} \quad \text{taken from [7]}$$

Where, P_t = Total power radiated

As the antenna used exerts directive properties, its actual density is,

$$W_t = \frac{W_0 \times D_t}{4\pi R^2} = \frac{P_t D_t}{4\pi R^2}$$

Hence,
$$R^2 = \frac{P_t D_t}{4\pi W_t}$$

i.e.
$$R^2 \propto D_t$$

Which implies range of communication system is directly proportional to directivity (directive gain) of the antenna. Here by replacing monopole antenna with high directive gain hybrid antenna we are going to achieve range more than thrice as earlier.

Similarly, the power received by the antenna and transferred to the load would be,

$$P_r = W_t A_r = \frac{P_t D_t A_r}{4\pi R^2}$$

Where, A_r = Effective area of the transmission antenna

Hence,
$$R^2 = \frac{P_t D_t A_r}{4\pi P_r}$$

i.e.
$$R^2 \propto A_r$$

Which illustrates range of the communication system is directly proportional to area of the receiving antenna. Here we employing two way wireless communications, where live video transmission is performed from humanoid side to user. By improving user side antenna aperture, we are bolstering overall efficiency for high data transmission as well as range of communication. Consequently, we have achieved improvement of range 4 to 5 times than earlier, as improved antenna has area of aperture 4-5 times larger than earlier.

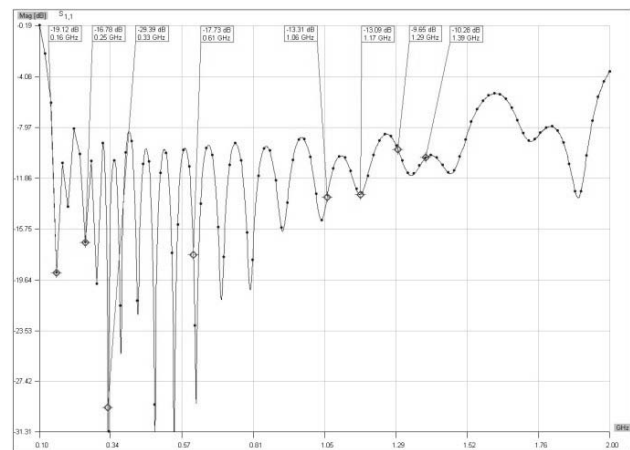


Fig. 8 S11 return loss output from WIPL-D Simulation software

Table I

S11 RETURN LOSS IN DESIRED FREQUENCY BAND

Frequency	S11
150MHz	-19.12dB
233MHz	-16.78dB
327MHz	-29.39dB
610MHz	-17.73dB
1060MHz	-13.31dB
1170MHz	-13.09dB
1280MHz	-9.65dB
1390MHz	-10.28dB

Above reading shows the S11 return loss simulation output, which delineates working frequency band of the designed antenna.

IV. MECHANICAL ARRANGEMENT AND IMPROVEMENT

Mechanical arrangements are meant to be modified according to the surface, application, working operations and surrounding environment. Hence what we have made is a prototype. For example if the application environment is near to poles where icy surfaces are most probably encountered, then drone or base is modified with inclusion of spikes or extra gripping ability. According to application the humanoid is adroitly modified to work for either bomb defusing purpose, future medical applications, in hazardous chemical industry or as a future soldier.

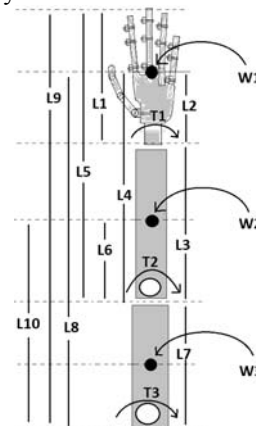


Fig.9 Pictorial representation for understanding calculations

In this prototype, we have made arrangements that could overcome generally faced problems along with few practically helpful modifications.

As we have named it as a humanoid, so it's our obligation to make it as resembling with actual human hand. So we took humanoid body parts ratios exactly equal to actual human body parts.

While considering dimensions, it was necessity to understand market availability of servo motors which could efficiently perform desired tasks. Consequently, we come up with the reading with motor torque requirements.

L1, L2, L3, L4,...L10 are the lengths, T1, T2 and T3 are torques, A1, A2, A3 are weights of respective structures mentioned in the above diagram, their values are as follows:

Table II

Notation	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10
Value(cm)	10	5	20	25	30	10	16	41	46	26

To obtain torque requirement at wrist,

$$T1=L1 \times A1 + 1/2 \times L1 \times W1$$

Where L1= 10 cm, A1= 0.03 kg, W1= 0.13 kg

Hence, T1= 0.9 Kg-cm

Similarly,

$$T2=(L1+L3) \times A1 + (1/2 \times L1 + L3) \times W1 + L3 \times A2 + 1/3 \times L3 \times W2$$

Hence, T2= 6.68 Kg-cm

$$T3=(L1+L3+L7) \times A1 + (1/2 \times L1 + L3 + L7) \times W1 +$$

$$(L3+L7) \times A2 + (1/3 \times L3 + L7) \times W2 + L7 \times A3 + 1/4 \times L7 \times W3$$

Hence, T3 = 16.27 Kg-cm

From above calculations we come to know that which kind of servo to be employed on particular joint.

Consequently, we employed 15, 7.5, 3.5 Kg-cm torque servos for shoulder, elbow and wrist motion respectively.

FORWARD KINEMATICS

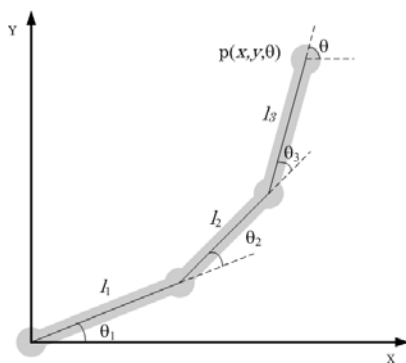
Through forward kinematics we could calculate effective end position or hand position as a function of joint angles.

In this section we are describing graphical forward kinematics method for determining end positions.

According to motions capabilities of designed humanoid arm we can differentiate it into two different following parts

Vertical Planar motion from shoulder to wrist

Horizontal Planar motion of wrist



As you can see from above diagram,

Here l_1, l_2, l_3 are representing shoulder, elbow, wrist length respectively $\theta_1, \theta_2, \theta_3$ are angles made by shoulder, elbow, wrist respectively with horizontal plane.

Using the vector algebra solution to analyses the graph, the coordinate of the robot end-effector can be solved as follows.

$$x = l_1 \cos(\theta_1) + l_2 \cos(\theta_1 + \theta_2) + l_3 \cos(\theta_1 + \theta_2 + \theta_3) \quad \text{---(1)}$$

$$y = l_1 \sin(\theta_1) + l_2 \sin(\theta_1 + \theta_2) + l_3 \sin(\theta_1 + \theta_2 + \theta_3) \quad \text{---(2)}$$

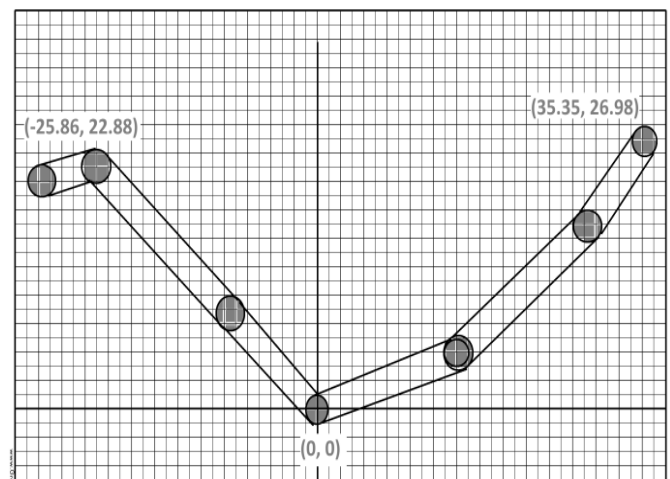
$$\theta = \theta_1 + \theta_2 + \theta_3 \quad \text{---(3)}$$

At each joint we have placed one servo which is solely responsible for variation of angle $\theta_1, \theta_2, \theta_3$. In our system servos are meant to move in window 20° to 130° . Hence while mapping we have to consider this upper and lower limits in order to achieve desired end position of humanoid hand.

By using above formulas,

For rest position $\theta_1, \theta_2, \theta_3$ are 20,20,20 respectively by putting this values and respective lengths ($l_1=16, l_2=20, l_3=10$) in equation (1, 2, 3) we get $X=35.35, Y=26.98, \theta=60$.

Since we are imitating human body motions so while considering extreme positions we have to take $\theta_1, \theta_2, \theta_3$ are 130,20,130 respectively by putting this values and respective lengths ($l_1=16, l_2=20, l_3=10$) in equation (1, 2, 3) we get $X=-25.86, Y=22.88, \theta=280$.



By using minimum and extreme values from above method we have mapped those in servo understandable maxima nad minima by providing window in between necessary values.

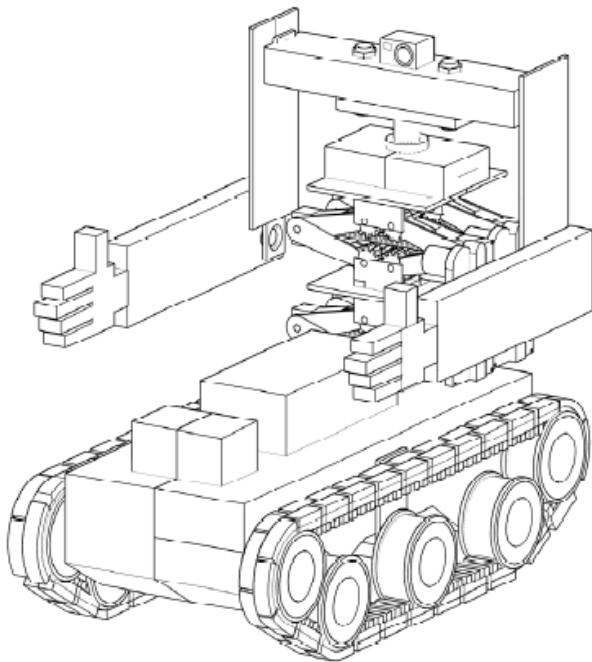


Fig.10 Cad representation of the humanoid robot

Also shown in the diagram, the entire structure is made of stainless steel, wooden material and pipes, it also houses the motors for each of the corner wheels. As one can see, the crawler has a distinct inverted U shaped structure on both the sides. This is accompanied by inclined surfaces on both front and the back ends of the crawler. These modifications allow the robot to climb inclines, traverse uneven surfaces and even climb stairs. The crawler comprises of ten wheels. Out of these, all eight corner wheels are powered by motors which are under DTMF control. However the wheels present at the center of both sides of the crawler are not powered by any motors.

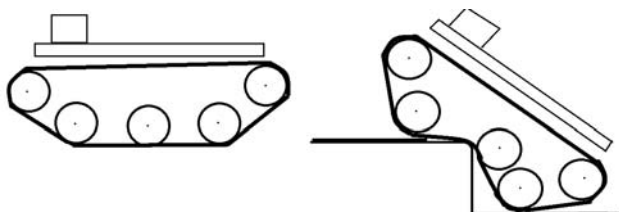


Fig.11 Structural modification of drone for motion on steps

Reference is now made to figure 11, which shows the movement of the crawler on the different types of surfaces. As can be seen, when moving on a levelled surface, the central wheel remains at the same level as that of the other two wheels. But when it starts climbing, the central wheel on both sides is pulled up, thus allowing for better grip as the belt folds around the stairs accordingly, thus increasing surface area and hence increasing grip.

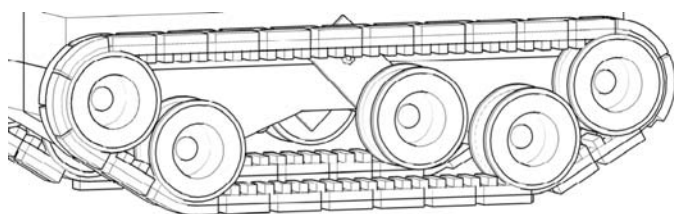


Fig.12 Cad representation of drone structure

Also shown in the figure 12 is a modified belt design. Two belts are used. One for each side. They are mounted around the 5 wheels of each side. These belts play an instrumental role in providing the necessary grip and friction which in turn enables the robot to move and climb effectively. The special thing about the belt we have used is that it is a powder filled belt which consists of several powdered filled blocks attached to the surface of the belt. The advantage of using such a belt is that after the powder-filled belts deforms to match the stair edge, the belts become harder and are therefore able to keep their shapes. This hysteresis characteristic of the attached powder-filled blocks is due to the fact that the powder flow generates a large equivalent friction coefficient at the middle area of the belt, where there is a lower grounding pressure area after the pressure has been increased once.

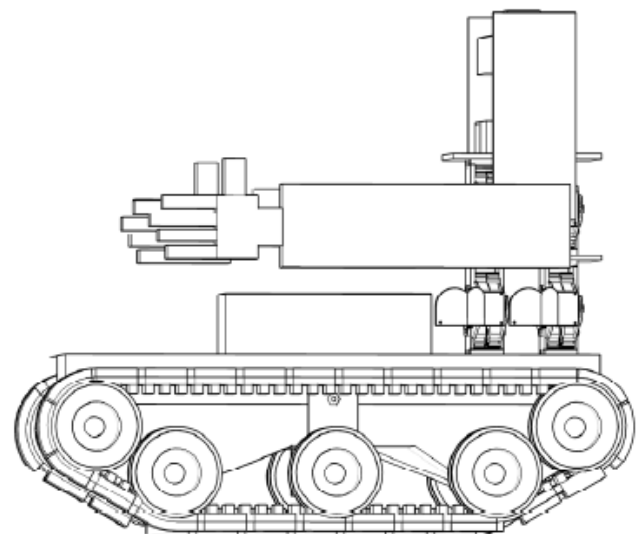


Fig.13 Side view of the humanoid robot

Reference is now made to figure 13 which show the side view of the entire robot. Also shown in the diagram is a feature that allows the assembly comprising of the 2 arms and the head assembly to rotate about its own axis. That is the shoulder and head of the robot can be rotated about its axis without having to move the whole crawler. This is achieved using a motor that is welded to the lifting surface of the two upper jacks and the shaft of which can be seen rising upward from the rectangular aluminium alloy block. The movement of the shoulder assembly is again controlled by the head accelerometer along with the right hand wrist accelerometer. If the right hand wrist accelerometer is bent in a direction opposite to natural motion for a duration of more than 5 seconds, the motor in charge of moving the two arms and head together is activated and moves or turns the shoulders and the head assembly according to the movement of the controller's head.

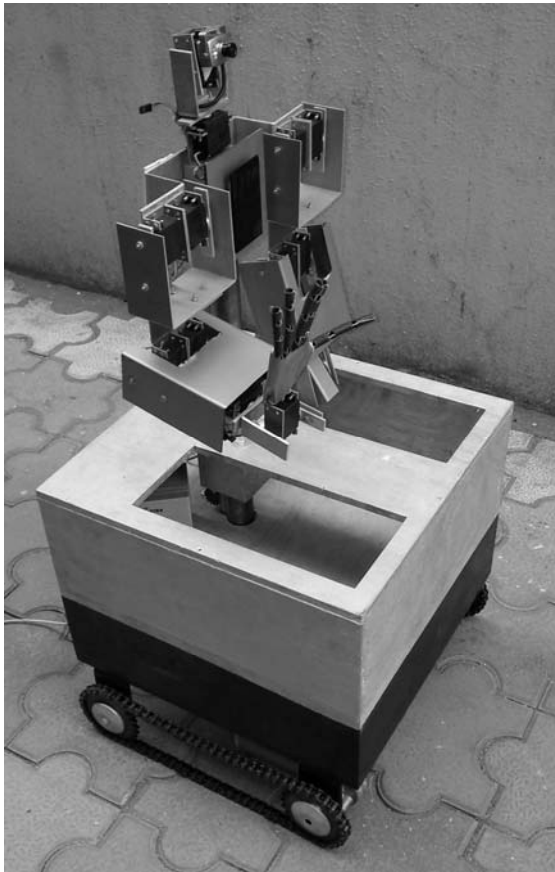


Fig. 14 Practical implementation of the humanoid drone hybrid

Apart from the features mentioned above the robot has several safety features like motor overload protection, limit switch for power failure etc. causing generation of emergency condition and holding the entire robot assembly static in the event of failures.

ACKNOWLEDGMENT

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PROGRAMMING OF ROBOTIC CELL FOR REDUCING CYCLE TIME & IMPROVED WELD QUALITY OF A DEFENDER SAFE PRODUCT

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ABSTRACT

Automation Industry uses welding robots for critical & Repetitive jobs. Welding Robot mimic the motion of a human welder, but robot arc welding gives greater accuracy and repeatability than its human counterpart. This paper is devoted to programming of ABB robot to weld different models of Defender Safe Product of Godrej Security Solutions. To meet the increasing demands, Godrej Security Solutions decided to set up an automation line, thus a Master Frame was manufactured from square Pipes & 5mm thick plates for defining work object & teaching positions welding seams accurately as C-shells used manufacturing Defender safe have some tolerance in their dimensions. To fulfil demands of production robotic cell needed to supply welded outer body on transfer line within required takt time, thus cycle time was reduced by increasing robot utilization time.

Keywords : welding robot; programming of ABB robot; reducing cycle time.

I. INTRODUCTION

A robot is defined as an automatically operated machine that replaces human effort although it may not resemble a human. A robot is designed and meant to be controlled by a computer or similar device. A robotic system that can be used together with the robots to perform the necessary tasks. The motions of the robot are controlled through a controller that is under the supervision of the computer which is running some type of program. Thus if the program is changed, the actions of the robot will be changed accordingly. Thus the robot is designed to be able to perform any task that can be programmed (within its limit and work envelope) simply by changing the program [1].

The aim of this project is to program a robot to perform welding operation in sync with reciprocating fixture & gantry loader-unloader so that welded outer body is continuously fed to automation line. This programming was done with an industrial robot (ABB IRB 1600) using RAPID programming language.

II. SYSTEM DESCRIPTION

To illustrate this project, the block diagram of the system is as illustrated in Fig.1. Fixture & Loader-unloader gantry are used to bring the workobject in Robotic cell. The main focus of this project is programming robot & interfacing it with other components of system for continuous welding of Defender Safe outerbody in Robotic Cell.

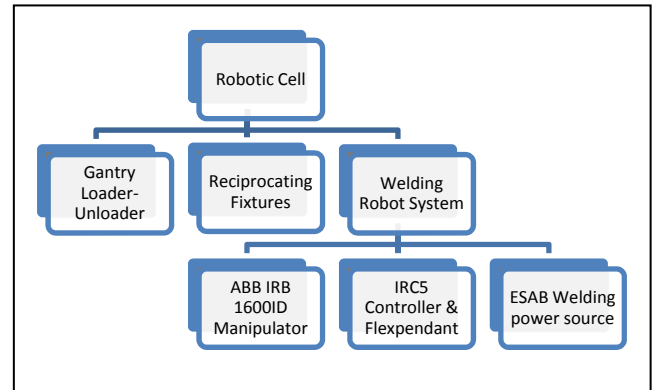


Figure 1: System Block Diagram.

A. Component Study

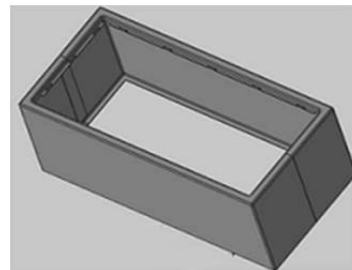


Figure 2: Assembly Diagram of Defender Safe Product

The outer body of Defender Safe product consists of C-shaped shells along with two joint strips, two vertical stiffeners & two horizontal stiffeners are welded together to get outer body as illustrated in Figure 2 which are drawn using Solid works Design software [2]. The C-shaped shells are manufactured by bending & folding operation of 5mm thick M.S. plate. While Horizontal & Vertical Stiffeners are manufactured by laser cutting operation, followed by notching.

B. Welding Parameters

Proper parameter setting of welding is needed to achieve smooth, spatter-free welding & also to get good welding quality. Usually Material thickness, wire diameter, voltage, wire feed, speed & gas flow rate are important factors. ABB has collaboration with ESAB for providing wire feeder, wire spool & welding source. Thus according to ESAB manual [3] welding seams in Defender Safe Product are in 1F/2F & 3F/4F positions & following are the recommended parameter settings for those positions.

Table I: Recommended welding Parameters by ESAB [3].

Position	1.2mm (15-20mm stick out)			Ø1.2mm (Wire Diameter)	Gas Flow Rate (l/min)
	I (A)	v wire (m/min)	U(V) Voltage		
1F/2F	180-300	6.0-14.0	24-31	Suitable	15-20
3F/4F	180-250	6.0-10.0	23-28	Suitable	15-20

Thus we made two welding schedules on basis of guidelines provided by ESAB manual [3].

Table II: Actual Welding Schedules used in Robot Program

Components	Joint Strips	Vertical & Horizontal Stiffener's
Position	3F/PF	1F/2F
I (A)	180-300	180-250
v wire feed Rate (m/min)	6.2	10.4
U(V) Voltage	22.5	26.5
Welding Schedule	9	1
Gas Flow Rate(l/min)	15-20	15-20

C. Flexpendant

The flexpendant which is also referred to as the teach pendant unit, is a hand held operator unit used to perform many of the tasks involved during the operation of a robot system such as modifying the work object, jogging the robot manipulator, modifying RAPID programs and it is also used to create instructions using teach method and jogging.[4].

D. IRC5 Controller

The IRC5 controller contains all the functions required to move and control the robot manipulator. The controller consists of two modules, the control module and the drive module. The control module contains all the control electronics such as main computer I/O boards and flash memory. The control module runs all software necessary for operating the robot system. The drive module contains all the power electronics supplying the robot Motors.

An IRC5 drive module may contain nine drive units and can handle six internal axes plus two or additional axes depending on the robot model [4].

E. IRB 1600ID Manipulator

The IRB 1600ID is a 6-axis industrial welding robot which can floor mounted, tilted and inverted, designed specifically for manufacturing industries that use flexible robot-based automation. The robot is equipped with an operating system called Robot Ware 5.13. This Robot Ware controls the motions, development and execution of programs. The IRB 1600ID robot manipulator has a weight of 250 kg and a repeatability position accuracy of 0.02mm. The average speed of the robot based on TCP velocity is 2.1 m/s. The robot uses a voltage supply of 200 – 600 V with 50 or 60 Hz frequency and a reach of 1.5m. [5].

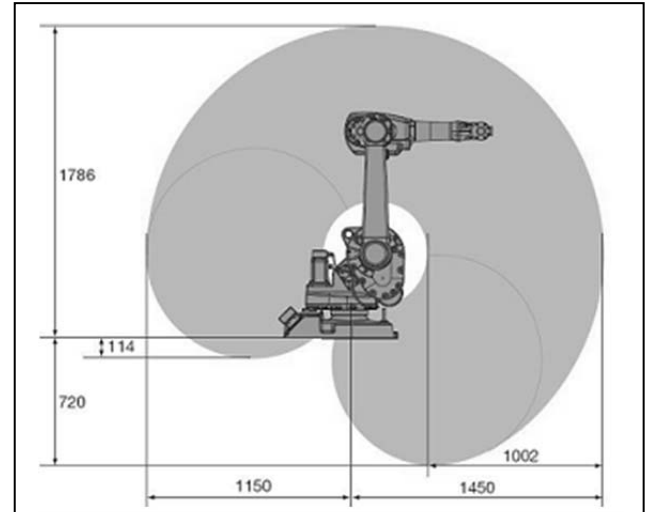


Figure 3: Workspace Diagram of IRB 1600ID Robot.

F. Layout of Robotic Cell [6].

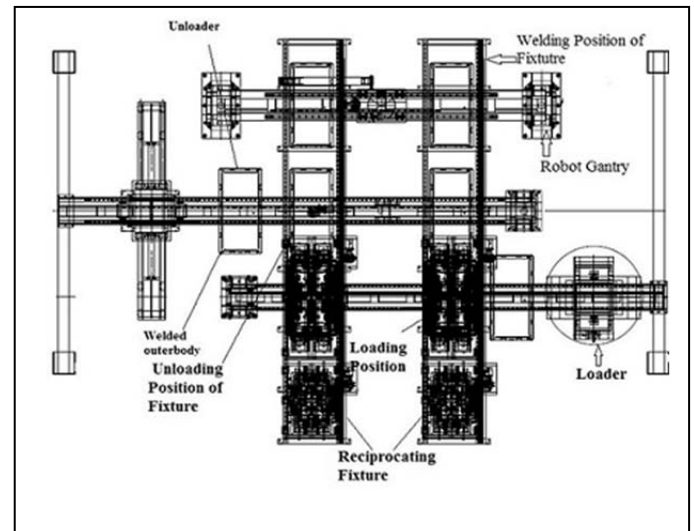


Figure 4: Layout of Robotic Cell.

Layout of welding cell is as illustrated in Fig 4.

- Orientation Trolley- has conveyors for pushing two C-Shaped shell forward & proximity sensors to detect the left & right hand side of C-shaped Shells.
- Loader-will pick up the unit & put on reciprocating fixture. (Y-direction).
- Reciprocating Fixture - moves to & fro linearly in x-direction to bring the outer body in work envelope of robot.
- Welding Robot 1- welds two Joint strips & 4 stiffeners to form outer body of Defender Safe.
- Unloader-will pick welded outer body of Defender Safe & places it on Transfer line.

II. PROJECT IMPLEMENTATION

The main objective of this project was to reduce cycle time & give consistent weld quality with given tolerance of outer body size of Defender safe .Thus layout study (Fig.4) was done for fixing position of loading, unloading & welding of Defender

Safe. Positioning is needed so that Gantry-Loader precisely loads the outer body shells on both the fixtures & also it should unload welded outer body precisely. Gantry loader, Unloader & Reciprocating fixtures use servomotor for its movement which is programmed by Mitsubishi Q series PLC. Thus by using PLC first HMI for Loader-Unloader gantry Fixture & Robot Gantry was made for ease of positioning. Plumb-bob as shown for centring as it is y-axis equivalent of a "water level".

A. Calibration of Robot

After positioning, calibration of every axis is done as it is necessary for accurate robot mov

. [7]

B. Workobject Definition

A work object is a coordinate system used to describe the position of a work piece. All programmed positions will be related to the work object frame which is related to the world coordinate system. This is done by defining three positions, two on the x-axis and one on the y-axis. Master frame (Fig 5) was made from hollow square pipes of sizes 40X40mm & 25X 25mm. All stiffeners & joint strip were also welded to this master frame. Same body were used to teach location of welding seams to Robot. On top of square frame for blocks were welded at centre of length & width to define X1, X2 & Y1 points. The points X1, X2 & Y1 are defined in such a manner that origin of work object is centre of cubic space of body. The work object is defined in such a way that it utilises maximum work envelope of robot & and robot can also reach at all points in body with ease & without singularity problem. The work envelope of Defender Safe were from X= -775mm to +775mm, Y= -392.5mm to 392.5mm & Z= 0 to 740mm. [8]

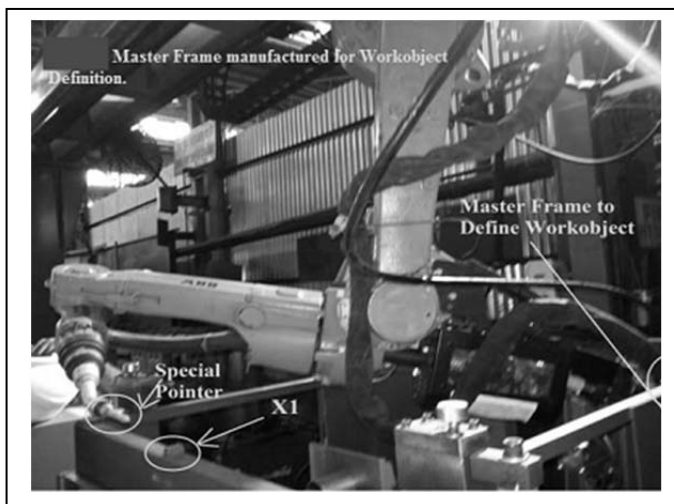


Figure 5: Master Frame manufactured for work object Definition.

C. Safety Interlocks

Safety interlocks are of immense importance:-

- Avoid machine accidents because of interference of two machines.
- To prevent any possibility of accident, which may cause danger to the life of operator.

To configure safety interlock a chunk of bits are reserved in two categories DO (Digital outputs) & DI (Digital Input). But same numbers of bits were reserved in PLC of main controller as that of IRC5 controller of robot.

Interlocks are configured using cross connections. The purpose of Logical Cross Connections is to check combinations of digital signals. This can be used to check or control process equipment that are external to the robot. The functionality can be compared to the PLC of main controller. By letting the I/O system handle logical operations with signals, a lot of RAPID code execution can be avoided. Logical Cross Connections can replace the process of reading signal values; calculate new values and writing the values to signals. [9]

D. Teaching Robot to weld.

For programming robot to weld it should be taught about welding seam orientation, air cut points, welding seam length & other parameters. Usually for teaching robot to weld it is jogged with the help of Flexpendant to all welding seam positions & coordinates of that point are recorded in various instructions within the program. Teaching is more precise than offline programming as it records actual coordinates & the possibility of robot colliding while execution of program is also eliminated.

E. Smartac Routine

Smartac is a tactile sensor used to find the location of inconsistent weld joints and offset the programmed points in a weld program. Once welding program is complete smartac program is developed & its offset distances are included in welding program to compensate the variation in dimension C-shells manufactured by bending & folding process. [10]

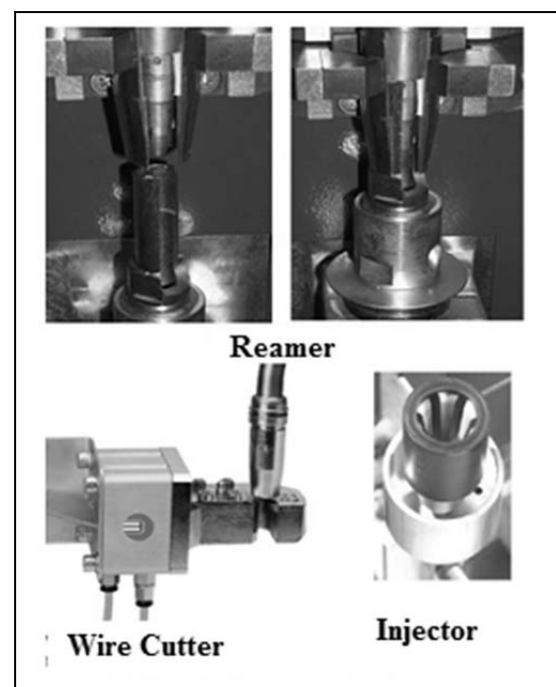


Figure 6: Robot Gun Cleaning Unit

F. Gun cleaning Routine

Gun cleaning or torch cleaning of robot is required after every welding cycle because spatter gets accumulated in gun & accumulated spatter leads to joint collision error. Thus for continuous welding operation gun cleaning at regular interval is recommended. ABICOR Binzel manufactures Gun cleaning unit for ABB which consists of wire cutter, reamer & injector (spraying unit) as illustrated in Fig.6.

G. Main Program

After creating welding & smartac routine Move J points are modified as depth of Class-A is more than Class-C. But welding seam locations for both the models are same thus all ArcL (Programming instruction in rapid used for welding operation) points are kept same. Now to identify various models part type data is taken from orientation unit. "5" & "11" were used for identification of class C & class A respectively. Modification of welding program lead to saving of memory space in Flexpendant by 50% as there are only two welding routines instead of four. In Main program first confirmation is taken from main controller that fixture & robot are at welding position, then depending part type (Class identification) welding & smartac routine is called in main program, while gun cleaning routine is same for all classes. Detail flow chart of programming is shown in Fig.7

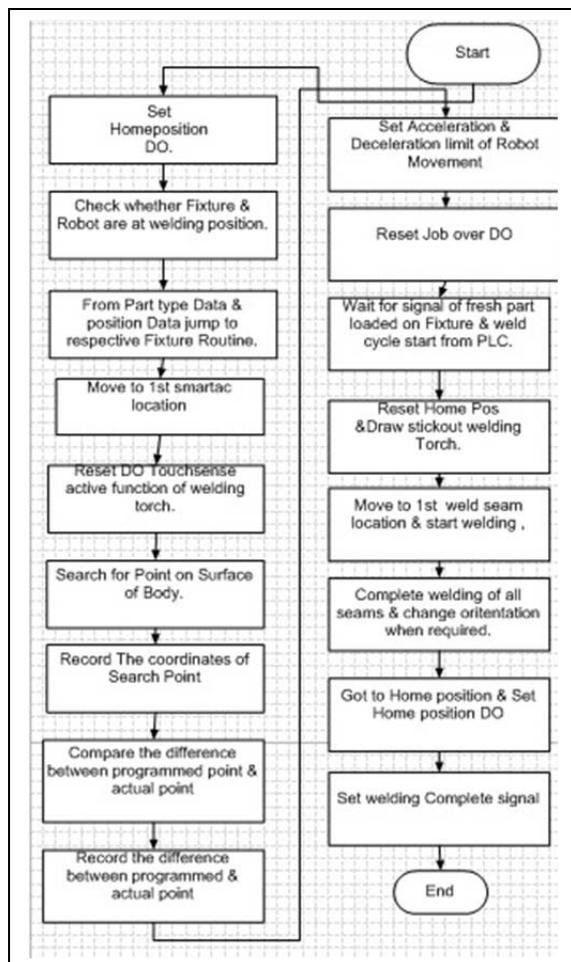


Figure 7: Flow chart of Software Programming

III. RESULTS AND DISCUSSIONS

A. Result

Figs. 8 show the picture of the ABB robot welding Defender Safe Body & Figure 9 shows uniform welding beads obtained by welding Robot on Joint strip in 3F/PF position (a) & in 1F/2F position on vertical stiffener (b) of Defender Safe.

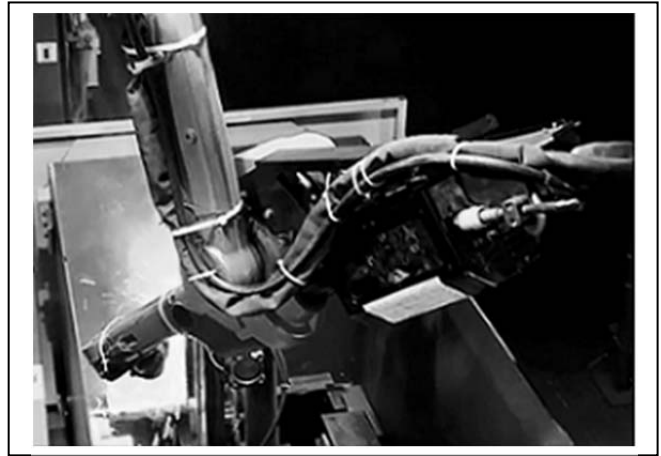


Figure 8: Robot Welding Class-A Body of Defender Safe.

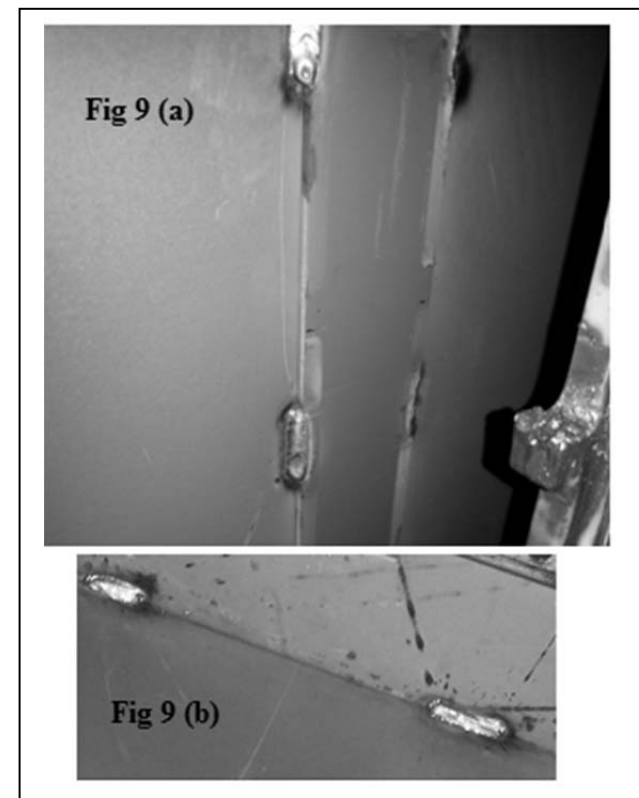


Figure 9: Uniform welding beads obtained by welding Robot on (a) Joint strip & (b) Vertical stiffener of Defender Safe.

B. Discussion

Simulation of the robot movement carried out so that the paths and targets could be visualised & welding seam location could also be confirmed, before starting actual welding trials. The basic structure of main program & other routines was written into the Flexpendant, but actual value of Move J, Arc L & smartac points was recorded in to it by teaching. The work object was created in such way that it could enable the welding

torch to reach each of 48 welding seams with ease. While welding trials it was noticed that the filler material while welding joint strip in 3F/PF position was dripping & welding bead was not uniform.

This problem was solved by reversing the path of traverse of robot, first robot used to go from down to up direction but later it was reversed also shielding gas flow rate was adjusted to get uniform welding Bead as illustrated in Fig 9. As mentioned in bit III. G welding routine was modified so that same program can work for Class-A & C.

In some cases while welding robot used to give joint collision error while welding last 4 seams of Defender safe as its welding torch could get filled with spatter when nearing end of welding cycle. This problem was solved by modifying reaming position in gun cleaning position (Figure 6) so that spatter in welding torch could remove completely at the end of every welding cycle.

The zone data was modified for the critical paths as shown in Figure 8 in which there were possibilities of robot axes & wire feeder could have collided with fixture or Defender safe. In such cases a zone from the range of 10mm (z10) to 200mm (z200) depending up on criticality of path were Defined as illustrated in Table III.

Table III: Zone data for points used in Rapid Program

Zone data	Value
Fine	The robot will go exactly to the specified position
z10	The robot path can cut corners when it is less than 10 mm from the destination point
z50	The robot path can cut corners when it is less than 50 mm from destination point

All the 48 welding seams on outer body of Defender Safe were successfully programmed on both the reciprocating Fixtures and Robot Interfacing with main controller was successful.

The programming of welding seam, traversing path and an interfacing was done on the robot proved to be efficient for both Class-A & C of Defender Safe Product. The robot was able to move through all the programmed paths at maximum speed. Despite variations in C-shells due to bending process the robot was able to weld with same accuracy due to use of smartac feature. (Bit III. E)

IV. CONCLUSION

The aims and objectives that were set at the beginning of this project were successfully achieved in the project. The need of programming an industrial robot for welding arose from increasing demand for defender safe product. From this project, I was able to program ABB IRB 1600ID robot for welding all seams on Defender Safe product and also for Gun cleaning. The Robot was able to weld with maximum speed & accuracy for all paths & routines created for both fixtures and the robot was also able to achieve reduction in cycle time by 10%; also welding quality was consistent for entire manufacturing shift.

ACKNOWLEDGMENT

I want to thank **Mr. Dalpat Panchal** (General Manager, Engineering & Automation, Godrej Security Solution Division) & **Mr. Rajesh Shende** (Associate General Manager, Engineering & Automation, Godrej Security Solution Division) for giving me this opportunity of doing this project. I would also like to thank **Mr. Vijaykumar Patil** (Senior Manager, Engineering & Automation, Godrej Security Solution Division) & **Mr. Brahmadeo Kamble** (Manager, Engineering & Automation, Godrej Security Solution Division) for guiding me throughout my project work.

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SIMULATION OF A DISCRETE SLIDING MODE CONTROLLER FOR HOLLOW COMPOSITE STRUCTURES TO SUPPRESS THE VIBRATIONS

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ABSTRACT

This paper features the modeling and design of a discrete sliding mode controller to control the vibrations of a smart thin walled composite box beam. Collocated piezoelectric patches are bonded as sensor / actuator to the master structure at a certain finite element location on the beam, i.e., nearby the fixed end of the composite box beam.

INTRODUCTION

The beam structure is modeled in state space form using the concept of piezoelectric theory, the Timoshenko beam theory and the Finite Element Method. The beam is subjected to an external disturbance (say, impulse or sine or random excitation). DSM controller is designed for the smart composite box beam. When the proposed controller is put in the loop with the plant, the plant performs well and the vibrations are damped out in a quicker time. The performance of the proposed controller is thus evaluated for vibration control and the conclusions are drawn.

Active vibration control is an important problem in structures. One of the ways to tackle this problem is to make the structure smart, intelligent, adaptive and self-controlling. The main objective of Active Vibration Control (AVC) is to reduce the vibration of a system by automatic modification of the system's structural response. In many situations, it is important to minimize these structural vibrations, as they may affect the stability and performance of the structures. This obviates the need to strengthen the structure from dynamic forces and disturbances in order to minimize the effects of vibrations and enables the development of lighter, often-cheaper structures exhibiting superior performance. Thus, the vibration control of any system (say, for example, a composite beam) is always a formidable challenge for any control system designer. Composites are being used widely as construction materials in aircraft industries because of their high strength to weight ratio, increased fatigue life and improved damage tolerance characteristics.

Modelling of system

Thin walled structures are integral parts of an aircraft. In many cases (rotor blades, wing spars etc), they can be modeled as one-dimensional beams, as the sectional dimensions are much smaller compared to the length. Several non-classical behaviors are exhibited by thin walled composite structures, which include the effect of elastic coupling, transverse shear deformation and restrained torsional warping. These characteristics can be successfully exploited for various aircraft applications. Normally, 1D modeling is sufficient to capture the essential features of the box beam. 1D approximation are associated with the assumption of local displacements in terms of generalized beam displacements, namely extension, bending in two directions, shear in two directions & twist.

In the present paper, a composite thin walled beam element with surface mounted PZT patches with open and closed contours is used for vibration control purposes. The element uses higher order interpolating polynomials that are derived by solving the electromechanically coupled static homogeneous governing differential equations and hence gives an exact elemental mass and stiffness matrix. Each node has six degrees of freedom (DOF), which include extension, two bending degrees of freedom in span wise and chord wise directions, corresponding rotations and twist.

First-order Timoshenko beam theory is used for modeling transverse shear deformation and out-of-plane torsional warping is modeled using Vlasov theory. A glass-epoxy box beam with 2 surface mounted PZT patches is used for the vibration suppression of the bending modes. The material properties and dimensions of the box beam and the PZT patches are taken from a standard beam. The cantilever box beam has a ply lay up of $[0_3 / 90_2 / 0_3]$ on all the 4 sides. The governing differential equation for a smart thin walled composite box beam is obtained.

These governing equations and the associated boundary conditions will be used for stiffness and electromechanical coupling matrix formulation. This is done by assuming appropriate polynomials for the displacement field based on the order of the static part of the differential equations and substituting these back into the governing equations. In this process, certain constants can be eliminated and, at the same time, certain constants become dependent on material and sectional properties.

The formulated smart beam element has the super convergence property as it uses exact solutions to the electromechanically coupled governing equations as its interpolation functions.

Hence, for point loads, one element between any two discontinuities is sufficient to capture the exact response for static analysis. This results in a substantial reduction in the system size. For dynamic analysis, a consistent mass matrix formulated on the basis of the interpolation functions is used. As a result, for a given discretization, the accuracy of the present formulation is expected to be superior compared to that of elements formulated on the basis of the conventional polynomial approximation. This is because the stiffness of the structure, which is exactly represented, is prone to higher error if an approximate polynomial is used in its formulation as is done in the conventional formulation.

The displacement vector $\mathbf{x}$ of the full system contains all the nodal displacements at each node. Using the equation of motion, the state space model of the system is obtained as

$$\dot{\mathbf{x}}(t) = A\mathbf{x}(t) + Bu(t) + Er(t), y(t) = C\mathbf{x}(t),$$

where A , B , C , E are the system matrix, input matrix, output matrix and the external disturbance matrix which couples the disturbance to the system. The output of the system is taken as the tip displacement. In many engineering problems, efficient reduction or condensation schemes are required to not only reduce the model size and decrease the computational time, but also to retain only the measurable degrees of freedom from the full analytical model. In the above case, the order of the system obtained was fairly high, i.e., 120, therefore, before we apply any control strategy, a reduced model for the above system needs to be obtained.

Thereafter, model order reduction is carried out eliminating the fast modes. For model order reduction, we use Marshall technique wherein, the system is decoupled into faster and slower modes and then derivative of the states corresponding to faster modes is set to zero and then solve for the remaining states. This method ensures that the response of the

reduced order model has correct steady state values and still maintain satisfactory dynamic behavior. The control strategy for the SISO representation of the developed smart composite beam model using the discrete sliding mode control law with 1 actuator input u and 1 sensor output y .

Simulations are done in Matlab as well as in Simulink. The open loop response, closed loop, the control input required to damp out the vibrations are observed and are shown in the figures below. A mathematical model for the composite box beam formulated is used for the vibration control purposes in the paper. A two-node beam element with 6 DOF is used to formulate the composite box beam element using Timoshenko beam theory.

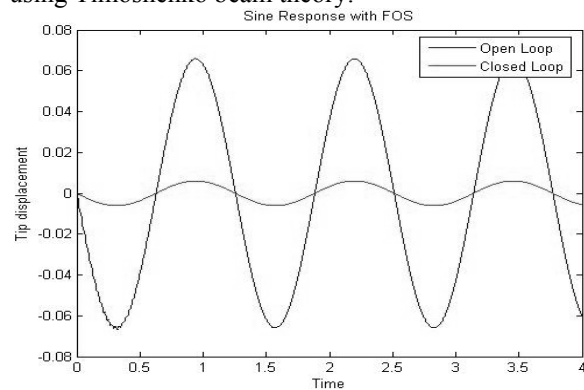


Fig. 1 Open loop and closed loop responses with and without the controller

Then, the state space model is validated by modeling the same beam structure in Msc PATRAN and NASTRAN and thus correlating the natural frequencies obtained by the 2 procedures. The sensor is used to sense the vibrations in the beam and send to the controller, where the signals are evaluated and corresponding destructive signals to curb down the vibrations are calculated by the controller. Finally, this is given as input to the actuator will induces destructive anti-vibration signals in the beam to reduce the overall vibration signature of the beam. Simulations are done in Matlab as well as in Simulink.

CONCLUSIONS

The modeling and design of a discrete sliding mode controller to control the vibrations of a smart thin walled composite box beam was considered in this paper. Collocated piezoelectric patches are bonded as sensor / actuator to the master structure at a certain finite element location on the beam, i.e., nearby the fixed end of the composite box beam and responses are observed with and without the controller. From the simulation results, it is observed that without the controller, the vibrations are existing and with the controller, the vibrations are dampened out. This

shows the effectiveness of the method proposed in this paper.

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DEVELOPMENT OF SWARM INTELLIGENCE IN MOBILE ROBOTICS SYSTEMS

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ABSTRACT

Swarm robotics is a relatively new and rapidly growing field in collective robotics. It involves the coordination of multirobot systems, which consist of large numbers of mostly simple physical robots. It is supposed that a desired collective behavior emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behavior occurs. Both miniaturization and cost are key-factors in swarm robotics. An application in which self-organization and self-assembling can be useful is the classical Search & Rescue in complex environments.

Index Terms : Grating, Light valve, Swarm Intelligence, S-bot, Self-Organizing, Swarm-Bots project.

I. INTRODUCTION

The research of Swarm Robotics [1] is to study the design of robots, their physical body and their controlling behaviors. It is inspired but not limited by the emergent behavior observed in social insects, called Swarm Intelligence (SI). Relatively simple individual rules can produce a large set of complex swarm behavior. A key-component is the communication between the members of the group that build a system of constant feedback. The swarm behavior involves constant change of individuals in cooperation with others, as well as the behavior of the whole group.

The paper is organized in the following sequence. A brief introduction about the survey work in the paper was given in the previous paragraphs. The section 2 gives information about distributed swarm intelligence. Section 3 gives the information about the hardware description of how to construct a bot. Section 4 discusses about applying the GLV technology. In section 5, comparison of the GLV technologies is presented. This is followed by the conclusions in section 6 and the references.

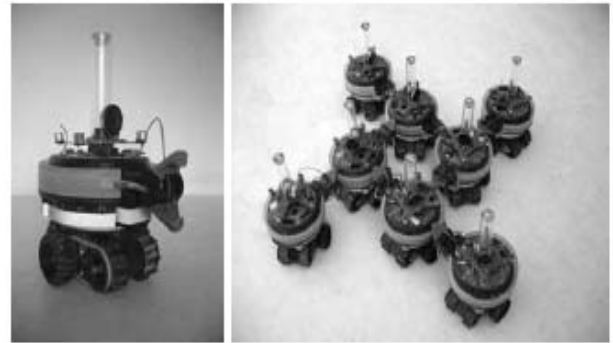


Fig. 1: Left: An s-bot. Right: A “star-shaped” swarm-bot composed of 8 s-bots.

For example, a Swarm Robot could transport an object too heavy for a single S-bot or it could navigate in environments where, because of the terrain roughness, an individual S-bot would have major difficulties (see Fig. 1).

A. Goals

Both miniaturization and cost are key-factors in swarm robotics. These are the constraints in building large groups of robotics; therefore the simplicity of the individual team member should be emphasized. This should motivate a swarm-intelligent approach to achieve meaningful behavior at swarm-level, instead of the individual level.



Fig.2 : Left: 6 S-bots, of which 4 in Swarm Robot formation, collaborate to transport a heavy object. Right: A 4 S-bots linear Swarm Robot moves on rough terrain.

B. Applications

Self-organization and self-assembling properties of Swarm Robots can be useful in the *Search & Rescue* operations in complex environments. Other potential applications for swarm robotics include tasks that demand for miniaturization (nanorobotics, microbotics), like distributed sensing tasks in micromachinery or the human body. On the other hand swarm robotics can be suited to tasks that demand cheap designs, for instance mining tasks or agricultural foraging tasks. Also some artists use swarm robotic techniques to realize new forms of interactive art.

II. SWARM INTELLIGENCE

Swarm Robotics finds its theoretical roots in recent studies in Swarm Intelligence (SI). Swarm Intelligence is artificial intelligence based on the collective behavior of decentralized, self-organized systems. The expression was introduced by Gerardo Beni and Jing Wang in 1989, in the context of cellular robotic systems. SI systems are typically made up of a population of simple agents interacting locally with one another and with their environment. The agents follow very simple rules, and although there is no centralized control structure dictating how individual agents should behave, local interactions between such agents lead to the emergence of complex global behavior. Natural examples of SI include ant colonies, bird flocking, animal herding, bacterial growth, and fish schooling. The application of swarm principles to robots is called swarm robotics, while Swarm Intelligence refers to the more general set of algorithms.

A. Example Algorithms

1) Ant colony optimization

Ant colony optimization [3] is a class of optimization algorithms modeled on the actions of an ant colony. Artificial 'ants' - simulation agents - locate optimal solutions by moving through a parameter space representing all possible solutions. Real ants lay down pheromones directing each other to resources while exploring their environment. The simulated 'ants' similarly record their positions and the quality of their solutions, so that in later simulation iterations more ants locate better solutions. One variation on this approach is the bee's algorithm, which is more analogous to the foraging patterns of the honey bee.

2) Particle swarm optimization

Particle swarm optimization [PSO] is a global optimization algorithm for dealing with problems in which a best solution can be represented as a point or surface in an n -dimensional space. Hypotheses are plotted in this space and seeded with an initial velocity, as well as a communication channel between the particles. Particles then move through the solution space, and are evaluated according to some fitness criterion after each time step. Over time, particles are accelerated towards those particles within their communication grouping which have better fitness values. The main advantage of such an approach over other global minimization strategies such as simulated annealing is that the large number of members that make up the particle swarm make the technique impressively resilient to the

problem of local minima.

B. Particle Swarm Optimization Algorithm

Suppose the following scenario: a group of birds are randomly searching food in an area. There is only one piece of food in the area being searched. All the birds do not know where the food is. But they know how far the food is in each iteration. So what's the best strategy to find the food? The effective one is to follow the bird which is nearest to the food. PSO learned from the scenario and used it to solve the optimization problems. In PSO, each single solution is a "bird" in the search space. We call it "particle". All of particles have fitness values which are evaluated by the fitness function to be optimized, and have velocities which direct the flying of the particles. The particles fly through the problem space by following the current optimum particles.

PSO is initialized with a group of random particles (solutions) and then searches for optima by updating generations. In every iteration, each particle is updated by following two "best" values. The first one is the best solution (fitness) it has achieved so far (The fitness value is also stored). This value is called pbest. Another "best" value that is tracked by the particle swarm optimizer is the best value, obtained so far by any particle in the population. This best value is a global best and called gbest. When a particle takes part of the population as its topological neighbors, the best value is a local best and is called lbest. After finding the two best values, the particle updates its velocity and positions with following equations below.

$$V[i] = v[i] + c1 * rand() * (pbest[i] - present[i]) + c2 * rand() * (gbest[i] - present[i])$$

$$present[i] = present[i] + v[i]$$

Here, $v[i]$ is the particle velocity, $present[i]$ is the current particle (solution). $pbest[i]$ and $gbest[i]$ are defined as stated before. $rand()$ is a random number between (0,1). $c1$, $c2$ are learning factors. Usually $c1 = c2 = 2$.

III. THE EXPERIMENTAL SCENARIO

In the following a work done in the "swarm bots" project [2], funded by the Future and Emerging Technologies programme of the European Commission, is presented.

A. Project Objective

The objective of the SWARM-BOTS project is to study a approach to the design, hardware implementation, test and use of self-assembling, self-organizing, metamorphic robotic systems called *swarm-bots*. This approach finds its theoretical roots in recent studies in swarm intelligence, that is, in studies of the self-organizing and self-assembling capabilities shown by social insects and other animal societies [5]. The main tangible objective of the project is the demonstration of the approach by means of the construction of at least one of such artifact. The intension is to construct a Swarm Robot. That is, an artifact composed of a number of simpler, insect-like, robots (S-bots), built out of relatively cheap components, capable of self-assembling and self-organizing to adapt to its environment.

B. Main Scenario

An application in which self-organization and self-assembling can be useful is the classical *Search & Rescue* in complex environments. A swarm of up to 35 *s-bots* must transport a heavy object from its initial to a goal location. On the right side of Fig. 6 can be seen the yellow goal location; on the left side the grey object to be transported, surrounded by *s-bots*. There are several possible paths from the initial to the goal location and these paths may have different lengths and may require avoiding obstacles and holes. The weight of the object is such that its transportation requires the coordinate effort of at least n *s-bots*, where $n > 1$ is a parameter. The overall scenario can be split into two main tasks: *finding an object or a goal location*, and *performing cooperative transport*. This is detailed in the following.

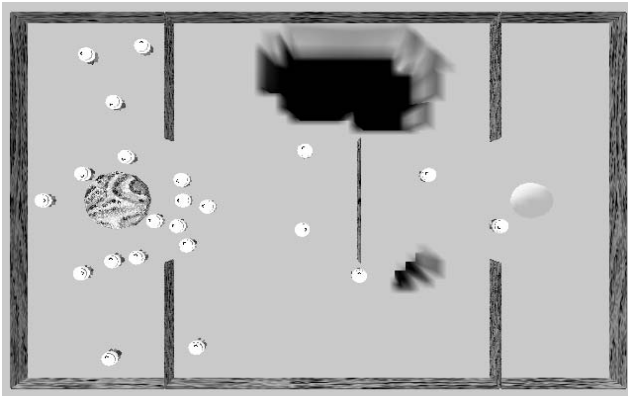


Fig. 6 : The *s-bots* are positioned in an arena and they have to locate and connect to the object to be transported. Other *s-bots* have to locate the goal and build a chain connecting it to the object's initial location.

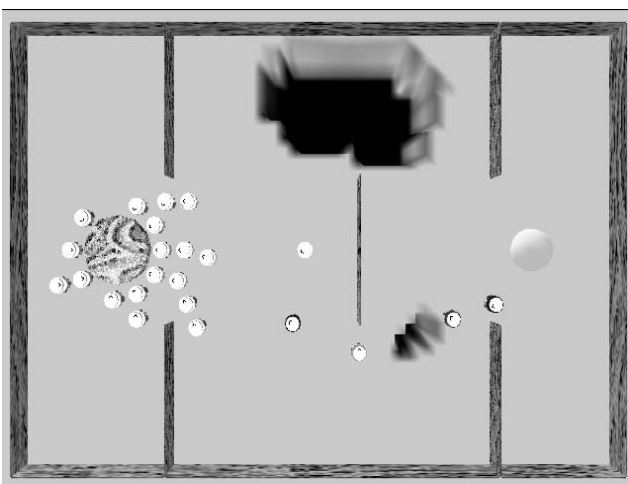


Fig. 7 : At this phase, the *s-bots* after having located the goal and the optimal path to it, have formed a chain connecting the object to it. The chain members are the coloured *s-bots*. The rest of the *s-bots* are connected to the object and the transportation phase is ready to start.

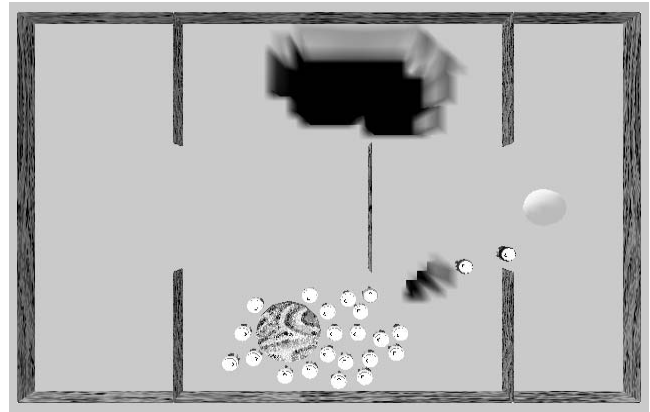


Fig. 8 : The object is been transported by the cooperative effort of the *s-bots* along the chain that has been established.

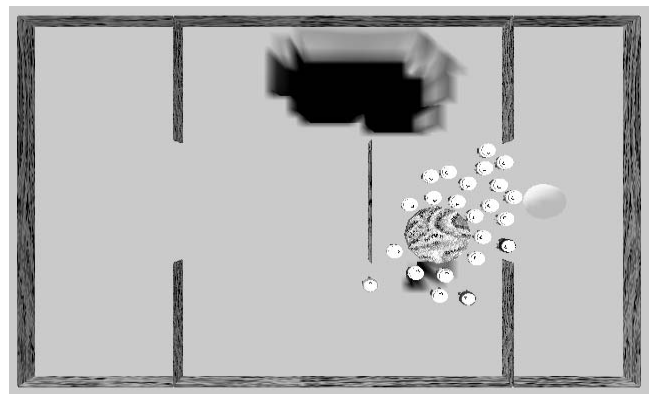


Fig. 9 : The task is nearly concluded as the object approaches the goal location.

IV. APPLICATIONS

Potential applications for swarm robotics include tasks that demand for miniaturization (nano-robotics, micro-robotics), like distributed sensing tasks in micro machinery or the human body. Researchers say that “Swarms of robots could one day be exploring space or doing dangerous jobs on Earth”. A group of undergraduate students at the University of Southampton has developed a swarm of identical, matchbox-sized robots, each of which costs just £24 to produce. The prototypes showed how swarm robots can independently divide up tasks, with no central program controlling them. They skitter around, communicating as they encounter each other via the same kind of infrared technology used in mobile phones. Red and green lights on the robot were used to show which task they had chosen.

V. FUTURE WORK

Researchers are investigating large swarms of up to 10,000 miniature robots which can work together to form a single, artificial life form. The U.S. military is investigating swarm techniques for controlling unmanned vehicles. The European Space Agency is thinking about an orbital swarm for self assembly and interferometry. NASA is investigating the use of swarm technology for planetary mapping. With this in mind, it seems that planets exploration or handling of

dangerous materials in hazardous environment may be some of the first applications in which Swarm Robots might be successfully employed. In general, swarm-bots are very suitable, and indeed preferable to classic mobile robots, for all those tasks requiring not only a high degree of team effort, but also a very low level of human intervention.

VI. CONCLUSIONS

Swarm-bots, because of their extreme plasticity, can find interesting applications anywhere it is required a high degree of physical adaptation and a low level of human intervention or monitoring. Tasks which fall in this category might be space exploration of harsh and humanly dangerous environments, assembly of space modules, handling of dangerous materials, mining, and even “harvesting” material or goods from a physically constrained location. Given such a multi-purpose nature, swarm-bots might also find further applications in the future which are currently even not foreseen.

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FOUR QUADRANT OPERATION OF A DUAL CONVERTER USING PROCESSOR

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ABSTRACT

In four quadrant operations Motor can be operated in either direction, in either of two Modes i.e. Motoring Mode and regeneration mode. This paper describes the development of an experimental four quadrant drive for speed control of DC Motor. It is mainly concerned with generating control pulses by using processor DSPIC 30F 6012A for separately excited DC Motor. This will improve the speed of motor control system. We can run motor in both forward and reverse direction. By using the Thyristor controller setting we can operate our drive for a constant speed.

Keyword : DSP Processor, SCRs, Dual Converter, Pulse Transformer, DcMotor, current sensor

I. INTRODUCTION

Dual converter consists of two fully controlled converter connected back to back. Dual converters are used for four quadrant operation of DC drives and speed control.[5] The ward Leonard method of speed control results poor performance even if the operating conditions are better and also its response is sluggish. Although 8 bit processor or microcontroller includes the necessary peripheral to provide solutions for digital controller application, they lack both performance and architecture needed to perform real time math-intensive advanced control algorithm for bandwidth. [6]

Performance for cycle is slightly sluggish where it takes 2 to 3 sec to react properly where there is distribution specially at low speed. This is what we need to overcome in order to achieve quick control of motor speed.

The 16 bit processor(DSPIC30F 6012A) includes the same advantages as 8 bit processor but also offers high speed high resolution and capability to implement the math algorithm to lower the system cost. Because of high bandwidth signal processing ability of the 16 bit processor can help us to easily achieve a Robust, precise and adaptive digital control system.

The objective of this paper is to explore the approach of designing and designing a DSP based trainer for speed control of dc motor in order to keep better flexibility and versatility.

II. BLOCK DIAGRAM

The simple block diagram of the system is shown in figure below. Block diagram consists of **DSP processor(DSPIC30F6012A)**: Low power high speed with 100K bytes of flash memory, 30 MIPS operations, two 40 bit wide accumulator with dual data latch 24-bit wide instructions, 16-bit wide data path, Up to 144

Kbytes on-chip Flash program space, Up to 48K instruction words, Up to 8 Kbytes of on-chip data RAM
Pulse sensor : MCT2E and hex inverter which is used to read the pulses from dc motor. Pulses are converted into logic pulses using 74HC04 hex inverter which will generate fixed logic pulses to the DSP processor. This sensor monitor the speed of motor or provide feedback to the DSP processor to further increase or decrease the firing angle of SCR. figure illustrates the basic blocks of the drive and how they interact.

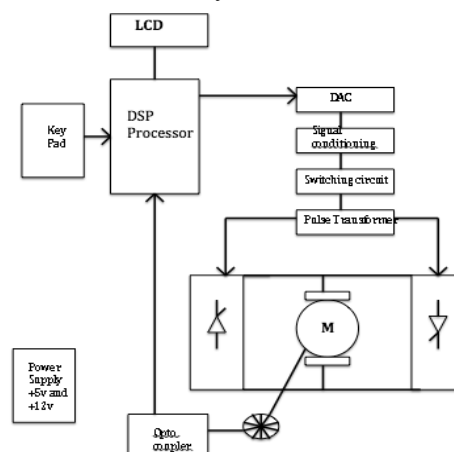


Fig 1: System block diagram

In this scheme a dual converter used for four quadrant operation of dc motor. There are two converter groups. one positive group and the other negative group. When two Thyristors of a particular group conducts simultaneously, then the load current flows. A DSP Processor is used for firing angle control of the dual converter. The Thyristors of converter in conduction should receive the firing pulses for either mode continuous or discontinues operation. Two Thyristors should receive The pulse at a time. The firing signal contains several pulses. The firing pulses so obtained turns the Thyristor ON reliably. Through the Keypad instructions are given by the user to the processor, where information is processed. The conduction of positive group converters and negative group converters is decided from above information and accordingly firing pulses are given to either positive group converter or negative group converter. The DSP processor also displays information about firing angle and direction of rotation of the d.c. motor. The zero cross-over of supply voltage is decided by the zero crossover of the supply voltage is detected using same supply voltage used for the incoming supply for dual converter. The firing angle is calculated with the help of this zero cross over detector.

III. DSP BASED DIGITAL CONTROLLER FOR FIRING PULSE

The triggering pulse for gate is always positive so when SCR is in reverse bias condition, pulse should not be given. For high power application the control circuit must be separated from power circuit, by pulse transformer arrangement. The pulse transformer is used to electrically isolate the power circuit from control circuit.[1]

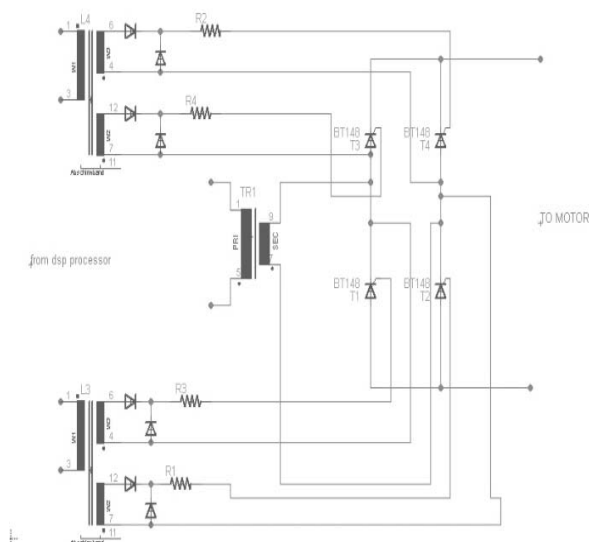


Fig 2: Circuit Diagram for firing pulses. The output of triggering circuit is given to SCR through transformer, which consists of two secondary windings. So, it has the capacity to trigger two SCRs at the same instant. The turn ratio between primary and secondary windings are usually 2:1:1 or 1:1:1.

IV. FLOW CHART OF CONTROL SCHEME

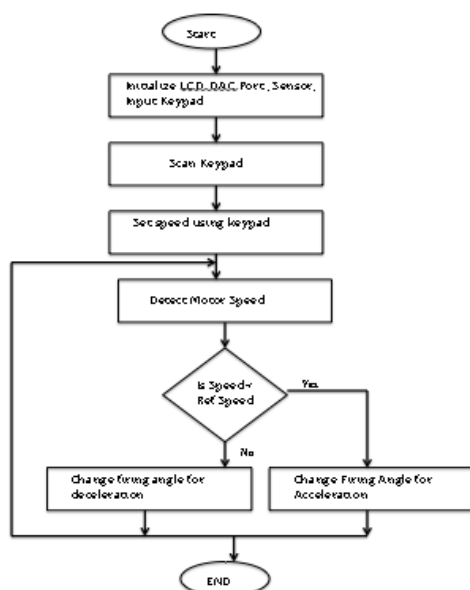


Fig 3: flow chart

In this scheme DSPIC 30F 6012A 16 bit processor is used to implement the direct digital control for the Thyristor drive system. The function of processor can be divided as initialization, control & pulse generation and display.[2] In the initialization function the program is initialized and test are made for proper operating condition. These signals are used to monitor the system. In the control and pulse generation function the input data of the inner and outer loops are processed to determine the interrupt levels and to control the output current respectively. In the interrupt routine, which converter (positive converter or negative converter) will be turned on and off is selected.

V. EXPERIMENTAL RESULTS

The DSP is programmed to provide firing angles. Firing angle was obtained at zero crossing detector. DSP 30F 6012A is programmed to provide a sequence of firing angles. Figure 4(a), 4(b), 4(c) and 4(d) shows the waveform of Armature voltage under various firing conditions. These waveforms were obtained in non-circulating mode of operation

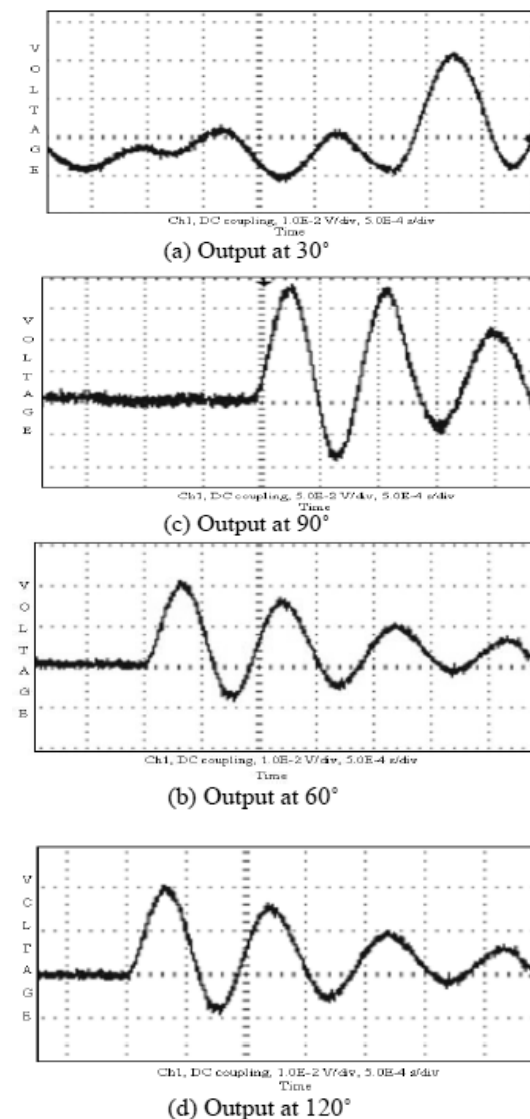


Fig 4 : Waveform of armature voltage

VI. CONCLUSION

Successful investigations on the operation of four quadrant operation of a dual converter using DSP processor is presented. The machine is separately excited with a constant DC field voltage source. There is thus no field voltage control. By default, the field current is set to its steady-state value when a simulation is started. DSP 30F 6012A was programmed to achieve firing pulses to trigger SCR. Performance was fast in presence of low speed because of DSP Processor. Power consumption was also less and more features can also included in future because of DSP Processor.

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ALMANAC BASED DUAL AXIS OPEN-LOOP TRACKER FOR SOLAR PANELS WITH OPTIMIZED CAPTIVE POWER CONSUMPTION

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ABSTRACT

With end of road visible for natural and mineral resources of Fuel and energy generation, focus is shifted to garnering maximum energy from renewable energy sources like Sun light and Wind. Solar power generation technology has matured and efforts are on to improve the yield of Effective energy generated. For this purpose Solar Tracking techniques are being used. This system, Almanac Based Dual Axis Open-loop Tracker (ABDAOT) under discussion here, suggests the solution with 2-Axis Sun tracking of the Solar panel using Azimuth and Altitude angles; to maximize generated power at the same time, using Almanac based sun angle calculations to implement Open loop system that minimizes the Captive consumption of the power. It therefore, improves the yield which is Effective usable Energy from the system.

Index Terms : Almanac, altitude angels, azimuth, solar, sun tracking.

I. INTRODUCTION

With depleting fossil and natural sources of fuel and energy in the world, more and more focus is shifting on electrical power generation from the renewable energy sources such as energy from Solar light and Wind power. Solar energy is being exploited maximum with continuous research in the materials used for Solar Photo-voltaic Panels and at the same time generating Maximum power from the sun using solar tracking techniques. Different types of Solar Tracking of the Solar panels are being employed in order to capture maximum energy from the sun rays. This has the basis of keeping the incident angle of the solar light-rays perpendicular to the plane of the panel for maximum amount of time for which the sunlight is received.

Generally, Single axis tracking and Dual axis tracking systems are used for this purpose. Further, it has been proved that the dual axis trackers are having better capture and conversion of solar energy as compared to single axis trackers. However, the main disadvantage of the dual axis

tracker is its captive consumption due to the operations of two motors. Additionally, tracking systems motors operate continuously to increase the captive consumption of the system due to closed loop control systems that find the optimum angle of incidence so as to provide maximum power. As the Usable power generated is difference of Actual power generated and captive power consumed.

Effective Usable Power = Solar Power Generation
– Captive Consumption

II. THEORY OF THE ABDAOT SYSTEM WITH THE OPTIMIZED CAPTIVE CONSUMPTION

It is the fact that the Usable power generated is difference of Actual power generated and captive power consumed; efforts are required to both maximize the generated power by the solar panels and minimize the captive consumption of the power by motors and operating control logic. In the Improved System implementation which optimizes the power generation output by –

Obtaining peak power generation due to continuous maintenance of the perpendicular incident angle of the sunrays with respect to the surface plane of the solar panel.

Reducing operational time of the motors by making it an open loop system which moves motors based on Almanac – Time of Day in the Day of Year for the given specific location on the earth.

Taking the controller circuit in to the dozed mode and makes it sleep saving power required to run the circuit. This is better managed due to absence of feedback control that requires continuous sensing.

Effectively keeping generated power at its maximum level the system minimizes the power consumed in the operations of the two Motors and their controllers and also operates the controller only when it is needed; thus improving the difference and the amount of usable power generated.

The foundation of the working of this system is Almanac Based Dual Axis Open-loop Tracking (ABDAOT) of the Solar panels. Let the three essential factors in the system be evaluated –

a. Dual Axis Tracking

It is a 2-axis tracker with two motors fitted to operate the panels.

Azimuth Motor : First motor is Azimuth Motor that controls the Azimuth angle of the panel. Azimuth angle allows the entire panel frame to be rotated. As this angle is largely controlled by Time of Year (TOY); the motor is required to be moved only once at the beginning of the day.

Altitude Motor : The second motor is Altitude Motor that controls the Altitude angle of the panel. It inclines the panel correctly against the sunrays as the day progresses. As this angle is largely controlled by Time of Day (TOD); the motor changes panel Altitude periodically, at about suitable intervals of 30 minutes.

B. Almanac Based System –

The system controls the motor operations based on Almanac. This is based on the notion that Sun's path in the sky is dependent on only three factors –

Time of Day (TOD) – The sun progresses along its path through the day. Altitude angle of the incident sunrays is determined by Time of Day.

Time of Year (TOY) – The sun position varies between N23.3 degrees and S23.3 degrees about the equator and it is determined by Time of Year. Geographical co-ordinates of the Location – Sun's path or Trajectory is directly dependent on the position of the location on the earth's surface; which is given by the Longitude and Latitude of that location.

Therefore, for a given specific location on earth, Sun's path every minute in a day and every day in the year is completely fixed and deterministic. Based on the calculations, the Sun's position can be computed and therefore the Azimuth and Altitude angles needed for obtaining the perpendicular incidence of the sunrays.

The Computations involve theory and mathematical equations used in Positional Astronomy and have their basis in 3-D Spherical Geometry. Following steps are necessary, to compute the Sun's path; given Time of Day, Time of Year, Longitude and Latitude co-ordinates of the specific location –

Step 1: Computation of Ecliptic coordinates –

Start by calculating n , the number of days (positive or negative) since Greenwich noon, Terrestrial Time, on 1 January 2000 (J2000.0). If you know the Julian date for your desired time then –

$$n = JD - 2451545. \quad (1)$$

Where JD is Julian Date computed on the basis of Time of Year (TOY) + Time of Day (TOD) computed as –

$$\Delta = \text{Year} - 1949 \quad (2)$$

$$\text{Leap} = \text{trunc}(\Delta / 4) \quad (3)$$

$$JD = 32916.5 + \text{delta} \times 365 + \text{leap} + \text{day} + \text{hour} / 24 \quad (4)$$

Then, Mean longitude of the Sun^[1,2,3] is computed as –

$$L = 280.460^\circ + 0.985647^\circ N \quad (5)$$

Then, Mean anomaly of the Sun^[1,2,3] is computed as

$$g = 357.528^\circ + 0.985603^\circ N \quad (6)$$

Put L and g in the range 0° to 360° by taking modulus to the base 360.

Finally, ecliptic longitude^[1,2,3] of the Sun is computed as –

$$\lambda = L + 1.915^\circ \sin g + 0.020^\circ \sin 2g \quad (7)$$

Step 2: Computation of Equatorial coordinates –

The Elliptic coordinates then are to be converted to the equatorial coordinate system by calculating the Right Ascension^[3,5] α , declination^[3,5] δ and obliquity of the ecliptic^[3,5] ϵ , and continuing – Right ascension as –

$$\alpha = \arctan(\cos \epsilon \cdot \tan \lambda) \quad (8)$$

And Declination as –

$$\delta = \arcsin(\sin \epsilon \cdot \sin \lambda) \quad (9)$$

And Obliquity of the ecliptic as –

$$\epsilon = 23.439^\circ - 0.0000004 n \quad (10)$$

Step 3: Calculation of Greenwich Mean Sidereal Time (Gmst) –

Calculation of Greenwich Mean Sidereal Time (Gmst)^[4,5,6] & Local Mean Sidereal Time (Lmst)^[4,5,6] for the specific location having found the Longitude and Latitude in the above steps.

$$Lmst = \left(\left[Gmst \frac{\text{longitude}}{15} \right] \text{Mod } 24 \right) \quad (11)$$

$$Gmst = \text{MOD} \left(\frac{[6.697375 + 0.06570982 \cdot 42 \cdot n + \text{hr}]}{24} \right) \quad (12)$$

$$Ha (\text{Hour Angle}) = (Lmst - \alpha) \quad (13)$$

Step 4: Calculation of Azimuth (Az) and Altitude Angles (Al) –

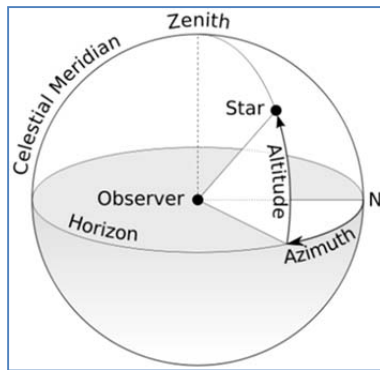
Determining the Sun's path in the spherical coordinates^[4,5,6] as –

$$Al = \arcsin[\sin \delta \cdot \sin(\text{latitude}) + \cos \delta \cdot \cos(\text{latitude}) \cdot \cos(ha)] \quad (14)$$

And

$$Az = \arcsin[-\cos \delta \cdot \sin(Ha) / \cos(Al)] \quad (15)$$

... Using Latitude of the Location



a) Expression of Azimuth and Altitude Angles

C. Open Loop Tracking –

The system operates as Open loop system without any feedback control, sensors and sense circuits. This reduces the complexity as well as power consumption. Further, motors are not needed to be continuously moved. This has an advantage over the closed loop system which may consume power keeping on searching optimum angles on a cloudy day.

ARCHITECTURE OF THE SYSTEM

The System has a Microcontroller based processing unit controlling the other functional parts in the system which consist of Azimuth and Altitude Motors with their Drivers, Local Display, GPS unit for Geographical position (Location co-ordinates) and the connectivity to master computer whenever needed for the configuration and calibration purpose. The different blocks in the system are –

Processing Unit –

Microcontroller based processing unit interfaces to Motors and their drivers, Display, GPS and Master computer system. It calculates the motion of the two motors and controls them. It communicates with the master computer during one time Configuration and for Re-calibration, if needed.

Azimuth and Altitude Motors with their Drivers

High precision geared DC motors are used for the demonstration unit with their current driver circuits. They form the actual Dual Axis tracking system for the solar panel.

GPS Unit

Geographical Positioning System^[7,8] is used to determine the Location on earth, of the Dual Tracker Installation in order to know the Longitude and Latitude as they are required for the calculation of Greenwich Mean Sidereal Time and Local Mean Sidereal Time^[5,6].

Local display

A LCD Display unit has been provided in the Demonstration unit for showing the parameters such as Azimuth angle and Altitude angle. In actual Real world implementation, this display can be optional unit of Interface.

Serial (RS232C)^[9] Interface

EIA RS232C^[9] is used for connectivity to Master computer that runs the angle calculation program and downloader during the one time configuration and recalibration operations.

Master Computer

Runs the Front end Programs for the necessary angle computations, one time configuration and downloader applications.

Solar Panel

A solar panel is used and it has a set of solar photovoltaic modules connected electrically and mounted on a supporting structure. In this paper Solar panel under study is connected to a Charger circuits and required Battery packs for storing power.

Battery Pack

A set of rechargeable identical batteries or cells are used in order to store all the power from the solar panels. The advantage of a battery pack is the ease with which it can be swapped in-out of the assembly.

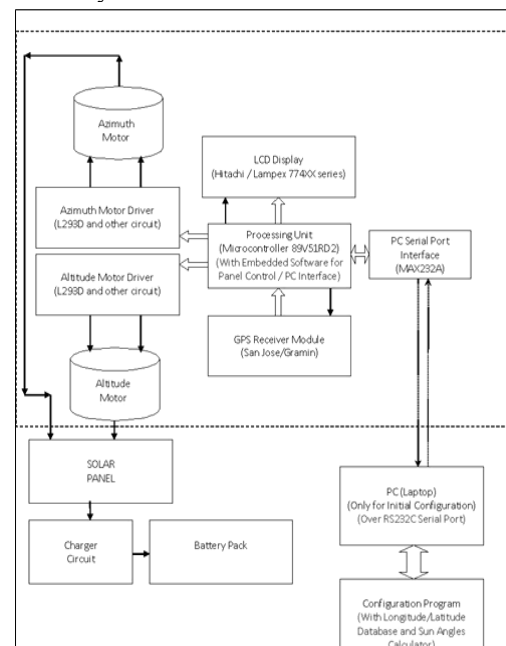


Fig.2. Architecture of the ABDAOT system

Operations

One Time Configuration / Calibration Mode–

The system is installed in the open space is free line of sight visibility to the sun with the marker aligning North-South direction. (If needed, exact NS alignment can be achieved with the help of a Compass needle) The on card GPS module returns Longitude and Latitude of the specific location and processing unit displays them and also communicates these positional co-ordinates to the Control computer connected through serial link.

The front end program running on the Control computer performs the necessary calculations as per the mathematics of Positional Astronomy and calculates the Azimuth and Altitude Sun angles for the given periodicity (30 minute intervals) and rounds them off to nearest integer. The angles are then downloaded in the Flash memory of the Processing unit (Microcontroller). This completes one time configuration / Calibration.

Now the control computer is disconnected. It would be needed only if the Position of the unit is changed requiring the recalculation of sun angles and recalibration of the system.

Run Mode

Now the system is standalone and self-sufficient. The motors are driven by the system as per the stored Sun angles to always maintain it having perpendicular incidence of sunrays, providing maximum power.

At the same time shifting to sleep or doze mode when no work is to be done avoiding unnecessary motor motion, thus reducing the captive consumption.

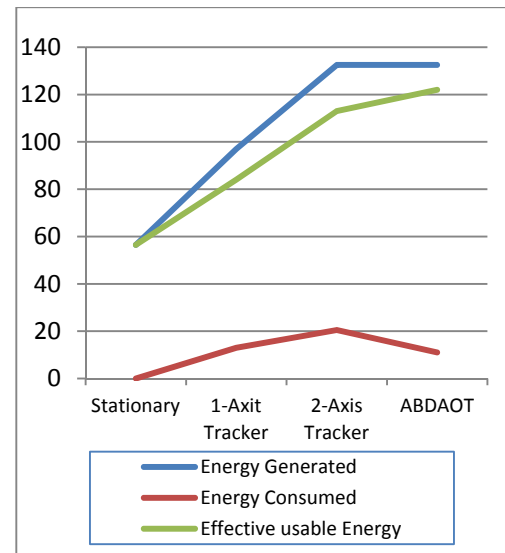
RESULTS AND CONCLUSION

The power generation is computed for the system and results were compared against 1-axis Sun trackers and 2-axis closed loop Sun trackers.

The results show remarkable savings in the consumed power in this (ABDAOT) system as compared to other models. Also, the power generated is better as compared to 1-axis system and almost similar to 2-axis system. However, the effective usable power in this (ABDAOT) system is best of all the Sun tracker systems due to substantial reduction in the captive consumption. Thus, it is proving the utility of the system.

Table 1. Comparative figures of Solar trackers

Type of Solar Panel System	Weather Condition	Energy Generated (Wh)	Captive energy Consumed (Wh)	Effective usable Energy (Wh)
Stationary Panel	Clear Sunny	55 - 58	-	55 - 58
	Cloudy	26 - 27	-	26 - 27
1-Axis Sun Tracker	Clear Sunny	95 - 99	13	82 - 86
	Cloudy	48 - 49	13	35 - 36
2-Axis Sun Tracker	Clear Sunny	130 - 135	19	111 - 116
	Cloudy	65 - 67	22	43 - 45
ABDAOT	Clear Sunny	130 - 135	11	119 - 124
	Cloudy	65 - 67	11	54 - 56



All Energy values in Watt-Hour (Wh)

Fig. 3. Comparative test results of different Solar trackers

Comparison of Trackers for Effective usable energy –

Therefore, the test results displayed in Fig. 3 and 4 provide substantiation to the conclusion that the ABDAOT system is the optimum solution for medium solar power needs as it provides best effective usable power. It is also relatively invariant to cloudy and hazy atmosphere as it has no feedback based on the current intensity of the sunlight.

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OBJECT SORTING WITH AUTONOMOUS PICK AND PLACE ROBOT BASED ON COMPUTER VISION

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ABSTRACT

Picking and placing is applicable in many places such as industries and warehouses. Due to advancements in the computer systems and its wide application, image processing has become tool of modern technology. In any automated system there is need of sensing the environment. The overall cost of the system increases with the use of multiple sensors. We propose a system of autonomous pick and place that uses computer vision as a tool for navigation and object shape recognition.

The system uses an overhead camera to track the robot and detect the objects. We developed a process model for pick and place and a method to track the robot inside the arena. We developed certain programming functions required for the achieving the task and a serial communication protocol to communicate between the master computer and the slave robot. Applying different methods to determine shape and color of the object is secondary goal achieved which can be further extended as per the desired application.

Keywords : Object sorting, real time, object detection, shape recognition, overhead camera, image processing, robot navigation.

I. INTRODUCTION

Automation [1] involves collecting the real time data, processing the data and performing the necessary operation which is a type of feedback mechanism. Obtaining data real time can be done with the help of sensors. There are various sensors for application specific tasks that can be used for data extraction from the environment.

Sensors such IR sharp range and proximity sensors can be used to measure the distance of the object. There are various other sensors such as gyro sensor, accelerometer, temperature sensor, light sensor that provide some other form of information from the environment. Taking camera as sensor input the entire scenario changes. Unlike the sharp sensors which are used to detect only the obstacle and distance only, camera can provide more features. Apart from it, we can get other features such as shape and color of the object. Moreover, if we use thermal cameras we can even sense ambient temperature using IR radiation from the environment.

Involvement of camera and image processing makes the use of single input sensor device to extract many features of the surroundings and when this type of system is integrated with the robot, we can apply it almost everywhere making the system more generic.

Industrial sorting uses a conveyer belt [2] where different objects move over the belt. There are sensors that detect colour of the objects to differentiate the objects. Image processing may also be used in this process. Top view is captured with the help of camera and the image is processed on high speed computers. Computers then issue commands accordingly to the actuators and they sort the objects accordingly.

This type of sorting is application specific and is not generalized. It can be defined in only certain workspace. There is need for generic system and algorithm of object sorting. This system is brought up with an idea where sorting is implemented in an arena and robot is used for sorting the objects. Once the program is developed, by tweaking some part of the program and hardware it shall be applicable to every possible field.

II. PROPOSED SYSTEM

The aim of the project is to sort objects in the arena using a robot and image processing. The specifications of the system are :

1. The color of the background in the arena used is white
2. Objects used in the system are regular shape objects such as box, sphere and hexagonal shaped box
3. The color of the objects used is dark. More specifically any color except white and lighter colors such as yellow.
4. Overhead camera mounted is at a fixed height with good image resolution

III. PROCESS MODEL

Fig.1 shows the process model of the system.

The basic steps used in the process model are as follows:

Step 1:

Capture the image using overhead camera. The overhead camera is fixed at height of around 3 meters or more.

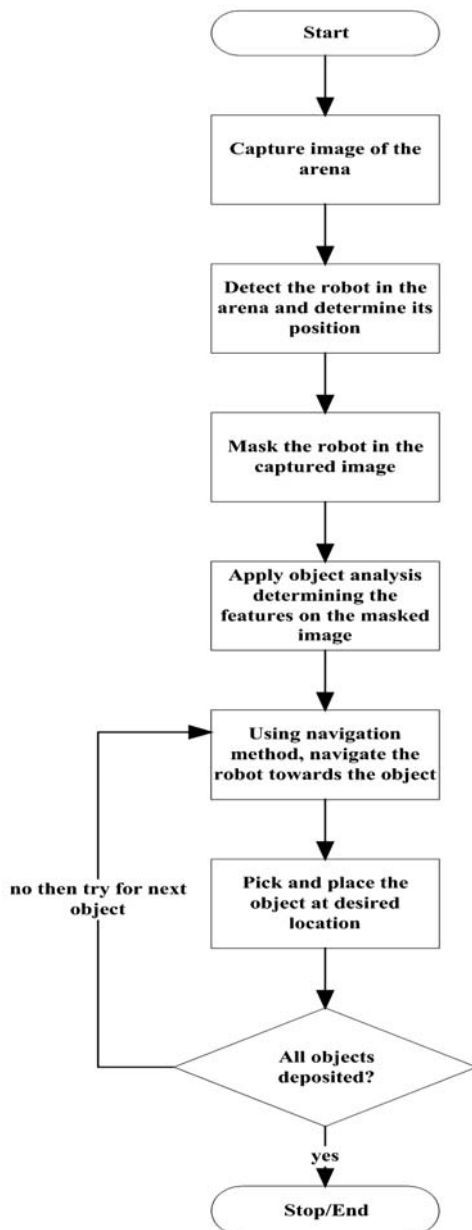


Fig. 1 : Process model of the system

Step 2:

Detect the robot in the arena and determine the position. Here, the position is denoted in pixels.

Step 3:

Masking is an important step of excluding the robot in analysis of object detection and shape analysis.

Step 4:

A new image is obtained which only consists of objects in the arena. This image is analyzed to determine all the possible objects in the arena, obtaining their positions and features.

Step 5:

After determining where the objects are located we can use the robot to navigate towards the desired object and perform pick and place operation at desired location. This involves step by step commands issued to the robot.

Step 6:

After the pick and place of a single object, this process can be repeated until all the objects are picked up and placed at desired locations.

IV. HARDWARE IMPLEMENTATION

Camera shall be mounted on the top of the arena which takes the image of the arena consisting of the robot and the objects. The camera is interfaced with Laptop via USB cable. The laptop will process the image and issue commands to the microcontroller on the robot. The detailed block diagram is given in Fig.2 which explains the hardware interface.

A. Selection of camera

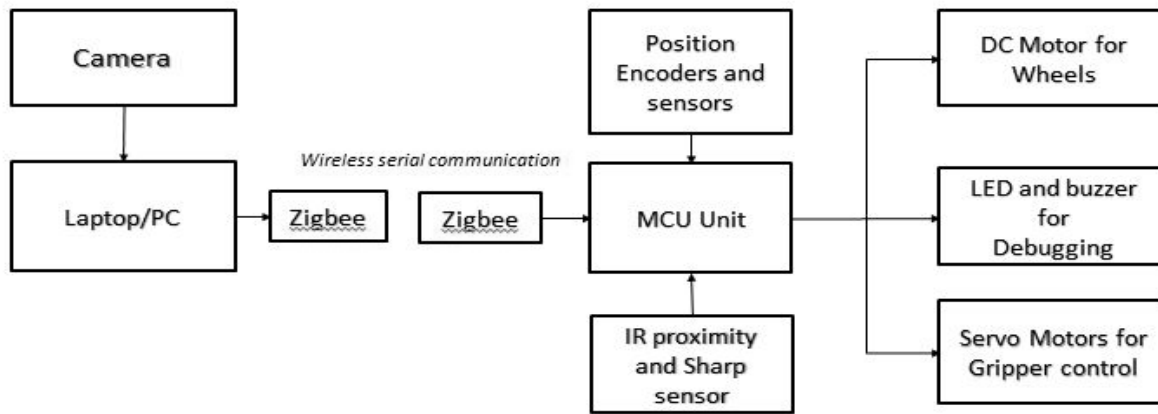
To start with capturing image we need to select a camera. There are various types of camera available such as wireless camera and USB camera. The issue in wireless camera is that it is prone to capture image with noise due to wireless transmission. There are chances that such type of noise created may or not be filtered. So, we chose to use a USB web camera for the task implementation. Apart from this USB 2.0 supports maximum 5 meter length [3] of the USB cable. So, we can easily keep the laptop in range of 5 meters.

B. Selection of communication device

There is a need of communication between the laptop and the robot. Cable communication cannot be used as the arena image taken shall also consist of the cables which becomes an unwanted part. Moreover, the wires may interfere in the operation due to limited length. Hence, use of wireless communication is mandatory. Now, there are various types of wireless communication available such as Bluetooth, Zigbee and Wi-Fi. Table I shows specifications of three wireless modules.

The communication between laptop and the controller involves simple commands. The packet size of the data is small. The power requirement for Zigbee is low compared to other modules.

Hence, it is suitable for embedded application. Comparing the operation of the wireless module, there are difficulties in driving a Bluetooth using a microcontroller as there is need of driver for Bluetooth. So, Zigbee is more suitable for the project.



Detailed block diagram of the system

TABLE I.

SPECIFICATION TABLE FOR DIFFERENT WIRELESS MODULES

Specification	Zigbee 802.15.4	Bluetooth 802.15.1	Wi-Fi 802.11b
Data capacity(kbps)	250	1000	11,000+
Range(mtrs)	70	10	100
Power requirement	Low	Medium	Large
Nodes per network	255-65000	8	30
Software size(Kbytes)	4-32	250	1000+
Cost	Medium	Low	High

C. Selection of microcontroller

Now the next thing is about the selection of micro controller. Microcontroller is responsible for the end operation and will act as slave to master PC. The project involves input from sensors, position encoders [5] and output to the motor driver and servo motors. The microcontroller should facilitate with enough pins with special functions such as interrupt handling, on chip ADC, PWM control, serial communication. The current sourcing and sinking of the microcontroller should also be good. We are using Atmega 2560 IC of the AVR [4] family that provides all the necessary functions. The microcontroller would be responsible for receiving commands from the laptop, processing inputs from the sensors, controlling the motors and grippers.

D. Robot structure

The robot consists of 2 DC motors controlling the wheels and a third castor wheel for support as shown in fig. 3. The position encoders are used for each DC motor. On the robot, a gripper is mounted which operates on single servo motor.

E. Use of position encoders

The robot is to move in the arena with the help of its two wheels controlled by DC motors and a third castor wheel for support. To increase the precision, we are using position encoders as shown in fig. 4 for the wheels which can determine the amount of wheel rotation.

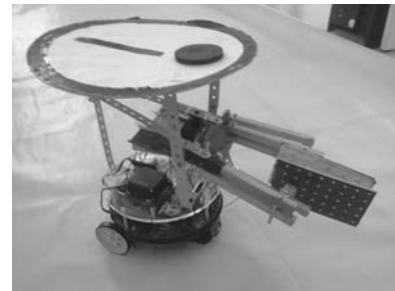


Fig. 2 : Structure of the robot



Fig. 3 : Position encoder

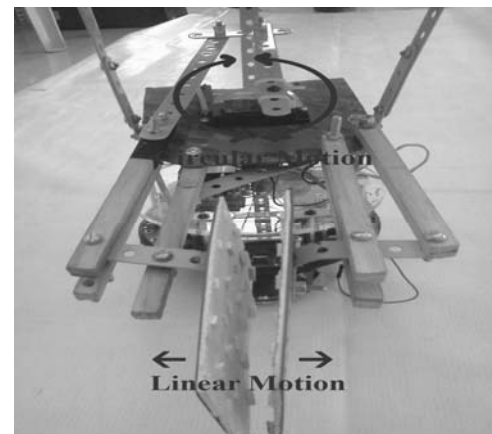


Fig. 4 : Structure of Gripper

F. Creating a servo operated gripper

Operating the gripper arms can be done using various motors such as servo or DC motor. The arm movement should be precise and accurate for handling objects of various shapes. DC motor does not use a feedback mechanism and is not accurate. Use of servo will enable to move the arm accurately with certain precision. As seen in Fig. 5, the circular motion of the servo is converted into linear motion.

G. Use of IR proximity and Sharp sensors

Use of IR proximity and Sharp sensors may or may not be used. If complete localization of the object is done using computer vision, then there may not be need of using proximity and sharp sensors.

V. SOFTWARE IMPLEMENTATION

The arena image shall be captured by the camera. There should be fixed setup and lighting conditions. The camera should be calibrated in both software and hardware for obtaining proper results.

The algorithm used in the image processing should be robust enough to detect and identify different shapes of the object. It should consist of proper analysis and determination of the program flow. Moreover, the action taken by issuing commands to the robot should be in synchronization with the robot. For implementing the given process model, we are programming in C/C++ using OpenCV [6-7] libraries for computer vision.

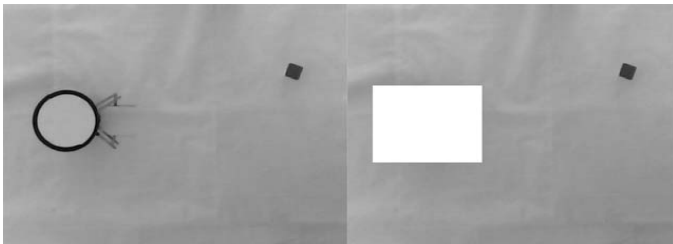


Fig. 5 : Initial image and masked image

G. Capturing the initial image and masking the robot

After the arena setup with robot at its initial position we capture the initial image as shown in fig. 6. The resolution with which we captured the image was $640 * 480$ pixels. The next step is to detect the robot. For detection of the robot, we have used a large circular ring as shown in fig. 6 comparatively bigger in size of that of the object.

The captured `IpImage` [6-7] image format is converted into `Mat` [8] image format. After converting the RGB image to grayscale and Gaussian blur [9-10] for smoothening the image, we can apply an OpenCV library function `HoughCircles` [11-12] to detect the large circle. Once the circle is detected, we can easily obtain its center and radius. By converting the pixels to value 255 (for white) we can mask the robot in the image as shown in fig.6

H. Detecting the objects and their analysis

In order to detect the all the objects in the arena, we use Blob [13] analysis on the new masked image we obtained. After filtering the blobs on the basis of area, we detect the objects and obtain their co-ordinates in terms of pixels. Extracting

only the parts of the image where objects are located we can reduce the process time of object analysis.

Later we easily obtain the colour of the object using the blob libraries, where it averages out hue values of only the pixels containing the object. The average hue value can be compared with the HSV [14] chart to determine the color of the object.

To determine the shape of the object we apply three functions of regular shape detection. `HoughCircles` as mentioned earlier can be used to determine whether the object is spherical in nature. Using other functions such as Harris corner detections [15] we can detect the corners in the image.

For line detection the image is converted to gray scale and canny edge detection is used to obtain binary image containing the edges. Then we can use Probabilistic Hough Line Transform [16]



Fig. 6 : Initial image and masked image

Hough Line Transform to detect the lines present in an image. Combining the results of corner and line detection, we can determine whether the object is a cube or a hexagon or a prism. By increasing the complexity of the program by using pattern detection and machine learning, we can detect much complex shapes and improvise the results.

I. Navigation algorithm

This becomes an essential part of an automated pick and place. In order to implement, we added two new markers as shown in fig. 7 one the small black circle and other the black strip. This helps in determining the orientation of the robot. The black strip lies along the axis of symmetry in the top view. This helps in determining the orientation. Now, the next problem is even if we detect the orientation of the robot we need to determine which side the robot is facing. This is solved by the small black circle that lies to one side of the strip preferably on the gripper side which helps in determining the front part of the robot.

Again applying the probabilistic line transform and Hough circles we can determine these two markers and obtain coordinates such as `headx`, `heady`, `x1`, `y1`, `x2` and `y2` as shown in fig. 7.

To start with algorithm, we determine where the object is located at front or behind the robot. Considering fig. 8 we have two objects. The distances d11 and d21 are distances between objects and (x1, y1) and distances d12 and d22 are distances between the objects and (headx, heady) calculated using distance formula (1) where 'd' is the distance between two coordinates (p1x,p1y) and (p2x,p2y). For object 1, comparison of the distances d11 and d12, we get d12 greater than d11 and hence object is behind the robot. So we can command the robot to rotate 180 degrees to make the object aligned in front.

The probability of special condition of the object just lying on the perpendicular bisector of the robot such that d11 is equal to d12 is 2 out of 360. This condition can rarely occur and if occurred we can command the robot to rotate slightly to come out of that condition

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (1)$$

If the object is in front of the robot, we proceed to next step of calculating the degrees by which the robot has been angularly deviated.

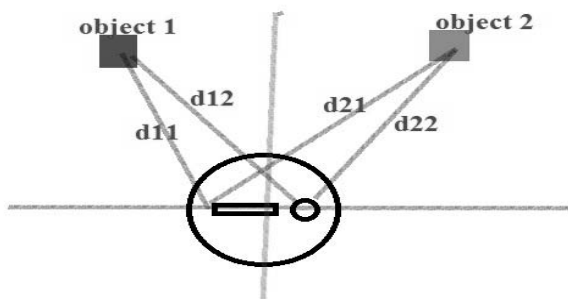


Fig. 7 : Determining whether the object is in front or behind the robot

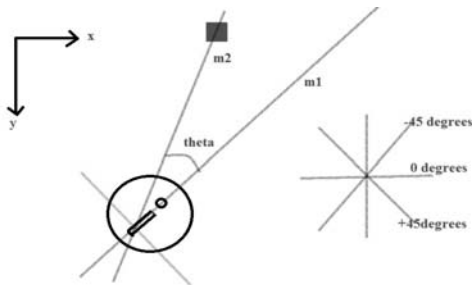


Fig. 8 : Finding the value of theta using difference of slopes

There are various approaches for determining amount of rotation required for alignment. One method is by calculating the distance of the object from the line. But as shown in fig. 10 for object lying at same distance away from a line (d1=d2) has different angle of orientation (theta1 not equal to theta2). Hence, this approach is not suitable.

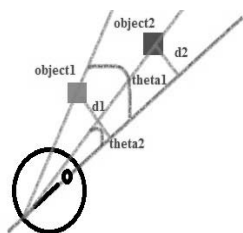


Fig. 9 : Finding the value of theta using distance approach

We use another approach using the coordinates (x1, y1), (headx, heady) and (objx, objy) where objx and objy are coordinates of the object we determine slope 'm' using (2)

$$m = (p_2y - p_1y) / (p_2x - p_1x) \quad (2)$$

$$\theta = \tan^{-1}(m_2) - \tan^{-1}(m_1) \quad (3)$$

Thus, m2 is slope of object with respect to robot and m1 is slope of robot direction. Using (3), if "theta" is negative then the object is to the left and if "theta" is positive then object is to the right by that value of degrees. The value of theta should be corrected accordingly if it exceeds 90 degrees on both ends.

J. Robot programming

Robot programming consists of receiving commands serially from the PC or laptop and some special functions for navigation using position encoders. As seen from the fig.4, our position encoder has 40 spokes and the diameter of wheel is 80mm. We got resolution of 6.28 mm/pulse. Using interrupt service routine [17] of microcontroller, we programmed various functions such as forward and backward in millimeters and sharp left and sharp right in degrees. These functions use multiple characters to receive from the PC. As an example, function "forward_mm(int mm)" requires 4 characters to be transmitted namely "F", "1", "2", "0" where

- 1) "f" is command character
- 2) "1" is 'hundreds' digit
- 3) "2" is 'tens' digit
- 4) "0" is 'units' digit

So, the robot would navigate 120 millimeters in forward direction.

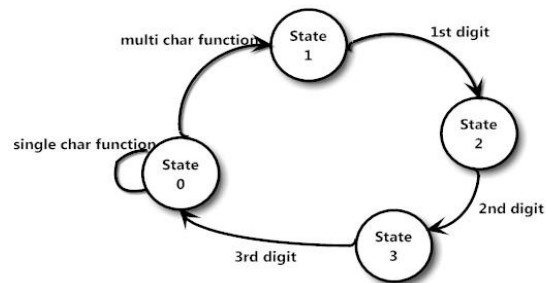


Fig. 10 : State diagram for serial communication protocol

Pick and Place commands can be issued using a single character. In order to support variable character function, we developed a protocol for communication whose state diagram is as shown in fig. 11. Additionally, we programmed the servo motors using pulse width modulation to control the gripper.

IV. EXPERIMENTS AND DISCUSSION

After successful implementation of the program and hardware, we tested and obtained the results. Fig. 1 shows the initial image taken. Considering the object in fig.1 to be picked up, we run the alignment function several times after taking a new image periodically. Based on the results, the robot used to align to the object in a single function call to considerably high accuracy.

The robot was programmed to reach near the object and execute the pick function. The linear distance between the robot and the object had a deviation of 50 mm with 80-90% success rate of picking up. This problem can be minimized easily using proximity or sharp range sensor to pick up the object at accurate distance. The angular deviation was 5-10 degrees at rare cases.

Based on this system, we can have multiple robots by providing a path using coordinates. The system uses a single image for object detection. Periodic image capture for object detection can help in tracking the object dynamically. Thus, it can be applicable in warehouses and storages.

V. SCOPE

Object sorting has its applications in many fields. The scope of the system is as follows:

- Industries and warehouses

Industries work with different raw materials, tools and machine parts. There are times where there is need to sort the raw materials. Apart from this can be used in warehouses for moving different boxes to different locations. This autonomous object sorting can increase efficiency at industrial level.

- Agricultural sorting

It has its application in grocery stores and food industry where good fruits can be sorted out from spoiled ones. On a large scale this has an application in super market grocery stores. It also fetches application in fruit picking. The idea here is to increase the complexity of shape and pattern detection

- Garbage Collection and Recycling

Due to over increasing pollution due to illegal dumping of garbage in this world, there is need of garbage collection and sorting. This has wonderful applications in segregating the recyclable objects like recyclable plastics from the garbage, which can be re-used. The advantage is that humans don't need to go and collect the garbage and thus ensures health safe operation.

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KINEMATIC MODELING OF QUADRUPEL INSECT ROBOT WITH FOUR BAR CHAIN INSECT LEG DESIGN

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ABSTRACT

This paper presents introduction to quadruped insect robot which is similar to a crab. Also various leg mechanisms used for locomotion of robot developed in past are mentioned. Kinematic model of insect robot leg involving four bar chain mechanism is developed. In kinematic modeling, it is assumed that quadruped robot leg is a manipulator. Kinematic modeling involves direct kinematics which deals with determination of position and orientation of endpoint of manipulator with respect to base given joint angles between various links in manipulator and inverse kinematics which deals with determination of these joint angles given the position and orientation of endpoint of manipulator in the form of Tool Configuration Vector (TCV). Quadruped robot performs trot and endpoint of its leg follows a semi-elliptical trajectory. For verification of inverse kinematic model, MATLAB program is developed. For verification of direct kinematic model, soft home position of robot leg is drawn. CAD model is developed in UG NX 7.5.

Keywords : quadruped robot; four bar chain mechanism; kinematic model

I. INTRODUCTION

Legged robots are superior due to their advantages over wheeled robots. Legged vehicles or legged robots exhibit legged locomotion whereas wheeled vehicles travel with the help of wheels. Leg locomotion is the discontinuous method of locomotion unlike wheeled locomotion. Among various categories of legged robots, quadruped robots are inspired from animals with four legs. They have more carrying capacity than biped robots and are less complex structure than hexapod robots [1]. This motivates to concentrate more over quadruped robot.

In spite of lot of research on legged robots, selecting mechanism for legged locomotion is one of the important issues to be focused. Till date very few mechanisms have been developed to be used for locomotion of legged robots [2]. Simple insect leg design, pantograph leg design which has been used in RIMHO robot [3], 2 and 3 degree of freedom leg design which has been used in SCOUT I & II robots [4] etc. are few of the mechanisms used for locomotion of robots in past. Mechanism is a device to transform input force and movement into a desired set of output force and movement which can be used for actuation. Basic elements in mechanism are links and joints. Out of many types of mechanisms, planar mechanisms are much suitable for locomotion of legged robots. Most basic planar mechanism is a four bar chain mechanism [5] sometimes called four bar kinematic chain. It consists of four bodies called links and four joints, usually revolute or prismatic.

In this paper, geometry and kinematic modeling of quadruped insect robot leg with four bar chain mechanism is done. Semi-elliptical trajectory is considered in inverse kinematics and graphs showing real time vs. joint angles are plotted. The same is verified in MATLAB software. Also CAD model for quadruped insect robot is developed.

II. KINEMATIC MODELING

Four bar chain can be used in modified form for leg locomotion. As shown in fig. 1, robot leg involving four bar kinematic chain may consists of four elements viz. Upper link, Middle link, Upper lower attachment, and Lower link.

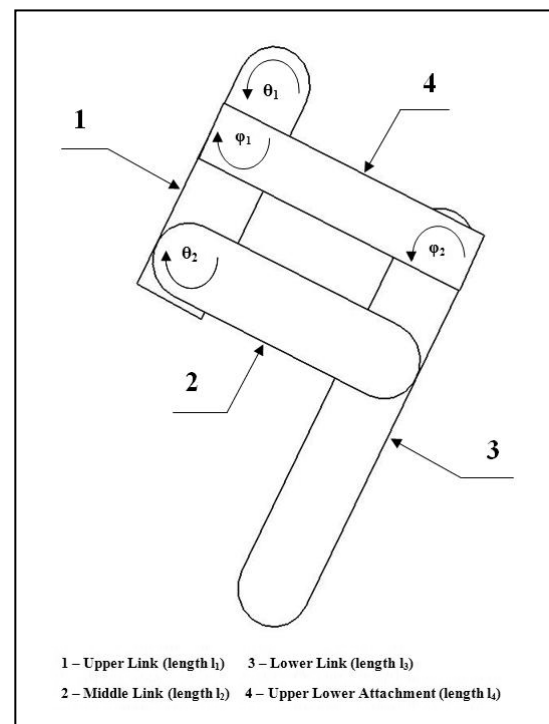


Figure 1 Quadruped insect robot leg involving four bar chain mechanism

In kinematic modeling, Link Coordinate Diagram is drawn for robot leg with four bar chain mechanism. Then coordinate frames are assigned to each link. D-H algorithm is used for this purpose. The Link Coordinate Diagram (LCD) for quadruped robot leg with four bar chain mechanism is shown in fig. 2 below.

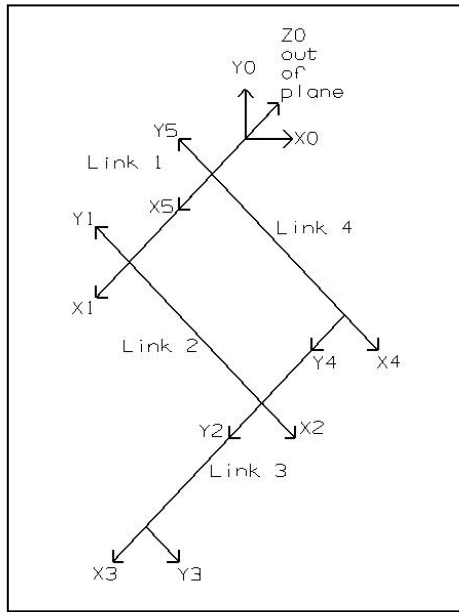


Figure 2 Link coordinate diagram for four bar chain mechanism

Kinematic modeling involves two problems viz. direct kinematics and inverse kinematics.

A. Direct kinematics

Direct kinematic problem is a two part problem [5].

1. Given the geometry of the robot leg (manipulator) and the actuated joint variables, obtain *passive* joint variables.
2. Obtain position and orientation of an endpoint of leg.

As shown in fig. 2 above, θ_1 and θ_2 are active joint variables and are known. All link lengths are known. φ_1 and φ_2 are passive joint variables and are unknown. But relation between active and passive joint variables is known. Four bar closed chain mechanism is broken into two kinematic chains which are nothing but 2R serial manipulators. These two 2R serial manipulators are left 2R manipulator and right 2R manipulator. For both the manipulators, the D-H parameters are determined. This is followed by derivation of transformation matrix. The D-H parameter table and transformation matrix for both the 2R serial manipulators are given below.

TABLE I. D-H parameter Table for Left 2R Manipulator Chain

Link	D-H parameters			
	d_k	θ_k	a_k	α_k
1	0	θ_1	l_1	0
2	0	θ_2	l_2	0

Transformation matrices for first and second row of D-H parameter table for left 2R manipulator (TABLE I),

$${}^0_1T = \begin{bmatrix} \cos \theta_1 & -\sin \theta_1 & 0 & l_1 * \cos \theta_1 \\ \sin \theta_1 & \cos \theta_1 & 0 & l_1 * \sin \theta_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (1)$$

$${}^1_2T = \begin{bmatrix} \cos \theta_2 & -\sin \theta_2 & 0 & l_2 * \cos \theta_2 \\ \sin \theta_2 & \cos \theta_2 & 0 & l_2 * \sin \theta_2 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (2)$$

The transformation matrix ${}^0_2T$ for mapping coordinate frame at point 2 with coordinate frame at point 0 is found to be,

$${}^0_2T = \begin{bmatrix} \cos (\theta_1 + \theta_2) & -\sin (\theta_1 + \theta_2) & 0 & l_2 * \cos (\theta_1 + \theta_2) + l_1 * \cos \theta_1 \\ \sin (\theta_1 + \theta_2) & \cos (\theta_1 + \theta_2) & 0 & l_2 * \sin (\theta_1 + \theta_2) + l_1 * \sin \theta_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (3)$$

TABLE II. D-H Parameter Table for Right 2R Manipulator Chain

Link	D-H parameters			
	d_k	θ_k	a_k	α_k
1	0	φ_1	l_4	0
2	0	φ_2	l_3	0

The transformation matrix ${}^0_2T$ of coordinate frame at point 3 with respect to coordinate frame at point 5 can be found for right 2R manipulator in the same way and is found to be,

$${}^0_2T = \begin{bmatrix} \cos (\varphi_1 + \varphi_2) & -\sin (\varphi_1 + \varphi_2) & 0 & l_2 * \cos (\varphi_1 + \varphi_2) + l_1 * \cos \varphi_1 \\ \sin (\varphi_1 + \varphi_2) & \cos (\varphi_1 + \varphi_2) & 0 & l_2 * \sin (\varphi_1 + \varphi_2) + l_1 * \sin \varphi_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (4)$$

For mapping coordinate frame at point 3 (which is also an endpoint of robot leg) on right manipulator with coordinate frame at point 0 (which is also a point on base) on left manipulator following transformation matrix is required,

$${}^0_3T = \begin{bmatrix} \cos (\theta_1 + \varphi_1 + \varphi_2) & -\sin (\theta_1 + \varphi_1 + \varphi_2) & 0 & l_3 * \cos (\theta_1 + \varphi_1 + \varphi_2) + l_4 * \cos (\theta_1 + \varphi_1) + l_5 * \cos \theta_1 \\ \sin (\theta_1 + \varphi_1 + \varphi_2) & \cos (\theta_1 + \varphi_1 + \varphi_2) & 0 & l_3 * \sin (\theta_1 + \varphi_1 + \varphi_2) + l_4 * \sin (\theta_1 + \varphi_1) + l_5 * \sin \theta_1 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (5)$$

From geometry of Fig. 1, assuming link 1 & 3 are parallel and link 2 & 4 are parallel. Therefore we have,

$$\varphi_1 = \theta_2 \quad (6)$$

$$\varphi_2 = -\theta_2 \quad (7)$$

Substituting above values in transformation matrix in (5), we get,

$${}^0_3T = \begin{bmatrix} \cos \theta_1 & -\sin \theta_1 & 0 & (l_3 + l_5) * \cos \theta_1 + l_4 * \cos (\theta_1 + \theta_2) \\ \sin \theta_1 & \cos \theta_1 & 0 & (l_3 + l_5) * \sin \theta_1 + l_4 * \sin (\theta_1 + \theta_2) \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (8)$$

Multiplying base coordinates by above transformation matrix, position and orientation of endpoint of leg (point 3) with respect to base can be found.

B. Inverse kinematics

Inverse kinematic problem involves determining active and passive joint variables, given the geometry and position & orientation of the endpoint of robot leg with respect to base [5]. For inverse kinematics, the input required is of Tool Configuration Vector (TCV). It is the compact representation of position and orientation of endpoint of kinematic chain. From Tool configuration vector from the arm matrix determined above in (8), x and y coordinates of point 3 with respect to base are given by

$$X_3 = (l_3 + l_5) * \cos \theta_1 + l_4 * \cos (\theta_1 + \theta_2) \quad (9)$$

$$Y_3 = (l_3 + l_5) * \sin \theta_1 + l_4 * \sin (\theta_1 + \theta_2) \quad (10)$$

Where, X_3 and Y_3 are known.

Solving (9) and (10) for θ_2 ,

$$\theta_2 = \cos^{-1} \left[\frac{X_3^2 + Y_3^2 - (l_3 + l_5)^2 - l_4^2}{2 * (l_3 + l_5) * l_4} \right] \quad (11)$$

Solving (9) & (10) for θ_1 by Cramer's rule, we get,

$$\theta_1 = \tan^{-1} \left(\frac{[(l_3 + l_5) + l_4 * \cos \theta_2] * Y_3 - [l_4 * \sin \theta_2] * X_3}{[(l_3 + l_5) + l_4 * \cos \theta_2] * X_3 + [l_4 * \sin \theta_2] * Y_3} \right) \quad (12)$$

Again from (6) and (7),

$$\varphi_1 = \theta_2 \text{ \& \; } \varphi_2 = -\theta_2$$

Thus, all joint variables are found.

III. TRAJECTORY GENERATION

Trajectory generation involves generating a time sequence of the manipulator endpoint position attained by an interpolating function (a polynomial) of the desired trajectory [6]. Semi-elliptical trajectory with 50 mm strides and cycle time of 6 seconds is assumed to be followed by robot leg endpoint. Assumptions made are as follows. Quadruped robot insect moves towards right direction. Pair of front legs and pair of rear legs are 155.2 mm apart. Quadruped robot frame is 242 mm above the ground when the robot is stationary and this distance is maintained throughout the locomotion. For the semi-elliptical trajectory, values of angles at hip joint (joint between robot frame and upper link) and knee joint (joint between upper link and middle link) are found out from inverse kinematics. It is assumed that quadruped robot moves with trot gait. Robot moves pairs of legs 2 & 4 and legs 1 & 3 alternately. Soft home position of leg when robot is stationary, drawn in UG NX 7.5 is shown in fig. 3 below.

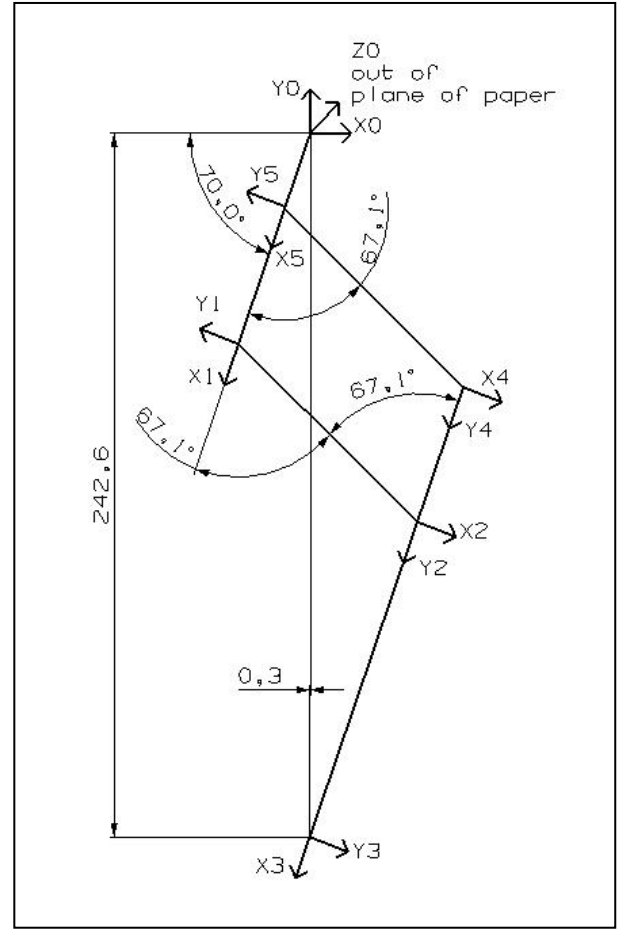


Figure 3 Soft Home Position (SHP) of robot leg

Calculations of joint angles for semi-elliptical trajectory are done in Microsoft Excel sheet. Graphs of real time (tn) required for single step vs. active joint angles (θ_1 & θ_2) and passive joint angles (φ_1 & φ_2) for diagonal pair of legs 2 & 4 and legs 1 & 3 drawn are shown in Fig. 4 and 5 respectively below.

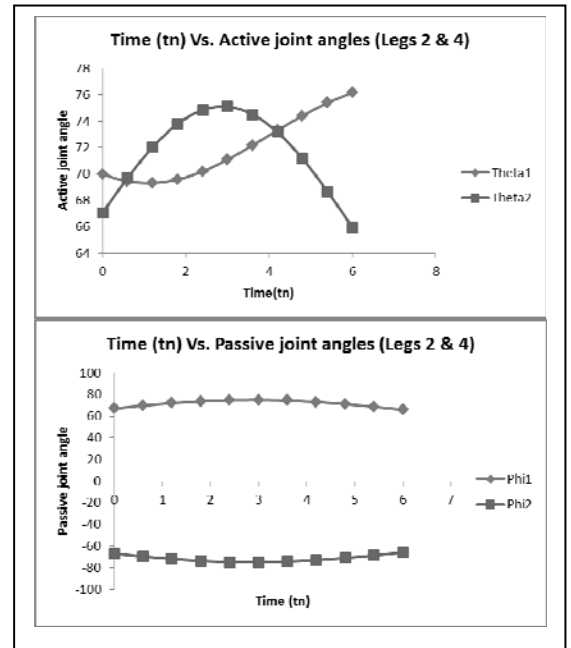


Figure 4 : Graph of real time required for single step vs. active & passive joint angles in robot leg (Legs 2 & 4)

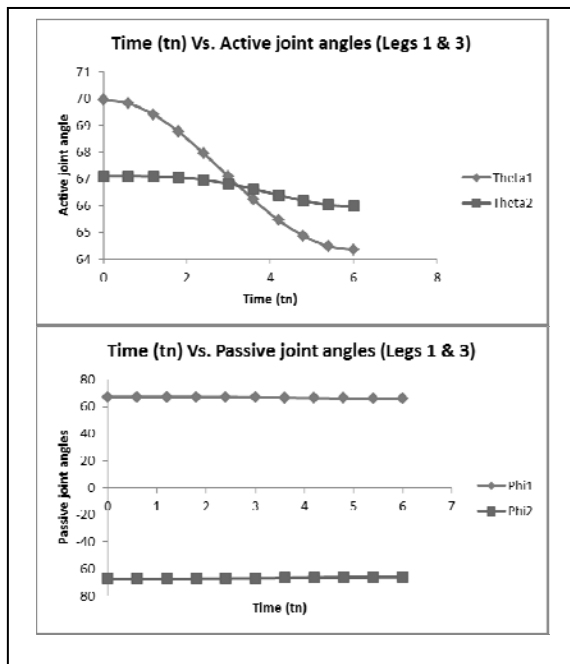


Figure 5: Graph of real time required for single step vs. active & passive joint angles in robot leg (Legs 1 & 3)

Using direct kinematic model, for joint angle variables $\theta_1 = 70^\circ$ and $\theta_2 = 67.10^\circ$ soft home position of leg is calculated from final transformation matrix in (8). Final transformation matrix obtained is

$${}^0_3T = \begin{bmatrix} 0.342 & -0.939 & 0 & -0.158 \\ 0.939 & 0.342 & 0 & 241.96 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \quad (13)$$

From transformation matrix ${}^0_3T$ in (14), distance of endpoint of leg with respect to base point 0 in X and Y direction is -0.158 mm and 241.96 mm respectively. Soft home position of robot leg drawn in UG NX 7.5 is shown in Fig. 3 above.

IV. CAD MODEL OF QUADRUPEL ROBOT

A CAD model of a quadruped robot developed in UG NX 7.5 is shown in figure 6 below. The model consists of torso frame and four legs.

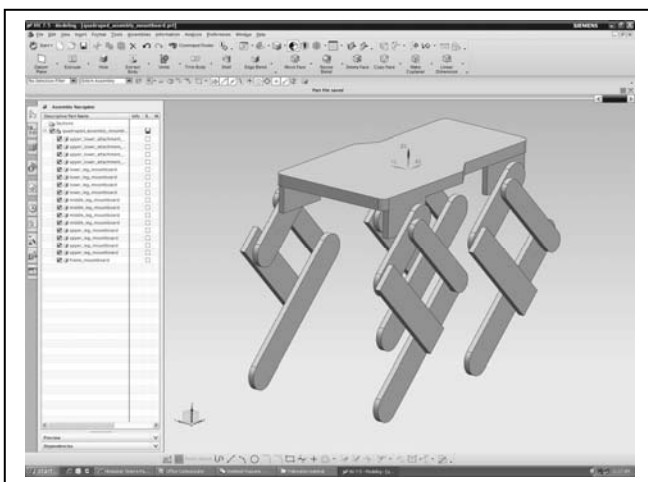


Figure 6: CAD model of quadruped robot

V. VERIFICATION OF KINEMATIC MODEL

Verification of joint angles calculations is done on MATLAB software. A MATLAB [7] program is developed in MATLAB R2010a for inverse kinematics. This MATLAB program includes calculations involved in inverse kinematics to determine joint angles. By providing input of distance of endpoint of robot leg with respect to base point (i.e. its position) in X and Y direction to this MATLAB program, joint angles required to attain that position are obtained as an output.

Graph of real time (tn) required for single step vs. active joint angles (θ_1 & θ_2) and passive joint angles (ϕ_1 & ϕ_2) for legs 2 & 4 are shown in Fig. 7 below.

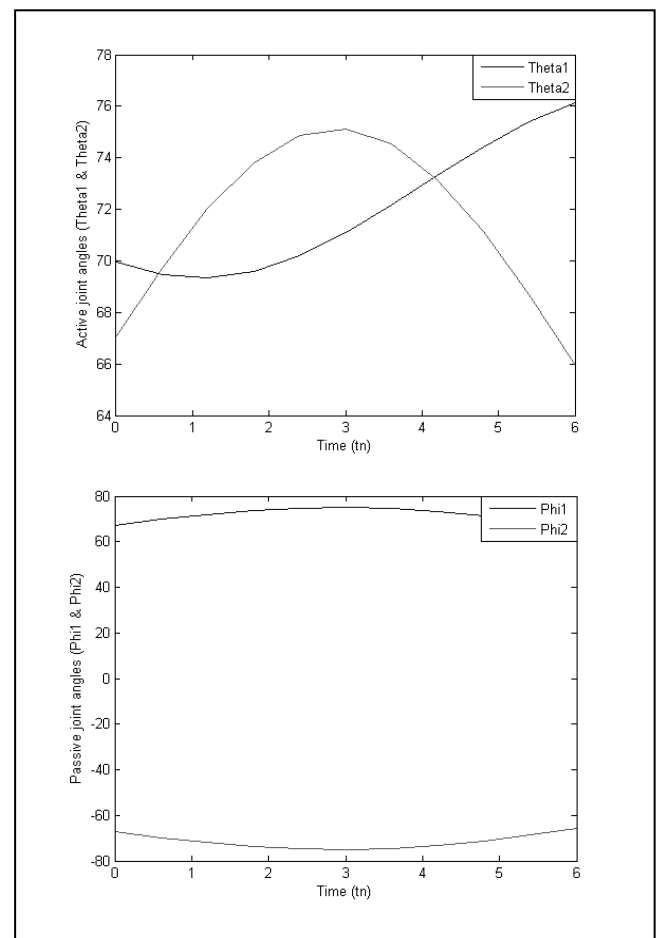


Figure 7: MATLAB output graphs of real time required for single step vs. active & passive joint angles in robot leg (Legs 2 & 4)

From fig. 4 and 7 shown above it is observed that graphs obtained from excel calculations and MATLAB program output for legs 2 & 4 are similar in nature.

Graph of real time (tn) required for single step vs. active joint angles (θ_1 & θ_2) and passive joint angles (ϕ_1 & ϕ_2) for legs 1 & 3 are shown in Fig. 8 below.

From fig. 5 and 7, shown above it is seen that graphs obtained from excel calculations and MATLAB program output for legs 1 & 3 are similar in nature. Therefore, inverse kinematic model is verified.

From soft home position of robot leg in fig. 3 and transformation matrix in (14), it is observed that position and orientation of endpoint of robot leg obtained from soft home position and transformation matrix is approximately same. Therefore, direct kinematic model is verified.

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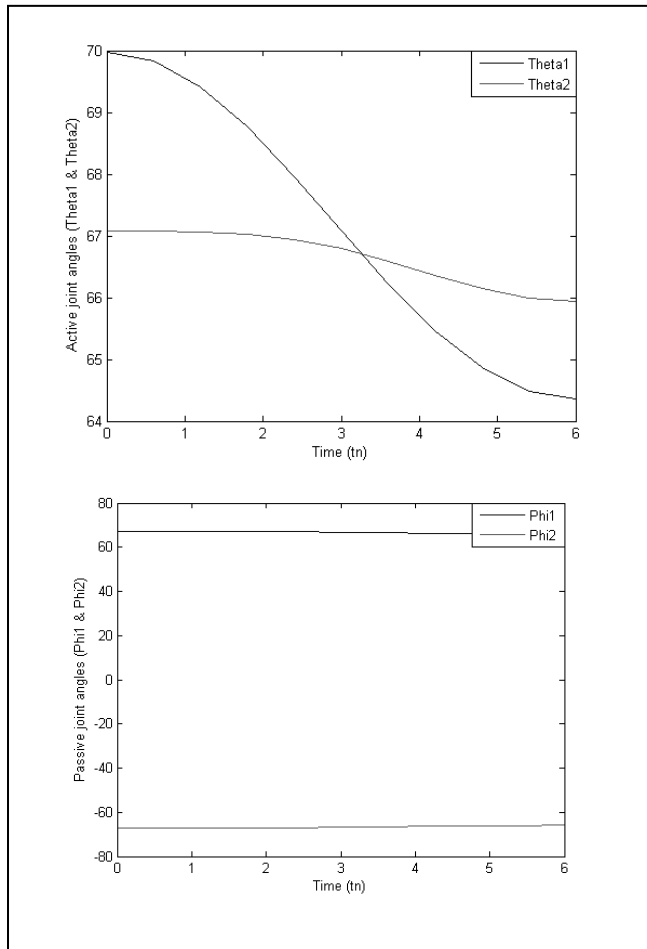


Figure 8 MATLAB output graph of real time required for single step vs. active and passive joint angles in robot leg (Legs 1 & 3)

VI. CONCLUSION

Quadruped insect robot leg can be structured in the form of four bar chain mechanism. One of the advantages for four bar chain mechanism in robot leg is actuation is required at only two joints to make leg move. Kinematic modeling links joint space variables to Cartesian space variables. Using direct kinematics, position and orientation of quadruped robot leg can be found. Inverse kinematics provides angles at joints between various links to attain certain position and orientation. Results are verified with MATLAB program. Also CAD model for quadruped insect robot is developed in UG NX 7.5.

WIRELESS MESH NETWORKS: REVIEW OF UNFAIRNESS ISSUE AND WAY OUT

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ABSTRACT

Wireless Mesh Network offer advantages in terms of scalability, self deployment and ease in implementation. As network resources are finite fair allocation of these amongst nodes is major issue. This paper tries to address this issue by using dual queue approach.

Keywords : *ad-hoc networks; unfairness; dual-queue; wireless mesh nodes; throughput*

I. INTRODUCTION

In contrast to the type of networks that rely on pre-deployed communication infrastructure, ad hoc networks attempt to meet the networking demand where it is very difficult or inefficient, if not impossible, to establish a network infrastructure. Ad-hoc networks are formed by a group of mobile nodes with wireless transceivers that can dynamically organize themselves into a temporary network with an arbitrary topology. The network resources (buffer space, bandwidth) are always finite in the any network to provide broadband access, so resources may have to be allocated and scheduling decisions have to be made [1] and there is possibility of delay in any system that involves waiting, so traffic flows that pass through many hops to their destination will experience more delay, and the end-to-end delay varies with the number of hops to the destination [2].

The throughput capacity of wireless mesh networks and the network performance will be increased if the issue of unfairness behavior of the flows in the network is addressed. The fair sharing of network resources can be achieved by giving the flows from distance source nodes crossing many network hops to the destination priority at each node queue over the flows from hops close to the destination (gateway). This reduces the end-to-end delay of the traffic flow and makes all the source nodes in the networks to have equal share of the network resources irrespective of their distance from the destination.

The aim of this paper is to investigate and provide a workable solution (using NS2) to address the end-to-end throughput unfairness behavior of traffic flows in multi-hop wireless mesh networks.

The approach is based on the position (the number of hops passed to the gateway) of the traffic source in the network relative to the gateway; the investigation is performed at the network layer which is responsible for end-to-end packets transmission (from source to destination across multiple hops).

II. BASICS

A. Hidden and Exposed Nodes

The most well known single-channel MAC layer protocol is CSMA/CA, which is also widely used to form mesh of wireless ad-hoc nodes. Each wireless node has two sensing ranges namely transmission range (TX) and carrier sense range (CS). Normally CS range is adjusted in such a way that node can sense nearly two hops away from self. Within the TX range which is smaller than CS range node can decode packets correctly. CS range is used to sense whether the carrier is busy or not.

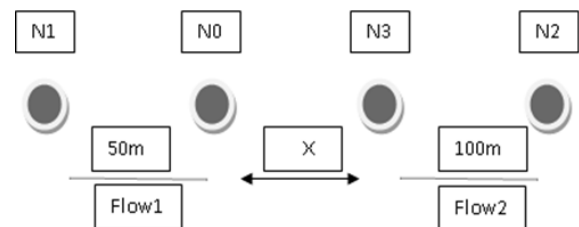


Fig. 1: Setup to study hidden and exposed node concept [3]

Node N0 and node N2 transmit CBR traffic to Node N1 and N3 respectively. As per the default NS2 settings transmit (TX) range is 250m and Carrier Sense (CS) range is 550m. The simulation carried out in NS2 with following parameters:

MAC: IEEE 802.11; Protocol: Ad-hoc on-demand distance vector (AODV); Traffic: Constant Bit Rate (CBR); Drop-tail Queue; Data Rate: 2 Mbps; Packet Size: 512 bytes; Interface Queue Length: 50.

Simulation carried out for 10 seconds and obtained results are shown in Figure 2. Analysis of obtained results is discussed to understand the effect of hidden and exposed nodes.

If a node correctly decoded the last packet detected, it must sense the channel to be idle for Distributed Inter Frame Space period (DIFS) prior to resuming back-

off. If it detected a packet but couldn't correctly decode it, it must back-off for Extended Inter Frame Space period (EIFS). i.e. EIFS > DIFS. If a node sends Request to Send (RTS) and does not receive Clear to Send (CTS), it doubles its contention window and then retries. This simply means that nodes within TX Range can detect as well as decode the packet correctly but nodes outside TX Range but within CS range are only able to detect the packet. This further implies that such nodes (outside TX Range) would back off for EIFS and not DIFS.

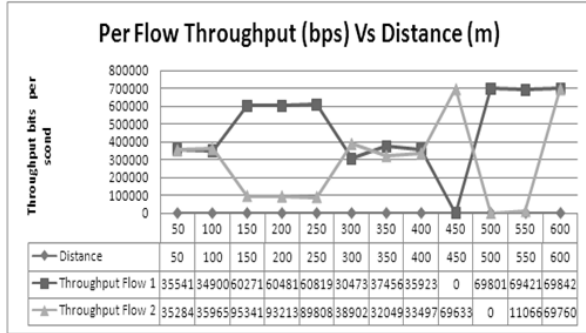


Fig. 2: Graph of obtained results, -hidden / exposed nodes

A. Forwarding Unfairness Amongst WMN nodes

A user node in a multi-hop network has to transmit both relayed and its own traffic. Therefore, besides the contention with other nodes for the same destination node, there is an inevitable contention between its own and relayed traffic [4]. This contention does not occur in fixed wireless local loops or wireless LANs in infrastructure mode where user nodes are always at one-hop distance from the base station or the access point.

As shown in Figure 3, experimental simulation set-up shows Node A, Node B and Gateway Node C. Node A and Node B are single hop and two hops distance to Gateway Node C. Node A and Node B send CBR traffic on wireless channel of 2MBPS to Gateway Node C.

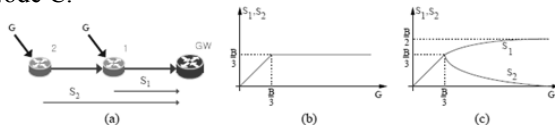


Fig. 3 : Forwarding Unfairness Amongst WMN nodes

As can be seen in Fig. 3(c), as the load at both nodes is increased, node 2 is gradually, but eventually completely starved by node 1. The overall system throughput (measured at the gateway) when the offered load is very high is $B/2$, where B is the throughput of the system when only node 1 forwards data to gateway.

So, the system operates at 75% efficiency because it gets $B/2$ while $2B/3$ is ideal and is unfair. This is further illustrated in figure-4.

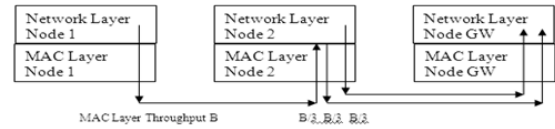


Fig. 4 : Bandwidth allocation at MAC layer

The unfair behavior observed in Fig.3(c) is rooted in the fact that both the traffic originating at node 1, as well as the relayed traffic from node 2, are queued together at node 1. When the traffic load increases, the network cannot forward all data en-queued at node 1, and the queue starts to overflow. With a probability that increases with the offered load, the queue will be full when a new packet arrives from node 1, and it will be dropped immediately after it is received. The exact, expected throughput was determined theoretically, and it was verified using ns-2.

As shown in figure3 (a), in NS2 environment 3 nodes simulated, node 0 and node 1 attached with UDP agent and CBR traffic source. Node 2 is behaving as Null node for this traffic. Traffic load from node 0 to node 2 is named as Flow 1, and traffic load from node 1 to node 2 as Flow2. Various results obtained from varied traffic load processed using "gawk" and "grep" utility of Linux environment. Results stored in excel file and put into graph. Figure-5 shows the graph from the obtained results. PDR stands for Packet Delivery Ratio.

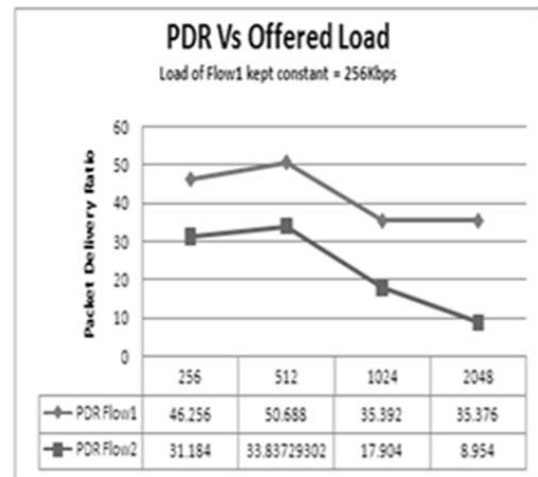


Fig. 5: Graph of obtained Results-Forwarding Unfairness

III. ANALYTICAL MODELING

Figure 6 shows our model where a node is simplified as a server with a queue. The server represents the wireless /conventional wired medium.

If the network in Fig. 6 is assumed to be a conventional wired network, it can be modeled as Figure-7.

In a typical wireless ad hoc network, nodes are expected to have a single transceiver and share a common channel. Thus, the server in node 1 is not independent of the server in node 2. The server in Fig. 7 can be corrected as Fig. 8 where two flows contend with each other to access the wireless medium. Figure 8 indicates that the traffic flow generated by node 2 has to go through two queues and get served twice by one server to reach the destination. In contrast, the traffic flow of node 1 goes through the queue and the server only once, which implies an unfair competition between the two flows unless otherwise controlled. In the same manner, the analysis can be extended to the networks with longer chain.

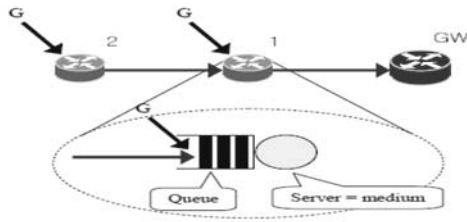


Fig. 6 : Two source chain network

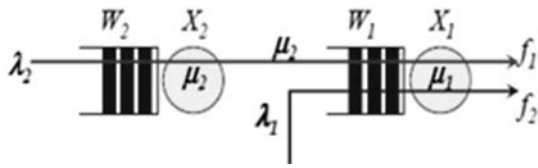


Fig. 7: Conventional Wired Network: Two Source Chain

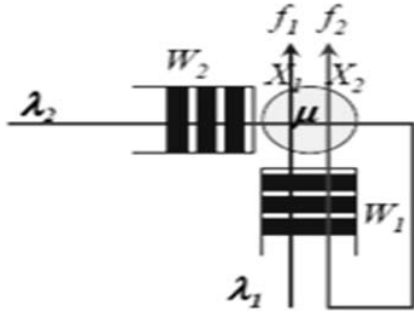


Fig. 8: Wireless Network: Two Source Chain

Where each parameter is defined as follows:

λ_i = arrival rate of i^{th} node

(i.e., rate of the generated traffic)

μ_i = service rate of i^{th} node

W_i = queuing delay of i^{th} node

X_i = service time of i^{th} node

(= transmission delay + propagation delay + others (e.g., random back-offs))

f_i = flow throughput of i^{th} node

$$= \frac{1}{W_i + X_i} \quad \text{----- (1)}$$

IV. PROPOSED SOLUTION

In this section, we propose various solutions to address the problem described in section II and explain the advantages and disadvantages of each scheme. For clarity, a simple multi-hop wireless network with four nodes as shown in Fig.9 is used in the analysis. We assume that all the traffic flows are unidirectional toward the gateway. Each node in Fig. 9 can be modeled as a wireless router with network-layer queue(s) and MAC-layer queue(s) as shown in Fig. 8.

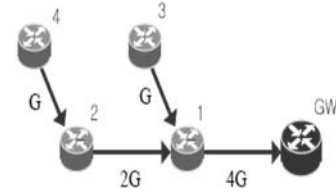


Fig. 9: Multi-hop Wireless Network with four nodes and single gateway

A. Isolate the Originating Traffic

Assuming that Fig.10 shows the network and MAC queues of node 1 in Fig. 9, f_1 is the originating traffic flow and f_2 , f_3 and f_4 are the relayed ones.

With the basic queuing scheme as shown in Fig. 10, it is clear that the traffic flow f_1 will receive more bandwidth and eventually starve others due to the problem described in the previous section. Since this problem stems from the fact that both the relayed and the originating traffic share a common queue [4], [9], the first solution that comes to one's mind is to use different queues for the relayed and for the originating traffic and to serve them in a round-robin fashion. This scheme will isolate the originating traffic which dominates the relayed traffic and protect the relayed traffic from being starved by the originating one.

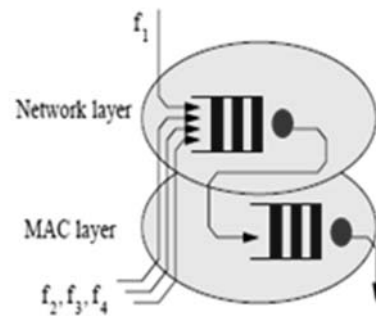


Fig. 10: Basic Queuing Scheme

B. Different Weight on Relyed Traffic

To alleviate the unfairness shown in the previous section, one can assign different weights to each queue so that the queue for the relayed traffic will receive more scheduling time when needed.

This scheme is modeled as shown in Fig. 11, where the larger disk indicates that a greater weight is given to the forwarding queue.

The weight of the forwarding queue can be fixed in all the nodes of the network, or different weights can be used, depending on the amount of relayed traffic at each node. The latter assumes that the amount of relayed traffic can somehow be determined in a distributed manner. For the network shown in Fig. 3, the desirable weight ratios of the originating versus relayed traffic are 1:3 and 1:1 for nodes 1 and 2, respectively.

Per flow queuing is more complex to design and may increase processing delay due to increased computation. And hence the study is focused on using two queues at network layer with different weights to alleviate unfairness problem experienced by wireless mesh nodes.

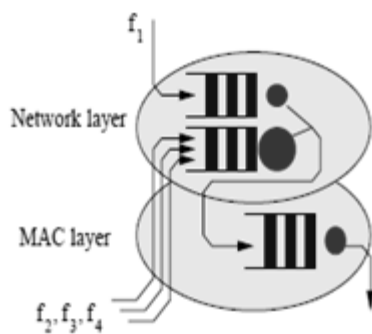


Fig. 11: Different Weight for relayed traffic

C. Methodology and Scheduling Algorithhm

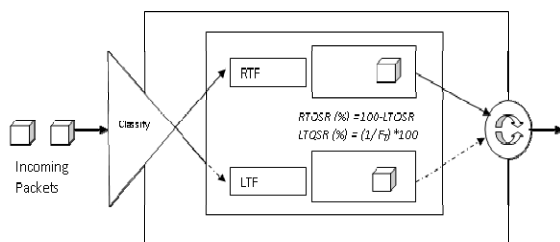


Fig. 12: Methodology of Related Work

Where RTF = Relayed Traffic Flow, LTF = Local Traffic Flow, RTQSR=Relayed Traffic Flow Queue Scheduling Rate, and LTQSR=Local Traffic Flow Queue Scheduling Rate, Ft= Total number of Traffic Flows.

The network clock cycle consists of two phases. In the first phase, traffic flow control information passes through the network from the last stage to the first one. In the second phase, packets flow from one stage to the next in accordance to the flow control information.

The arrival process of each packet is Poisson process, that is, the probability that a packet arrives within a clock cycle is constant and the arrivals are independent of each other. We will denote this probability as λ . This probability can be further broken down to λ_l and λ_r , which represent the arrival probability for local and remote traffic packets, respectively. It holds that $\lambda = \lambda_l + \lambda_r$. Under the dual-priority mechanism, when applications or architectural modules enter a packet to the network, they specify its priority, designating it either as high or low. The criteria for priority selection may stem from the nature of packet data. A high-/low-priority packet arriving at the first stage is discarded if the High low-priority buffer of the corresponding network switch is full, respectively. Upon reception, packets are first classified according to their priority and are then assigned to the queue specifically dedicated to the particular priority. Each packet priority queue is mathematically calculated *weight*, which specifies the time ratio that will be dedicated to schedule that particular queue. Naturally, the sum of all time scheduled must be equal to network clock cycle.

V. RELATED WORK

There are two nos. of simulation, simulation of unfair scheduling; dual queue option is set to 0 in routing protocol code, while simulation of fair scheduling use dual queue option in routing protocol code. Table I lists files from ns2 directory which underwent changes to develop modified AODV protocol [5] named here as Fair Resource Wireless Mesh Network Protocol (FRAWMN)

TABLE I. CHANGES DONE IN AODV PROTOCOL

File Name	Function	Additional functions
aodv.cc	C++ code	lrf.enqueue(), rtf.enqueue()
aodv_rqueu e.cc	Queuing C++ code	compute_weight()

The simulation is carried using NS2 scripts under Fedora operating system on VMware machine. Table II lists simulation parameters. Various results for both simulations compared together to depict behavior of modified AODV protocol herein named as FRAWMN.

Nomenclature FS means Fair Scheduling and NFS means No Fair Scheduling. As shown in figure 13, obtained results are plotted to depict how the flow 1 is fairly treated using modified protocol FRAWMN. In absence of dual queue option, throughput of flow 2, 3 and 4 drops, and flow 1 acts as greedy flow. Figure 14 shows the flow id versus throughput for each flow id.

TABLE II. SIMULATION PARAMETERS

Parameter	Value
Flat-grid Topology Dimensions	1000m X 1000m
Number of Gateways	10
Number of Mesh Nodes	50
Packet Interval Time	0.05 Second
Traffic	CBR
Traffic Packet Size	2000 bytes / 512 bytes
Connection Agent	UDP

Jain Fairness Index is given as

$$f(x_1, x_2, x_3, \dots, x_n) = \frac{(\sum_{i=1}^n x_i)^2}{n \sum_{i=1}^n x_i^2} \text{ ----- (2)}$$

Where x_i is flow id and n = number of contending flows.

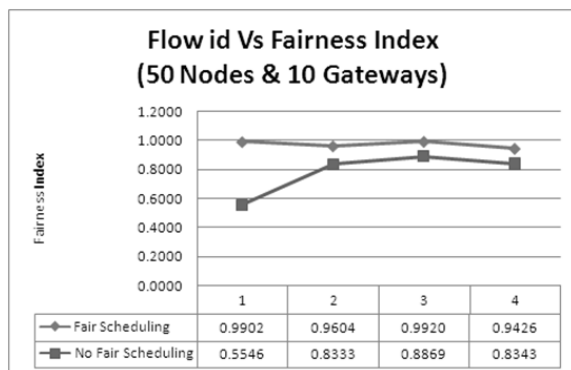


Fig. 13: Flow id Vs Fairness Index- Fair & No Fair Scheduling

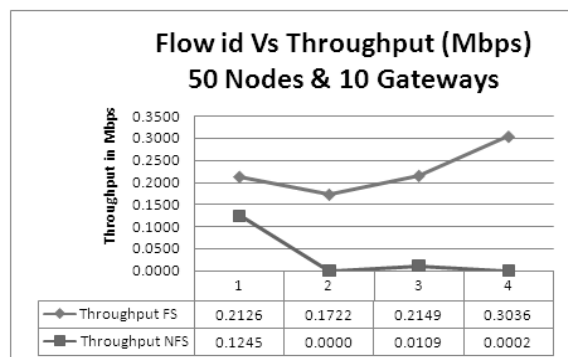


Fig. 14: Flow id Vs Throughput – Fair & No Fair Scheduling

VI. CONCLUSION

Thus mechanism to isolate originating traffic and allocating a proportional part of network cycle for catering relayed traffic shown improvement in fairness index as well as throughput. Further planning is to test this for wider ranges, varied traffic, different protocol and more number of nodes with limited number of gateways.

VII. ACKNOWLEDGEMENT

The authors would like to thank Dr. Manjusha Deshmukh, Prof. Dattatray S. Bade for fruitful discussions on the queue mechanism and Prof. Sheetal Bukkavar for her help in setting up the simulations.

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NRZ VERSUS RZ IN 40-CHANNEL OC-768 DWDM LINK (50 GHZ GRID) WITH MULTIPLE BACKWARD PUMPED RAMAN AMPLIFICATION

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ABSTRACT

In this paper we have proposed and investigated the new trends and progress of fiber Raman amplification for dense wavelength division multiplexing photonic communication networks. Forty individual channels carrying PRBS data are transmitted over a 50 km length of ITU-T G.652 single mode dispersive fiber. The design objective is to utilize distributed Raman amplification to compensate for the link attenuation thereby effectively increasing the inter-EDFA span in a longer-haul link. We compare non-return-to-zero (NRZ) with return-to-zero (RZ) modulation format for dense wavelength division multiplexed systems operating at data rates up to 40 Gb/s.

Keywords : PRBS, Return-to-Zero (RZ), Digital Crossconnect System (DCS), phonons, Dense Wavelength Division Multiplexing (DWDM), stimulated raman scattering (SRS), raman amplification, pump evolution, EDFA.

I. INTRODUCTION

It is needless to mention that the 21st century activities will be drastically hindered without the advent of modern communication system [1]. Off all, the most advanced communication system has been culminated in the form of Internet, allowing all computers on the planet and in the orbit to be connected to each other simultaneously. While telecommunication remains as a major medium and has its own demand for higher bandwidth, the demand for even higher bandwidth is sky rocketed by exponential growth of the Internet traffic. The cumulative demand for bandwidth poses a serious limitation for the existing carrier technologies. High demand coupled with high usage rates, a deregulated telecommunications environment, and high availability requirements is rapidly depleting the capacities of fibers.

Faced with the challenge of dramatically increasing capacity while constraining costs, carriers have two options: Install new fiber or increase the effective bandwidth of existing fiber. Laying new fiber is the traditional means used by carriers to expand their networks. Deploying new fiber, however, is a costly proposition. It is estimated at about dollar 70,000 per mile, most of which is the cost of permits and construction rather than the fiber itself. Laying new fiber may make sense only when it is desirable to expand the embedded base.

Increasing the effective capacity of existing fiber can be accomplished in two ways [1], increase the bit rate of existing systems or increase the number of wavelengths on a fiber.

An issue still remains as to determining whether NRZ or RZ is the more optimal modulation scheme for use in DWDM. Intuitively, the following suppositions can be made, firstly, due to higher peak power, RZ may suffer more non-linearities, and due to shorter pulse width, RZ may suffer more dispersion. Secondly, due to a longer pulse time and longer interaction time between wavelengths, NRZ may suffer more non-linearities. In this letter, we compare NRZ with RZ modulation for dispersion-managed systems operating at data rates up to 40 Gb/s.

In section II, describes the basic concept of Raman amplification, comparison of Raman amplifiers with Erbium Doped Fiber Amplifiers (EDFA) and the use of Raman Amplification in DWDM system. In section III, the design and simulation results of a 40 channel DWDM link with backward pumped Raman amplification is mentioned along with the comparison. The paper ends with section V, which includes the summary and the future scope of Raman amplification in DWDM systems.

II. RAMAN AMPLIFICATION IN DWDM SYSTEM

Raman amplification is based on stimulated Raman scattering (SRS) a non-linear effect in fiber optical transmission that results in signal amplification if optical pump waves with the correct wavelength and power are launched into the fiber [2]-[4].

One of the most recent and interesting developments includes the constructive usage of the so-called Raman effect in optical amplifiers [8]. A Raman amplifier uses intrinsic properties of silica fibers to obtain signal amplification. This means that transmission fibers can be used as a medium for amplification, and hence that the intrinsic attenuation of data signals transmitted over the fiber can be combated within the fiber. An amplifier working on the basis of this principle is commonly known as a distributed Raman amplifier (DRA).

The physical property behind DRAs is called SRS. This occurs when a sufficiently large pump is co-launched at a lower wavelength than the signal to be amplified. The Raman gain depends strongly on the pump power and the frequency offset between pump and signal. Amplification occurs when the pump photon gives up its energy to create a new photon at the signal wavelength plus some residual energy, which is absorbed as phonons (vibrational energy) as shown in figure 1.

As there is a wide range of vibrational states above the ground state, a broad range of possible transitions, are providing gain. This is shown by figure 1. Generally, Raman gain increases almost linearly with wavelength offset between signal and pump peaking at about 100 nm and then dropping rapidly with increased offset [9]. The disadvantage of Raman amplification is the need for high pump powers to provide a reasonable gain.

This opens a new range of possible applications. It is possible, for instance, to partially compensate fiber attenuation using the Raman effect and, thus, to increase the EDFA locations. This saves costs as less EDFAs are needed on the link, and the number of sites to be maintained is reduced [8], [11].

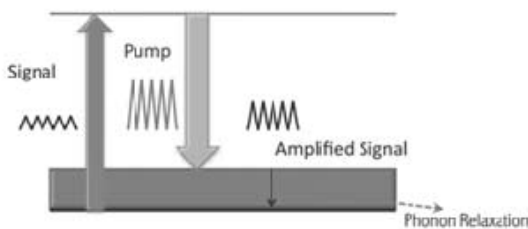


Fig. 1: Energy Level Diagram of Raman Amplifier [8]

Raman amplifiers offer several advantages compared to EDFAs, including the following:

- Low noise build-up.
- Simple design, as direct signal amplification is achieved in the optical fiber, and no special transmission medium is needed.
- Flexible assignment of signal frequencies.
- Broad gain bandwidth.

However, despite the many advantages of Raman amplification, there can be some degradation effects. For example, not only the specially launched pump waves but also some of the WDM channels may provide power to amplify the other channels. This would result in power exchange between WDM channels and thus cross-talk leading to signal degradation.

These negative effects occur in unidirectional and bidirectional WDM transmission. So for accurate analysis of advanced WDM systems, it is crucial to model all Raman interactions.

Additionally, degrading effects like spontaneous Raman scattering and backward Rayleigh scattering have to be considered. Raman amplifiers are topologically simpler to design than doped-fiber amplifiers, as the existing transmission fiber can be used as a medium if properly pumped. However, the selection of pump powers and wavelengths, as well as the number and separation of pumps, strongly determines the wavelength behaviour of Raman gain and noise.

When building distributed Raman amplifiers, designers face the question of using forward or backward pumping (or even both) with respect to signal propagation. The backward pumping scheme is most commonly used as it offers several advantages. Pump noise strongly affects the WDM signals to be amplified if forward pumping is applied, as the Raman process is nearly instantaneous [5], [6]. When the Raman pump wave has slight random power fluctuations in time, which is almost always the case, individual bits might be amplified differentially, which leads to amplitude fluctuations or jitters. If backward pumping is applied the amplitude fluctuations will be averaged out [7].

III. 40 GBPS DWDM LINK WITH BACKWARD PUMPED RAMAN AMPLIFICATION

This example simulates a realistic scenario of a 40Gbps DWDM link with inter-channel spacing of 50 GHz. Forty individual channels carrying PRBS data are transmitted over a 50 km length of ITU-T G.652 single mode dispersive fiber. The link has been simulated for both the NRZ and the RZ coding techniques. Figure 2 below shows a snap-shot of the layout. The multi-line capability of OptSims CW laser model makes it very convenient to generate the source-grid for simulating WDM channels.

A. Spectrum of Channels

Since backward pumping helps in averaging out power ripples at the receiver end, we choose a backward pumping scheme that employs eight CW pump signals with carefully chosen nominal wavelengths and power values. Input of -165 dBm is given to the system and output of -58 dBm is obtained from the DWDM system for both NRZ and RZ coding using backward pumped Raman amplifier.

B. Backward Pump Characteristics

Raman amplification is a wide-band phenomenon having a highly irregular gain profile over wavelength. The highest Raman gain is observed for a frequency differential range (range of difference between pump signal and data signal nominal frequencies) of 8 to 12 THz.

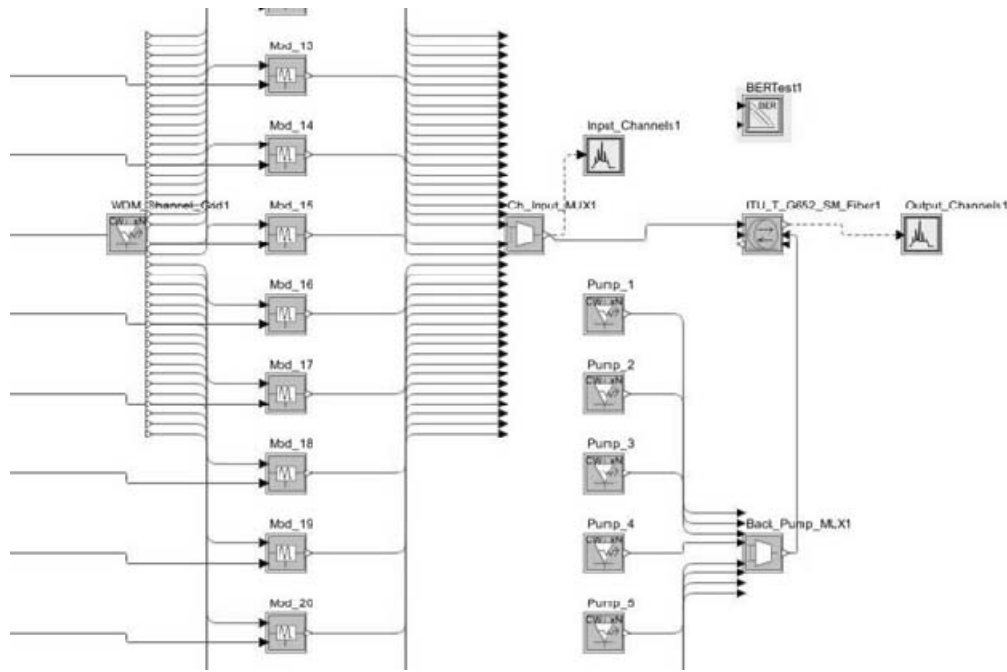


Fig. 2: Sectional snap-shot of a 40-channel DWDM link layout

Outside this range, the gain profile exhibits a sharp decline. Therefore, if the number of pumps, their wavelengths, and the power values are chosen carefully, we can achieve the desired gain shape for the input DWDM channels. Using both NRZ and RZ line coding, the same results are obtained for backward pumped characteristics.

C. Characteristics of Output Signal

The output signal for NRZ coding is observed at 1550 nm. As shown in figure 3, forward gain of 6.2 dB is obtained at 1550 nm. It can be seen in figure 4 that power of 1 mW is launched into the fiber at 1550 nm and a final power of 5 mW is obtained at 1550 nm. The forward effective noise figure is shown in figure 5. Effective noise figure of -3.3 dB is obtained at 1550 nm. Figure 6 shows that signal to noise ratio at 1550 nm is 42 dB.

The output signal for RZ coding is observed at 1550 nm. As shown in figure 7, forward gain of 7 dB is obtained at 1550 nm which is comparatively higher than that obtained using NRZ coding. It can be seen in figure 8 that power of 1 mW is launched into the fiber at 1550 nm and a final power of 3 mW is obtained at 1550 nm which is lower than that obtained using NRZ coding. The forward effective noise figure is shown in figure 9. Effective noise figure of -3.6 dB is obtained at 1550 nm. Figure 10 shows that signal to noise ratio at 1550 nm is 38 dB which is lower than that obtained using NRZ coding which could be easily assumed since the output power of RZ is comparatively lower than that of NRZ.

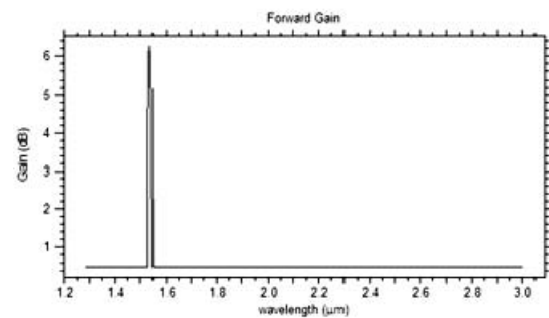


Fig. 3: Forward gain (NRZ coding)

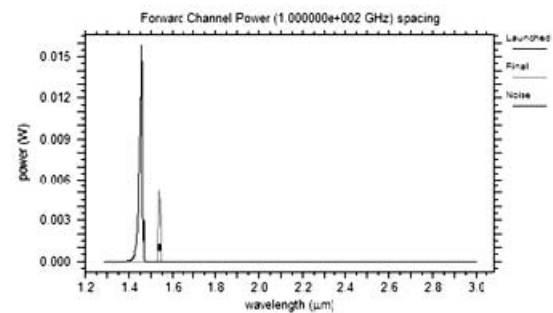


Fig. 4: Forward channel power (NRZ coding)

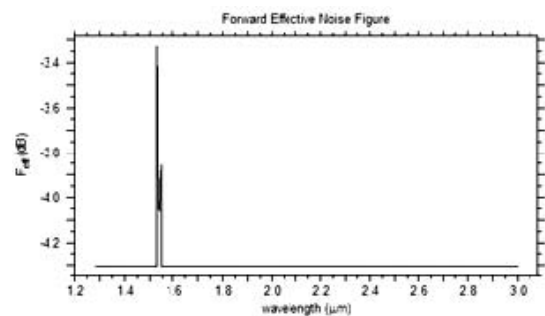


Fig. 5: Forward effective noise figure (NRZ coding)

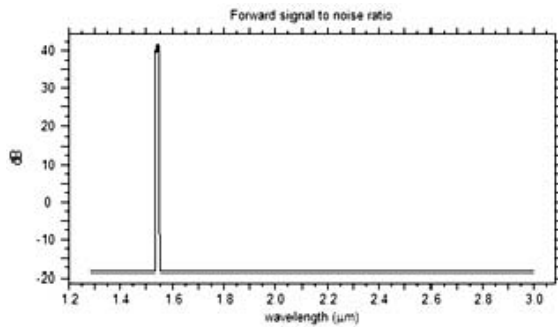


Fig. 6: Forward signal to noise ratio (NRZ coding)

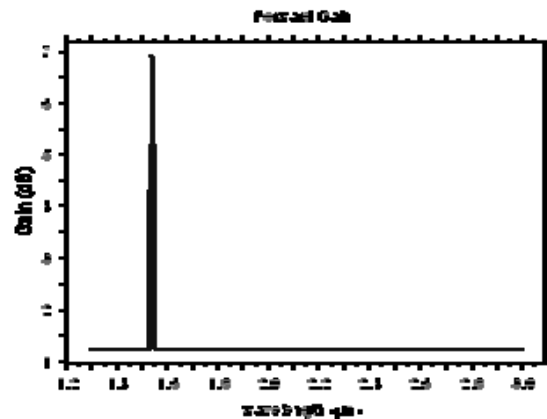


Fig. 7: Forward gain (RZ coding)

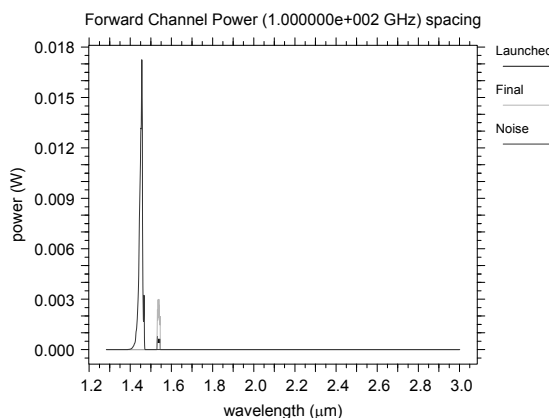


Fig. 8: Forward channel power (RZ coding)

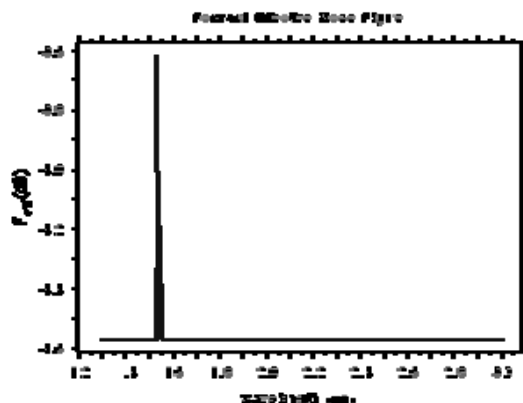


Fig. 9: Forward effective noise figure (RZ coding)

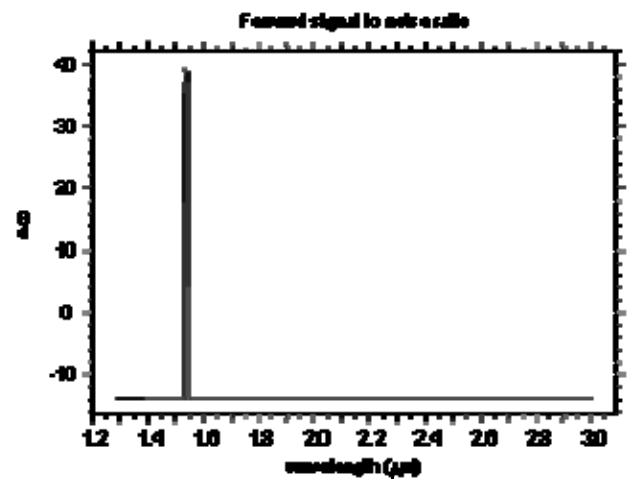


Fig. 10: Forward signal to noise ratio (RZ coding)

IV. CONCLUSION

The advantages of fiber Raman amplifiers over the optical amplifiers include the possibility to operate in any wavelength region and superior noise performance of distributed amplification, as well as permits, with the appropriate choice of pump wavelengths and powers, flattening of the gain profile over the whole bandwidth.

This paper describes the simulation of a realistic scenario of a 40Gbps DWDM link with interchannel spacing of 50 GHz. Forty individual channels carrying PRBS data are transmitted over a 50 km length of ITU-T G.652 single mode dispersive fiber. RZ line coding is used in this system. The multi-line capability of OptSims CW laser model makes it very convenient to generate the source-grid for simulating WDM channels. In this paper we have compared the performance of NRZ with RZ coding for DWDM systems operating at 40 Gbps. NRZ is more adversely affected by non-linearities, whereas RZ is more affected by dispersion. The systems that operate at 10 or 20 Gbps have better performance using RZ modulation because non-linearity dominates. However, 40 Gbps systems favor the usage of NRZ because dispersion becomes the key limiting factor at 40 Gbps.

ACKNOWLEDGMENT

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CONSISTENT & TRIVIAL ROUTING APPROACH FOR IN-NETWORK AGGREGATION IN WIRELESS SENSOR NETWORK

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ABSTRACT

A wireless sensor network (WSNs) consists of many sensor nodes and these networks are deployed in different applications for monitoring environmental conditions. These sensor nodes are limited energy which limit the lifetime of a sensor network. In WSN's nodes are densely located, so there is duplication of data as multiple nodes sensing same event. Such duplication of data is responsible for wastage of node energy. Since energy saving is one of the important issues. So, data aggregation, data fusion should be used for saving energy. Data aggregation is effective method to eliminate redundancy and to minimize the number of transmission. In this paper I present an efficient, trivial data aggregation strategy based on tree & cluster formation which eliminates such data duplication and improves node energy, efficiency & provides the best aggregation quality when compared to other existing systems, regarding scalability, communication cost, delivery efficiency, aggregation rate and aggregated data delivery rate. These node structures are then used to route packets to sink in an efficient manner. This helps in building efficient wireless sensor network.

Keywords : Data Aggregation, Information Fusion, In-Network Aggregation, Routing Protocol, Routing Tree

I. INTRODUCTION

A Wireless Sensor Network (WSN) consists of spatially distributed autonomous devices that cooperatively sense physical or environmental conditions, such as temperature, sound, vibration, pressure, motion or pollutants at different locations. WSN in its simplest form can be defined as a network of devices denoted as nodes that can sense the environment and communication of the information gathered from the monitored field through wireless links; the data is forwarded, possibly via multiple hops relaying, to a sink that can use it locally, or is connected to other networks (e.g., the Internet) through a gateway. Sensor nodes are energy-constrained devices and the energy consumption is generally associated with the amount of gathered data, since communication is often the most expensive activity in terms of energy. We shall consider two-tiered wireless sensor network with three main actors. Sensors are in charge of sensing data. The sink accepts queries from users, contacts Inner network to get answers, and returns them to users. Storage nodes stores data from sensors and seek answers for queries from the sink node.

A sensor network consists of multiple stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. The storage nodes also brings many security challenges since the storage node stores the data received from sensors and serve as an important role for answering queries, they are more vulnerable to be compromised, mainly in a hostile environment. A compromised storage node causes threats to a sensor network.

II. LITERATURE SURVEY

Routing techniques in wireless sensor networks: a survey By J. Al-Karaki and A. Kamal (IEEE Transaction on Wireless Communications)

- Wireless sensor networks consist of small nodes with sensing, computation, and wireless communications capabilities. Many routing, power management, and data dissemination protocols have been specifically designed for WSNs where energy awareness is an essential design issue.
- Routing protocols in WSNs might differ depending on the application and network architecture. A survey of state-of-the-art routing techniques in WSNs.

III. EXISTING SYSTEM

WSNs are data-driven networks that usually produce a large amount of information that needs to be routed, often in a multi hop fashion, toward a sink node, which works as a gateway to a monitoring center.

The solution to this problem was proposed by which is called as "InFRA and SPT Scheme". This scheme has two main drawbacks :

- A) A possible strategy to optimize the routing task is to use the available processing capacity provided by the intermediate sensor nodes along the routing paths. This is known as data centric routing or in-network data aggregation.

- B) Data aggregation is an effective technique for saving energy in WSNs. Due to the inherent redundancy in the raw data gathered by the sensor nodes, in-networking aggregation can often be used to decrease the communication cost by eliminating redundancy and forwarding only smaller aggregated information.

Disadvantages :

- This will not do the maximization of data aggregation; and
- In this scheme, does not calculate the number hops and clustering.

IV. PROPOSED SYSTEM

The proposed scheme to Aggregation aware routing algorithms play an important role in event based WSN's the Main algorithm [1], a novel and reliable Data Aggregation Aware Routing Protocol for WSNs. In proposed algorithm I extensively compared to two other known routing algorithms [2], the InFRA and SPT, regarding scalability, communication costs, delivery efficiency, aggregation rate and aggregated data delivery rate.

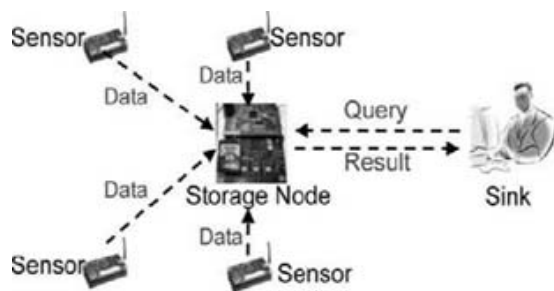


Fig. 1: Structure sensor network

V. IMPLEMENTATION

1. Algorithm: Data Routing for In-Network aggregation for WSN's.
2. Building the Hop Tree.
3. Cluster Formation.
4. Routing Formation and Hop Tree Updates.
5. Route Repair Mechanism.

5.1 ALGORITHM : Data Routing for In-Network Aggregation for WSN's

The main goal of our proposed algorithm is to build a routing tree with the shortest paths that connect all source nodes to the sink while maximizing data aggregation [3], [4]. The proposed algorithm considers the following roles in the routing infrastructure creation:

- *Collaborator*: a node that detects an event and reports the gathered data to a coordinator node;
- *Coordinator*: a node that also detects an event and is responsible for gathering all the gathered data sent by collaborator nodes, aggregating them and sending the result toward the sink node;
- *Sink*: a node interested in receiving data from a set of coordinator and collaborator nodes;
- *Relay*: a node that forwards data toward the sink.

5.2. Building the Hop Tree

The Proposed algorithm can be divided into three phases. In this phase, the distance from the sink to each node is computed in hops. This phase is started by the sink node sending, by means of a flooding, the Hop Configuration Message (HCM) to all network nodes. The HCM message contains two fields: ID and HopToTree, where ID is node identifier that started or retransmitted the HCM message and HopToTree is the distance, in hops, by which an HCM message has passed.

Algorithm 1: Hop Tree Configuration Phase

1. Node sink sends a broadcast of HCM messages with the value of $\text{HopToTree}_e = 1$.
2. **For each** $u \in R$ **do**
If $\text{HopToTree}(u) > \text{HopToTree}(\text{HCM})$ **and** **First Sending** (u) **then**
 $\text{Next Hop} \leftarrow \text{ID}_{\text{HCM}}$;
 $\text{HopToTree} \leftarrow \text{HopToTree}_{\text{HCM}} + 1$;
3. Node u updates the value of the ID field in the message HCM.
 $\text{ID}_{\text{HCM}} \leftarrow \text{ID}_u$;
4. Node u updates the value of the HopToTree field in the message HCM
 $\text{HopToTree}_{\text{HCM}} \leftarrow \text{HopToTree}$;
5. Node u sends a broadcast message of the HCM with the new values;
 $\text{FirstSending}_u \leftarrow \text{false}$;
6. **End**
7. **Else**
Node u discards the received message HCM;
8. **End**
9. **End**

5.3 Cluster Formation

When an event is detected by one or more nodes, the leader election algorithm starts and sensing nodes will be running for leadership (group coordinator) [5]. For this election, all sensing nodes are eligible.

- If this is the first event, the leader node will be the one that is closest to the sink node. Otherwise, the leader will be the node that is closest to an already established route;
- In the case of a tie, i.e., two or more concurrent nodes have the same distance in hops to the sink (or to an established route); the node with the smallest ID maintains eligibility. Another possibility is to use the energy level as a tiebreak criterion.
- At the end of the election algorithm only one node in the group will be declared as the leader (Coordinator). The remaining nodes that detected the same event will be the Collaborators.
- The Coordinator gathers the information collected by the Collaborators and sends them to the sink.

Algorithm 2: Cluster formation and leader election

- 1. Input:** S
S - Set of nodes that detected the event.
- 2. Output:** u
A node of the ϵ set S is elected leader of the group.
- 3. For each** u **S do**
 Role_u $\leftarrow$ coordinator;
 Node u sends message MCC in broadcast
 Announcement of event detection; $\in$
 Nu is the set of neighbors of node u S
- Node u retransmits the MCC message received from **For each** w $\in$ N_u **do If** HopToTree (u) > HopToTree (w) **then**^{nodew}
- End** u $\leftarrow$ collaborator;
- Node u retransmits the MCC message received from node w;
Else if HopToTree (u) = HopToTree (w) $\wedge$ ID (u) > ID (w) **then**
 Role_u $\leftarrow$ collaborator;
- End**
- Else**
 Node u discards the MCC message received from w;
- End**
- End**
- End**
- End**^{Role}

5.4. Routing Formation and Hop Tree Updates

The elected group leader, starts establishing the new route for the event dissemination. The Coordinator sends a route establishment message to its Next Hop node. When the Next Hop node receives a route establishment message, it re-transmits the message to its Next Hop and starts the hop tree updating process. These steps are repeated until either the sink is reached or a node that is part of an already established route is found [6]. The routes are created by choosing the best neighbor at each hop.

Algorithm 3 : Route establishment and hop tree update

- Leader node v of the new event sends a message REM to its NextHop_v;
- Repeat**
- u is the node that received the REM message that was sent by node v.
If u = NextHop_v
then HopToTree_u $\leftarrow$ 0;
 Node u is part of the new route built
 Role u $\leftarrow$ Relay;
 Node u sends the message REM to its NextHop_u; Node u broadcasts the message HCM with the value of HopToTree = 1; Nodes that receive the HCM message sent by node u.
- End**
- Until** Find out the sink node or a node belonging to the routing structure already established.
- Repeat**
- sons_u is the number of descendants of u **If** sons_u > 1 **then**
- Aggregates all data and sends it to the NextHop_u; **If** Role u = Relay **then** Execute the mechanism
- End**
- End**
- Else** Send data to NextHop_u;
- If** Role u = Relay **then** Execute the mechanism
- End**
- End**
- Until** The node has data to transmit/retransmit;

5.5. Route Repair Mechanism

The route created to send the data toward the sink node is unique and efficient since it maximizes the points of aggregation and, consequently, the information fusion. However, because this route is unique, any failure in one of its nodes will cause disruption, preventing the delivery of several gathered event data. Possible causes of failure include low energy, physical destruction, and communication blockage [7], [8].

- Some are based on periodic flooding mechanisms, and rooted at the sink, to repair broken paths and to discover new routes to forward traffic around faulty nodes.
- This mechanism is not satisfactory in terms of energy saving because it wastes a lot of energy with repairing messages.
- Proposed algorithm offers a piggybacked, ACK-based, route repair mechanism, which consists of two parts: failure detection at the NextHop node, and selection of a new NextHop.

VI. CONCLUSION

Performance is measured in terms of the output provided by the application. Requirement specification plays an important part in the analysis of a system. Only when the requirement specifications are properly given, it is possible to design a system, which will fit into required environment. It rests largely with the users of the existing system to give the requirement specifications because they are the people who finally use the system. This is because the requirements have to be known during the initial stages so that the system can be designed according to those requirements. It is very difficult to change the system once it has been designed and on the other hand designing a system, which does not cater to the requirements of the user, is of no use.

In Proposed algorithm, a novel and reliable Data Aggregation Aware Routing Protocol for WSNs. Our proposed algorithm was extensively compared to two other known routing algorithms, the InFRA and SPT, regarding scalability, communication costs, delivery efficiency, aggregation rate and aggregated data delivery rate. By maximizing the aggregation points and offering a fault tolerant mechanism to improve delivery rate, the obtained results clearly show that Proposed algorithm outperformed the InFRA and SPT algorithms for all evaluated scenarios. In proposed algorithm has some key aspects required by WSNs aggregation aware routing algorithms such as a reduced number of messages for setting up a routing tree, maximized number of overlapping routes, high aggregation rate, and reliable data aggregation and transmission.

VII. FUTURE WORK

Spatial and temporal correlation of the aggregated data will also be taken into consideration as well as the construction of a routing tree that meets application needs. We also plan to modify this proposed algorithm to stochastically select nodes that will be part of the communication structure.

The goal is to find a balance between the overhead and the quality of the routing tree. In addition, new strategies will be devised to control the waiting time for aggregator nodes based on two criteria: average distance of the event coordinators, and spatial and semantics event correlation.

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A REVIEW OF INTRUSION DETECTION SCHEMES IN WIRELESS SENSOR NETWORK

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ABSTRACT

Different study gives different types of Intrusion Detection System in Wireless Sensor Network. WSN's nodes are frequently deployed in open environment therefore they are vulnerable to attack. Hence for complete defense mechanism. We present an exhaustive classification of various approaches of IDS in WSN. Two main approaches describe in this paper are anomaly detection which is signature free and misuse detection which is signature based we give merits and demerits of many proposed IDS so that Researchers got tracks in their research.

Keywords : *Wireless sensor Networks, Security, Misuse based intrusion, Anomaly based intrusion.*

I. INTRODUCTION

According to the 29th Statistical Survey Report on Internet Development in China [3], as of January 2012, number of Internet users has reached 5.13 hundred million. Along with an increase of 38.3% in the use of Internet, E-commerce activities like online shopping have expanded rapidly reached 194 hundred millions up by 20.8%. Therefore due to openness of internet, the expansion of internet and unexpected security threat shows increased Attacks on network. That effect increased in criminal activity. To monitor this attacks IDS is introduced. For truly secure sensor networks we need a second line of defense: an Intrusion Detection System that can detect a third party that tries to develop the security of the network, even if this attack has not been seen before [4][5]. If the intruder is detected soon enough, we can take any suitable measures before any damage is done or any data is compromised. Thus, intrusion detection presents a second wall of defense and it is a necessity in a high survivability network. Some Intrusions are

- The network attacks against different vulnerable services,
- Data-driven attacks on various applications,
- Host-based attacks like licenses,
- Unauthorized logins and access to private files,
- Malware like viruses, worms and Trojan horses.

The existing network defense solutions, like firewalls, were not deliberate to handle network and application layer attacks such as Denial of Service and denial of Service attacks, worms, viruses, and Trojans. Along with the drastic growth of the Internet, the high incidence of the threats over the Internet has been the reason for the security persons to think of IDSs.

The rest of this paper is organized as follows, section 2 provides Types of Attacks on WSN, and then in section 3 different types of intrusion detection is explained. The various intrusion detection methods are elaborated with taxonomy in section 4, in section 5 concludes the paper based on our analysis and findings. Finally comparison of different intrusion detection methods is given in tabular format.

II. TYPES OF ATTACKS IN WSN

Wireless Sensor Network application scenarios security is a very important concern specially in commercial applications WSN is widely being used in many industry including Health-care, Military applications, Environmental applications, Home applications, Interactive museums, etc [5]. In a wireless sensor network, an IDS is an important security mechanism against both insider and outsider attacks. It focuses on detection of misbehaviour or malicious nodes. When IDS detects a sensor node bad, it tries to isolate that malicious node from the network.

1. *Jamming*: It represents an attack on the availability of a network. It creates denial-of-service conditions.
2. *Wormhole Attack*: A severe threat against packet routing in sensor networks. In this attack, an adversary receives packets at one location and tunnels them to another location in the network, where the packets are retransmitted.
3. *Sinkhole Attack*: A malicious node tries to attract all traffic from a particular area towards itself usually by modifying or spoofing routing metrics.
4. *Selective Forwarding Attack*: In this attack some packets are correctly forwarded but others are silently and intentionally dropped.
5. *Sybil Attack*: A single node presents multiple identities to other nodes in the network.
6. *Hello Flood Attack*: Discovery protocols on WSNs use HELLO messages types to discover its neighboring nodes. In an attack type HELLO Flooding, an attacker will use this mechanism to saturate the network and consume energy [1][5].

III. TYPES OF INTRUSION DETECTION

An Intrusion Detection System that can detect an outsiders that tries to break the security of the network, even if this attack has not been seen before.

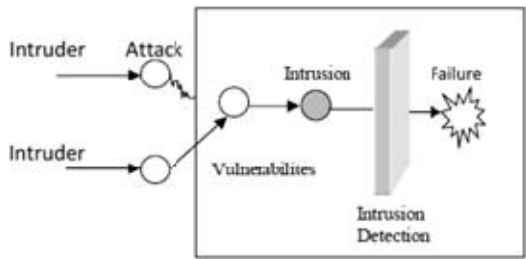


Figure 1. Intrusion Detection System

If the intruder is detected earlier, we can take any respective measures before any damage is done or any data is compromised (Figure 1). Therefore, intrusion detection presents a second wall of defense. All computer activity and network traffic falls in one of three categories including, normal, abnormal but not malicious, and malicious [5]. Traditionally, intrusion detection systems are divided into two categories:

- A) Host-based IDS and
- B) Network-based IDS.

A) Host-based intrusion detection (HIDS):

It monitors computer processes for signs of misuse. It is designed to detect, and respond to system activity and attacks on a given host (node). All this decision is made based on information collected at that host by reviewing audit logs for suspicious activity.

B) Network-based intrusion detection (NIDS) :

It monitors network traffic for signs of misuse. It uses raw network packets as the data source. It listens on the network, captures and examines individual packets in real time. It can analyze the entire packet, including the header. Long term objective of NIDS is to address all aspect of Intrusion detection [21].

IV. INTRUSION DETECTION METHODS

Intrusion detection systems must be able to distinguish between normal and abnormal activities in order to discover malicious attempts in time.

There are three main methods that an intrusion detection system uses to classify the attacks.

- A) Misuse based Detection.
- B) Anomaly based Detection.
- C) Specification based detection.

Out of these Specification Based IDS combines the aim of misuse and anomaly but having drawback is

the manual development of all specifications, which is a time-consuming process for human beings [1]. Therefore we concentrate on misuse and anomaly based detection methods.

A) Misuse based Detection

In misuse detection or signature-based detection systems, the observed behavior is compared with known attack patterns (signatures) [1]. Action patterns that may create a security threat must be defined and stored to the system. Then, the misuse detection system tries to recognize any “bad” behavior according to these patterns. The main disadvantages of such system are they can’t detect novel attacks. In addition someone has to continuously update the attack signature database.

It consists of two approaches that is watchdog and spontaneous watchdog detection approach as shown in taxonomy of IDS in figure 2.

1) Watchdog approach :

Watchdog methods detects misbehaving nodes for that they used broadcast nature of wireless communication. using IDS agent it monitors the packets sent by its neighbours by overhearing them [6][7].

2) Spontaneous watchdog approach :

Mechanism that reduces the number of nodes which analyze the packets of network, a novel technique for optimally monitoring neighbours spontaneous watchdog is introduced [8].

B) Anomaly based Detection

Anomaly detection is overcomes the limitation of misuse detection by focusing on normal behaviours rather than attack behaviours. This approach is analyzing whether behavior of nodes can be normal or abnormal according to certain assumptions. It detects unknown attacks promisingly. Hence undergoes seven sub methods as follows:

1) Statistical model based:

In this method Nodes keep statistics about their neighbors, therefore called as statistical model based method. The attacks reveal themselves by deviations from the normal transceiver and traffic behaviors by considering some assumptions [9][10].

2) Clustering algorithm based:

Data mining techniques are introduced into intrusion detection systems to improve their effectiveness and efficiency. Like association algorithm such as Apriori and toscan traffic data K-means algorithm used. Also traffic based profile learning strategy is used by making some hypothesis for detecting anomalies [11][12].

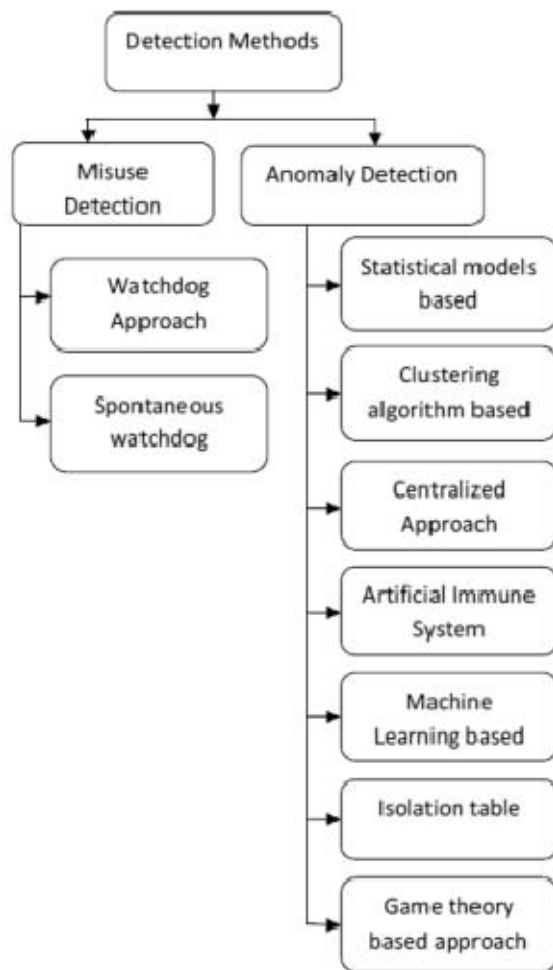


Fig. 2 : Taxonomy of Intrusion Detection Methods.

3) Centralized approach:

A new framework for detecting anomalies call centralized which correlate information from two sources one is from regular data collection and other is from implementing new routing protocol [13].

4) Artificial Immune System:

In this system when we defining an intrusion detection system several noticeable facts firstly specified, otherwise detection is not possible. For artificial immune systems these facts are defined by genes. And for detecting intrusion it used biological inspired algorithm for example dendritic cell algorithm (DCA) [15][16].

5) Machine Learning based:

It uses concept of automata theory and rate the confidence using binary prediction engine which helps to predicts confidence ratio to calculate training datasets. And used vector theory for distributed anomaly detection [14][17].

6) Isolation table:

In this approach for isolate malicious nodes, a method using isolation table to avoid IDS consuming unnecessary energy.

Which required through sensing, transmitting and computing data in WSN. It compares sensor node behaviors with attack behaviors to determine anomaly information [18].

7) Game theory based approach:

In Game, each participant wants to win when Game's over. For that each participant will select his strategy. This approach gives a non-cooperative two player nonzero-sum game between the sensor network and the attacker and implemented smart learning approach to predict the future behavior of the attacker and game between an attacker and a cluster head node which is attacking and defensive [19][20].

V. CONCLUSION

In this review paper, we describe an Intrusion Detection system in wireless sensor network with their types. We focus on specific two methods misuse based detection and anomaly based detection and classifying them according to their merits, demerits and detection of known or unknown attacks. Most of the proposed detection methods are attack specific because of limited coverage of attack in each methods. So there will be need to develop a generic attack method which helps or detects all types of attacks. For this purpose all available or proposed methods must be analyzed by the researchers. We hope that this study will be beneficial to researchers in this area.

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Sr. No	Detection Techniques	Approach	Ref. No	Advantages	Disadvantages	Detection of known Attack	Detection of Unknown Attack
1	Misuse Based Detection	Watchdog Approach	6	Detected misbehavior of nodes.	Strict memory constraints of WSNs make misuse detection based ids that need to store attack signature difficult to implement.	Yes	No
			7	Packet monitoring takes place in several specific nodes in the network.	Because of randomness selection of packets not all packets are covered.		
2		Spontaneous watchdog	8	Techniques used for optimal monitoring of neighbors.	-	Yes	No
3	Anomaly Based Detection	Statistical model based	9	Used average of the received power propagation model and packet arrival rate at each neighbor node.	Not present how experimental setup was designed. Simulator information is not given.	Yes	Yes
			10	Uses mean and standard Deviation metrics.	No information is given about how many number of nodes used.		
4		Clustering algorithm based	11	Used Apriori algo. to extract traffic pattern & k-means algo. to generate detection model.	In large WSN if providing a local training dataset to each node then it complex.	Yes	Yes
			12	Used arrival order of different packets.	Result not given.		
5		Centralized approach	13	System implemented in Tiny OS with positive Result.	-	Yes	Yes
6		Artificial Immune System	15	Uses dendrites cell algorithm (DCA) and tested in TOSSIM.	-	Yes	Yes
			16	Uses biological inspired algorithm to detect misbehavior.	-		
7		Machine Learning based	14	Uses machines learning algo. As SLIPPER and automata learning approaches.	Result not given.	Yes	Yes
			17	Uses support vector machines to detect anomalies.(high detection accuracy)	-		
8		Isolation table	18	Using ns2 Isolation stimulation gives valid results.	High energy consumption	Yes	Yes
9		Game theory based approach	19	Uses non-cooperative game approach. Good for defense mechanism	High energy consumption.	Yes	Yes
			20	Good for wired network in terms of security.	When nodes are large then Performance of this models are decreases.		

Table 1. Comparison of Different IDS Methods

TRUST AND REPUTATION MODEL OVERCOMING SECURITY THREATS IN WIRELESS SENSOR NETWORK

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ABSTRACT

Wireless sensor network security is been a very challenging domain due to its deployment in hostile environment, inherent insecurity in communication medium and resource constraints. Being a distributed system over wireless channel further adds to the difficulty of designing secured wireless sensor network. In last few years Trust and Reputation technique have immerged as a novel idea for dealing with some security deficiency in distributed system. Some of these Trust and Reputation model have also been scaled for wireless sensor network. In this paper, we present Trust and Reputation models which overcome critical security threats in wireless sensor network. We have analyze and describe each of these security threats along with different Trust and Reputation model. This leads to propose some recommendation to face security threats using a particular Trust and Reputation mechanism. This work serves as reference guide when developing secure wireless sensor network using Trust and Reputation mechanism.

Keywords : WSN; Security Threats; Trust and Reputation Model

I. INTRODUCTION

Wireless Sensor Network (WSN) finds its use in many applications such as environment monitoring, military surveillance, home application, medical care and many more. WSN have immerged as a promising network infrastructure. The advancement in micro-electronic-mechanical system (MEMS) and wireless technology have lead to development of multifunctional sensor nodes. This sensor node possesses low cost, low computation power and constrained energy of sensor node. This type of sensor networks is mostly used in hostile environment such as gas chambers or radioactive areas. Hence sensor nodes are more susceptible to get damaged and send incorrectly sensed data or fail completely. WSN is inherently unsecured due to communication medium; that is air. This new dimensions of WSN makes it p rone to different kinds of attacks which are not generally seen in other type of networks.

Trust and Reputation model [1] have been proposed by many researchers for distributed system where each node do not know about every node in the network. Trust and Reputation model is a way of rewarding and punishing a peer of its trust value depending upon service provided by that peer.

WSN is also distributed system where each sensor node does not know about every node in sensor field. Hence Trust and Reputation model can be used to overcome the threats in WSN. This paper aims to understand the effect of different Trust and Reputation models on the security threats [2,3,4,5,6,7,8,9,10] in WSN.

The rest of the paper is organized as follows: Section II describes the security threats in wireless sensor network. In section III, Trust and reputation management is discussed. The section IV describes different Trust and reputation model. Section V compares different Trust and Reputation model with respect to security threats. Section VI concludes the paper.

II. SECURITY THREATS IN WIRELESS SENSOR NETWORK

Wireless sensor network security is been a domain of constraint resources and they are deployed in hostile environment. Along with its inherent unsecured communication medium the threats for WSN further increases. This threats need to be considered before designing a wireless sensor network. The given below are the security threats [2,3,4,5,6,7,8,9,10,15,16] which arrives due to compromised or malicious node within a sensor node.

A. Traffic Analysis Attacks

A wireless sensor network is seen as network of nodes with low computation power with few fully functional nodes known as sink nodes or gateways. Thus data collected by every node is eventually routed to these fully functional nodes. If these fully functional nodes are disabled by attacker it will turn into a useless network [10]. Hence for identifying this fully functional nodes traffic analysis attack is done. This attack actually gathers information needed for other attacks such as DOS attack.

B. Acknowledgement Spoofing

Wireless sensor network consist routing protocols which makes use of acknowledgement. These acknowledgements are spoofed by adversary adjacent nodes due to communication medium and used to represent a weak link stronger or a dead node alive [16]. This eventually results in loss of packets.

C. Insider Attacks

In this class of attack, the attackers have an authentic node in wireless sensor network [8]. This attack generally consists of infected node running corrupted code or adversary which uses gadgets such as laptop running stolen code and data from authentic nodes. Due to this stolen data and code constrain very few nodes can be compromised and used by attacker as insider. This attack is also known as Mote Class attack[16].

D. Outsider Attacks

In outsider attack attackers do not possess any authentic node from sensor network but they have exceptionally stronger gadgets which have more power in all aspects than sensor nodes and hence can easily replace sensor node in authentic network. The attacker possesses such powerful devices such that a single attacker is enough to block whole network. It is also known as Laptop Class attack[16].

E. Eavesdropping

Fundamentally eavesdropping is a prerequisite for many attacks in wireless sensor network. The attacker in this case only listens to the content being communicated between sensor nodes [16]. As communication medium is air eavesdropping and observing the data being communicated is easier. This observed data can then be used to in other attacks.

F. Impersonation

As name suggest the attacker duplicates the identity of an authentic node from the sensor network. After doing this attacker augments the node with duplicate ID to the sensor network. In this attack, attacker copies the ID of authentic node from sensor network [16]. Adversary can make use of this duplicated node to drop, fabricate or misroute the packets. Using such replication attacker can discover the cryptographic keys which are due to multiple ID or node duplication.

G. Denial of Service (DOS)

The Denial of Service attack can take place at different layers of wireless sensor network. It may be a work of simple radio jamming at physical layer or tampering of packets which is known as modification or fabrication [15]. The nodes fail unpredictably due to DOS attack. The DOS attack sends excessive packet to targeted victim in order to exhaust resources of the victim node [5].

H. Hello Flood

The Hello flood attack is a variant of DOS attack in which network is flooded with hello packets which renders network useless for the transmission of genuine packets in sensor network [15]. When victim nodes receive such route request for sink it gets deceived by the attack and go through the attack [16].

I. Sybil Attack :

In a Sybil attack, a single malicious node receives multiple identities [15]. In WSN most of the protocols assume that a single node possesses a unique identity. This gives the impression that attacker is present at more than one place at a time [6]. The attacker may use false identities of the nodes adjacent to targeted victims so that malicious node will be selected as next hop [16]. The degree of security assured by multipath routing scheme will be reduced by this attack.

J. Sinkhole/Blackhole Attack:

The attacker makes the malicious node more attractive by giving false shorter route or more computational power and many more things which will attract as many traffic as possible [9]. These nodes then act as sinkhole or blackhole and have numerous opportunities to misguide, violate or drop packets. It may also support other attacks such as selective forwarding [16].

K. Wormhole Attack

In wormhole attack, a low latency side channel for communication is established by attacker to create a wormhole [7]. It can be better understood with the discussing a scenario. Suppose there are two attackers in a same sensor network consisting of a higher speed and a long range link. An attacker can send the message received by him to other attacker using side channel. This message can be sent in a single hop using side channel. All the neighboring nodes will favor these malicious nodes for communication as they show low latency. Service will be improved as long as side channel exist. If attacker moves or stops the tunnel messages it will result in re-initialization of some services [16].

L. Selective Forwarding

In Wireless Sensor Networks every node participates in routing by forwarding the packet. Hence DOS attack via routing can be carried out using selective forwarding. A compromised sensor node can discard to forward certain messages. If dropping policy is random it increases the local packet loss rates. It can also trigger end-to-end recovery mechanisms which is costly [16]. An attacker may also target victim and drop messages to or from that targeted victims.

M. Packet Tampering

It is attack on information transit [15]. In sensor network packet is routed using multi-hop routing. This information if passed through malicious node it can alter, fabricate or modify the packet. In this attack data is tampered but network performance is not degraded. In short it affects the quality of information delivered by the network and not network performance itself.

III. TRUST AND REPUTATION MODEL

Trust and reputation have gained importance in an environment where individual nodes do not know everyone in network and lack of previous knowledge can lead to undesired situation. In such case trust and reputation model can identify trustworthy or reputable nodes which prevent malicious nodes to enter in the network. We have noticed that most of the current trust and reputation models in the literature [1] follow these four general steps:

1. Collection of information about a certain peer in the network by asking other peer their opinion about that peer.
2. Aggregation of all the received information about the peers and somehow computing a score for every peer in the network.
3. Selection of the most trustworthy or reputable peers in the network for providing a service and having an interaction with them, assessing a feedback of the satisfaction for the received service.
4. Last step of rewarding or punishing is carried out, depending upon the satisfaction by adjusting consequently the global trust or reputation deposited in the selected peer.

However, we realize that a single trust and reputation model do not address all the threats in wireless sensor network. Hence different models are proposed to deal with different threats in a wireless sensor network. So selecting a trust and reputation model for sensor network is a trade-off between model and different threats in the wireless sensor network.

IV. DEALING WITH SECURITY THREATS USING TRUST AND REPUTATION MODEL

This section will discuss the well known trust and reputation model used for wireless sensor network. The Eigen Trust [11], Peer Trust [12] and BTRM-WSN [13] are the representative Trust and Reputation models which will be discussed and experimental results showing how model reacts to security threats are taken from reference papers.

A. Eigen Trust

The Eigen Trust [11,17] is one of the most Trust and Reputation model in this field. Each peer is assigned a global trust value based on previous contribution of that peer. Thus local trust of peer i about peer j is define as the difference between the satisfactory and unsatisfactory interactions of peers i and j and denoted by s_{ij} . It is calculated in the following way:

$$s_{ij} = \text{sat}(i, j) - \text{unsat}(i, j) \quad (1)$$

Moreover, a normalized local trust value $c_{ij} \in [0, 1]$ by every other peer for peer i is computed as:

$$c_{ij} = \frac{\max(s_{ij}, 0)}{\sum_j \max(s_{ij}, 0)} \quad (2)$$

The global reputation of peer i is given by the local trust values given to peer i by other peers in the network, weighted by the global reputation of the assigning peers. If C is matrix $[c_{ij}]$, then a vector defined as follows:

$$C = \begin{pmatrix} c_{11} & \cdot & \cdot & c_{1n} \\ \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot \\ c_{n1} & \cdot & \cdot & c_{nn} \end{pmatrix} \quad c_{ij} = \begin{pmatrix} c_{i1} \\ \cdot \\ \cdot \\ c_{in} \end{pmatrix}$$

The trust that peer i places in peer k is represented as t_{ik} which is calculated based on asking his neighboring peers, and defined as follows:

$$\vec{t}_i = C^T \vec{c}_i = \left(\sum_{j=1}^n c_{ij} c_{j1} \dots \sum_{j=1}^n c_{ij} c_{jk} \dots \sum_{j=1}^n c_{ij} c_{jn} \right) \quad (4)$$

By querying adjacent peers of neighboring peers, peer i gets a wider view of peer's k reputation, that is:

$$\vec{t}_i = (C^T)^2 \vec{c}_i \quad (5)$$

Repeating this for a number of times and large enough number m of queries, peer i will get same eigenvector as every other peer in the network.

B. Peer Trust:

The Peer Trust [12,17] is a model which is characterize by aggregating important aspects related to the trust and reputation management. This includes the feedback received by peer, number of transactions of a peer, peers credibility for recommendations, transaction and network context factor. The trust value calculation for peer u is denoted by $T(u)$ and expressed as:

$$T(u) = \alpha \sum_{i=1}^{I(u)} S(u, i) CR(p(u, i)) TF(u, i) + \beta \times CF(u) \quad (6)$$

Where $I(u)$ denotes the total transactions performed by peer u , $p(u, i)$ represents the peer participating in peer u 's i^{th} transaction, $S(u, i)$ is the normalized satisfaction peer u receives in its i^{th} transaction from $p(u, i)$, $CR(v)$ denotes the credibility of the recommendation by v , $TF(u, i)$ shows the adaptive transaction context factor in i^{th} transaction for peer u , and $CF(u)$ denote the adaptive network context factor for peer u .

$$Cr(p(u, i)) = \frac{\text{Sim}(p(u, i), w)}{\sum_{j=1}^{I(u)} \text{Sim}(p(u, i), w)} \quad (7)$$

Where,

$$Sim(v, w) = 1 - \frac{\sum_{x \in IJS(v, w)} \left(\frac{\sum_{i=1}^I I(x, v) S(x, i)}{I(x, v)} - \frac{\sum_{i=1}^I I(x, w) S(x, i)}{I(x, w)} \right)}{|IJS(v, w)|} \quad (8)$$

Here $I(u, v)$ is the total number of transactions between peer u and peer v , set of peers that have interacted with peer v is denoted by $IS(v)$ and $IJS(v, w)$ which is computed as $IS(v) \cap IS(w)$ is nothing but the common set of peers that have interacted with both peer v and w .

C. BTRM-WSN :

This model is inspired from ant colony system algorithm [14] which is itself bio-inspired. BTRM-WSN [13,17] is a novel trust model for wireless sensor networks. Due to its inherent characteristics it can easily adapt to sudden change in topology of network or behavior of peers. It allows us to find the most trustworthy path from source peer till destination peer in a network providing most reputable service. In this model, a set of artificial agents (ants) is launched through the network which leaves traces of pheromones in every link connecting two nodes while searching for reputable service provider peers. The amount of confidence that sensor a has on sensor b , for finding the most trustworthy path through sensor b , is the amount of pheromone between sensors a and b , denoted as τ_{ab} . At each node, every ant carries out decision of the sensor node in the network to move towards next. For this decision, each arc not visited yet by ants is associated with a probability as follows:

$$p_k(r, s) = \begin{cases} \frac{[\tau_{rs}]^\alpha [\eta_{rs}]^\beta}{\sum_{u \in J_k(r)} [\tau_{rs}]^\alpha [\eta_{rs}]^\beta} & , \text{if } s \in J_k(r) \\ 0 & , \text{otherwise} \end{cases} \quad (9)$$

Where $p_k(r, s)$ denotes the probability that ant k will move from sensor r to s . Here η_{rs} represents heuristic of link joining r and s which is defined by the distance between both sensors. α is the parameters to balance the pheromone and β is the parameters to balance the heuristic. $J_k(r)$ denotes a set of nodes in neighborhood of node r which are yet to be visited by ant k . The pheromone traces are modified by an ant as soon as it crosses a link every time in following way:

$$\tau_{s1s2} = (1 - \phi) \tau_{s1s2} + \phi \Omega \quad (10)$$

$$\text{Where } \Omega = (1 + (1 - \phi)(1 - \tau_{s1s2} \eta_{s1s2})) \tau_{s1s2} \quad (11)$$

Here ϕ and τ_{s1s2} and ϕ are the parameters which control the amount of pheromones left by ants. In the same way, an additional update is received by the best path found by all ants, as follows:

$$\tau_{rs} = (1 - \rho) \tau_{rs} + \rho(1 + \tau_{rs} \eta_{rs} Q(S_{Global_Best})) \tau_{rs} \quad (12)$$

Where $Q(S_{Global_Best})$ is the quality of that path. The average pheromone of the edges belonging to that path, $\tau_{\square_k}$, is used to measure the quality of the path S_k . The $\%A_k$ denotes the percentage of ants that have selected the precise path as the most trustworthy and its length. Quality can be calculated as follows:

$$Q(S_k) = \frac{\tau_{\square_k}}{\sqrt{Length(S_k)}} \% A_k \quad (13)$$

In BTRM-WSN, when ant k finds a peer offering the desired service, the average pheromone trace, $\tau_{\square_k}$, of the edges composing the current path is computed. If the value of $\tau_{\square_k}$ is greater than that of given threshold, then ant k stops and returns current solution with a probability equal to $\tau_{\square_k}$. Otherwise ant k decides that the current service provider is not enough trustworthy and then travels ahead in network trying to find a better service provider. In every trust and reputation model last step is rewarding or punishing path leading to selected peer. In BTRM-WSN this is explicitly performed. Rewarding is done by pheromones reinforcement and punishing is done by pheromones evaporation of the path leading to selected peer. This reinforcement and evaporation is done as follows:

$$\tau_{rs} = (\tau_{rs} - \phi \times df_{rs}) \frac{Sat}{df_{rs}} \quad (14)$$

Where ϕ is a parameter controlling amount of pheromone left by ants and Sat is the user's satisfaction. The distance factor of the link between sensors r and s is represented as d_{rs} , which is defined as follows:

$$df_{rs} = \sqrt{\frac{d_{rs}}{L(S_k)(L(S_k) - d_{rs} + 1)}} \quad (15)$$

Here, the clients distance from link between sensors r and s is denoted as d_{rs} . $L(S_k)$ represents the length of the solution found by ant k .

IV. COMPARISON OF DIFFERENT TRUST AND REPUTATION MODELS WITH RESPECT TO SECURITY THREATS (10)

The different trust and reputation model are discussed in previous section. This section will compare these trust and reputation model with respect to how well they are able to secure the wireless sensor network from different threats.

The different literature and trust reputation models are reviewed and analyzed in order to deduce how a particular security threat is treated by that trust and reputation model. The Table I compare all trust and reputation models discussed so far.

When a trust and Reputation Model is completely successful in avoiding a particular threat it is denoted by table entry 'Yes' as it is shown for DOS attack and Hello flood attack. When it is not capable of handling a specific security threat it is denoted by entry 'No' as in for wormhole attack.

There are some attacks against which Trust and Reputation management do not have any effect it is represented as 'not Effective' in the table such as eavesdropping. There are cases when Trust and Reputation model works fine till a specific constraints are satisfied. This would be better understood by considering a scenario. As we know that trust value of compromised inside peer won't degrade as long as it do not performs any malicious activity to degrade network performance. Knowing this a inside attacker can stealthily listen to packets and fabricate them without being detected by Trust and Reputation model.

Similarly, in case of selective forwarding packet of specific targets or random targets will be dropped or misrouted resulting in loss of packet and it will degrade trust value of malicious peer. But if packet delivery rate of malicious node is higher than packet loss rate then trust value will increase and trust and reputation model will get deceived by the attack.

As with insider attack, impersonation will remain undetected as long as it does not provide any bad service. The outsider attack is a different class of attack all together. Attacker carries a very powerful high end device with him and can perform attack at any communication layer may it be radio jamming at physical layer or at any other layer. As we can understand from this outsider attack has very wide range and few of them can be stopped by Trust and Reputation model. Hence outsider attack holds table entry as 'Moderate', as moderate amount of outsider attacks can be stopped by this models.

The wormhole attack is special kind of active attack which makes use of Trust and Reputation management for its own benefit. In wormhole attack a low latency side channel is introduced by two malicious peers in the sensor network. By providing this long range and high speed side channel more packets start routing from this two nodes to travel through the network. This increase trust value of these two peers as they are providing a good service.

This increase in trust value further attracts more peers in the network. This affects other peers in network and other non adjacent peers of these two malicious peers also start sending packets via these peers. When a large number of peers in sensor network get converged to these two malicious peers then they suddenly stops this low latency side channel resulting in a sensor network which is divided into two disconnected parts. To make it work again re-initialization is needed. In this way wormhole attack exploit the inherent characteristics of Trust and Reputation model and deceives it.

V. CONCLUSION AND FUTURE WORK

From our study it is clear that a single trust and reputation model cannot cater all the threats in wireless sensor network. Each one of them has different impact on security of the sensor network. Like Eigen Trust can handle from Sybil attack but BTRM-WSN or Peer Trust cannot handle this attack. The passive attack like Traffic analysis and eavesdropping are not tackled by any Trust and Reputation model. From this study it is clear that as long as attack is passive may it be insider attack or impersonation it will go undetected.

The Trust and Reputation model is not able to handle packet tampering attack. A packet tampering or fabrication attack only modifies or alters information in transit. Hence it goes undetected as it attacks data and not the network.

To protect wireless sensor network from passive attacks and packet tampering, cryptography techniques can be used.

This work states that Trust and Reputation models are only capable of handling active attacks. In case of wormhole attack even being an active attack it deceives Trust and Reputation models due to its attack pattern.

In future we aim to study effect of different routing protocols on the security of wireless sensor network along with trust and reputation model.

TABLE I. Comparison of Trust and Reputation models with respect to security threats in wireless sensor network

Security Threats	Trust and Reputation model		
	<i>Eigen Trust</i>	<i>Peer Trust</i>	<i>BTRM-WSN</i>
<i>Traffic Analysis Attacks</i>	Not Effective	Not Effective	Not Effective
<i>Acknowledgement Spoofing</i>	Yes	Yes	Yes
<i>Insider Attacks</i>	Only if it degrades the network performance	Only if it degrades the network performance	Only if it degrades the network performance
<i>Outsider Attacks</i>	Moderately	Moderately	Moderately
<i>Eavesdropping</i>	Not Effective	Not Effective	Not Effective
<i>Impersonation</i>	Only if it provides bad service	Only if it provides bad service	Only if it provides bad service
<i>Denial of Service (DOS)</i>	Yes	Yes	Yes
<i>Hello Flood</i>	Yes	Yes	Yes
<i>Sybil Attack</i>	Yes	No	No
<i>Sinkhole/Blackhole Attack</i>	Yes	Yes	Yes
<i>Wormhole Attack</i>	No	No	No
<i>Selective Forwarding</i>	Only if local packet loss rate is higher	Only if local packet loss rate is higher	Only if local packet loss rate is higher
<i>Packet Tampering</i>	Not Effective	Not Effective	Not Effective

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STUDY OF ENERGY EFFICIENT TECHNIQUES TO IMPLEMENT GREEN WIRELESS NETWORKS

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ABSTRACT

Energy consumption of wireless networks is now a very important research topic and several research teams worldwide are proposing solutions for the so-called green wireless networks. There are number of challenges offered by mobile ad-hoc network environment like limited power, route failure, synchronization, security etc. Nodes in the mobile ad-hoc network environment have limited battery power. Extra amount of energy is needed by router to forward and to relay packets. The thrust of my study is that components in network devices can be put to sleep (more correctly into energy saving modes) with some changes to Internet protocols in order to save energy. Their idea of coordinated sleeping is similar to the notion of power-aware routing. Different parameters influencing the energy consumption have been thoroughly studied.

Keywords : energy conservation, Internet, wireless

I. INTRODUCTION

It is a worldwide goal to reduce energy consumption and CO₂ emissions. A part of this energy reduction scheme concerns the telecommunication industry and ICT that participates in a direct or indirect ways. Characteristic examples are green networks, smart buildings, smart grids, Intelligent Transportation Systems (ITS), energy efficient electronics (OLEDs, photonics, nanotechnology)

Mobile ad-hoc networks are based on a set of nodes which randomly communicate with each other over a wireless medium. These networks are without infrastructure and have multiple hops over wireless links. Wireless hosts are powered by batteries, which provide energy for a limited period. To conserve energy, power consumption control scheme is used to reduce energy consumption by varying the transmission power. Power consumption control in ad-hoc networks have been the focus of extensive research due to low energy capacity of network. Life of a node can thus be increased by efficient battery management and transmission power management. Power consumption also depends on the medium access layer and protocol from physical to transport layers, which selects the minimum amount of transmission energy required to exchange messages between any pair of neighbouring nodes. Several medium access control protocols have been developed for wireless environments such as carrier avoidance IEEE802.11 and IEEE 802.11e.[5]

There are two different ways in which energy saving is done One is power saving and the other is power control. Power saving means to reduce power consumption and Power control means to adjust transmission power of mobile nodes[6]. Power control problems in wireless ad-hoc networks have become more complex due to complexity of its architecture. the transmission power of node affects the mobile ad-hoc network functions severely.

II. LITERATURE SURVEY

A mobile ad-hoc network comprises of mobile nodes that communicate over wireless links that are normally bandwidth constrained. Ad-hoc networks are low power battery operated networks. Hence, Energy consumption control is very serious problem in such mobile ad-hoc networks. Literature review focuses on energy saving by route discovery, Energy saving by transmission power, Energy Saving by transmission range and energy saving by energy management model.

i. Energy saving by route discovery

It is observed from literature survey that mobile ad-hoc network arbitrary motion of nodes results in unpredictable and frequent topology changes. Additionally, since nodes in a mobile ad hoc network normally have limited transmission ranges, nodes cannot communicate directly with each other. Hence, routing paths in mobile ad-hoc networks contain multiple hops, and each node in mobile ad hoc networks has the responsibility to act as a router. Because of the importance of routing protocols in dynamic multi-hop networks, a lot of mobile ad hoc network routing protocols have been proposed in the last few years [5].

ii. Energy saving by transmission power.

It is observed from this study that high transmission power on a link may improve the quality, throughput on that link and increase the levels of interference on other links. A decrease in the transmission power can have the opposite effects.[7,8] Practically from various experiments, three interference scenarios have been deduced: a) the overlapping case, where the aggregate throughput is achievable with two overlapping links.

Aggregate throughput is not affected by power control, b) the hidden terminal case, where proper power control can primarily improve fairness and c) the potentially disjoint case, where proper power control can enable simultaneous transmissions and thus improve throughput.[10] Quality of signal transmission is also maintained by power control in a network. In the overlapping case, power control does not increase the maximum achievable throughput. In the hidden terminal case, power control improves the throughput.

iii. Energy saving by transmission power

It is observed from survey that radio transmission range as a system parameter affects the energy consumption economy of wireless ad-hoc networks. On the one hand, a large transmission range increases the expected progress of a data packet toward its final destination at the expense of a higher energy consumption per transmission. On the other hand, a short transmission range consumes less per transmission energy, but requires a larger number of hops for a data packet to reach its destination[5].

iv. Energy saving by energy management model.

It is observed from literature review that On-demand power management frame work is not effective for large size network due to dynamic configuration of network. Powers saving algorithms are not effective in case of high speed dynamic network. Ad-hoc medium access layer can not maintain quality of service with low transmission power. Multiple input multiple output communication system could not maintain lifetime of network. Network efficiency could not improved by using routing algorithm. Power control is not maintained by power saving.[12]

V CONCLUSION

Power demands in next generation networking equipment have put forth a fundamental challenge to continuous bandwidth scaling in the Internet. Relying solely on system design techniques to limit the power consumption of high speed equipment will likely not be enough[11]. To address this problem, we advocate power-awareness in the design, configuration and management of networks. In this seminar, literature survey was carried out on the studies, which need to be addressed in an attempt to promote energy consumption control for wireless networks. In this seminar, we have studied development of Green Wireless Network based on IEEE 802.11. Parameters influencing the energy consumption are also highlighted.

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UNIVERSAL NFC RECEIVER :

AN INTRODUCTION TO PREPARATION OF SEVERAL MODULES

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ABSTRACT

This paper is focused on the preparation of modules of making an Universal NFC receiver. It consists of several modules such as AVR board for interfacing with NFC receiver, MAX 232 module for interfacing with PC / Laptop, Power Supply is also the most important module. Several multiple applications will develop on Mobile using Android Apps. For this purpose, Software Development Kit(SDK) is used. The NFC receiver is installed at the target system which will be connected with AVR microcontroller board. In this paper, we are using AVR Atmega 8 Microcontroller which is having feature of 8 KB flash memory. AVR board is connected to NFC receiver along with server at the target through MAX 232 serial communication. Power supply circuit is also provided for this implementation. This universal NFC receiver will handle several applications such as Banking Transactions , Searching Various items while shopping in the mall etc.
Keywords : Android, AVR Board, Mobile Computing, MAX 232 , Near Field Communication , Power Supply .

I. NEAR FIELD COMMUNICATION

Near field communication (NFC)[1] is a set of standards for smart phones and similar devices to establish radio communication with each other by touching them together or bringing them into close proximity, usually no more than a few inches. Present and anticipated applications include contactless transactions, data exchange, and simplified setup of more complex communications such as Wi-Fi. Communication is also possible between an NFC device and an unpowered NFC chip, called a "tag".

In NFC, the communication occurs when two NFC compatible devices are brought together less than four centimeters, or simply by touching themselves. It operates at 13.56 MHz and can transfer data up to 424 Kbits per second In an NFC model two devices are involved in the communication, which are called initiator and target. Initiator is an active NFC device which is responsible for starting the communication. Also it has an embedded energy component whereas target can be either a tag, RFID card[10] or an NFC device which responses the initiator's requests. Working distance with compact standard antennas: up to 20 cm . Supported data rates: 106, 2012, 424 or 848 Kbit/s information in the NFC device is used for further operations.

II. OPERATING MODES OF NFC

A. Reader / Writer Mode

In the reader/writer mode, NFC devices can read and write data from/to NFC tags and smart cards. NFC device acts as an initiator and passive tag is the target. Passive tag does not need any source of power. Active NFC device creates magnetic inductive coupling and transfers energy to smart card when it gets close enough. After the smart card is powered, communication starts. In this mode of communication the data speed can increase up to 106 Kbit/sec.

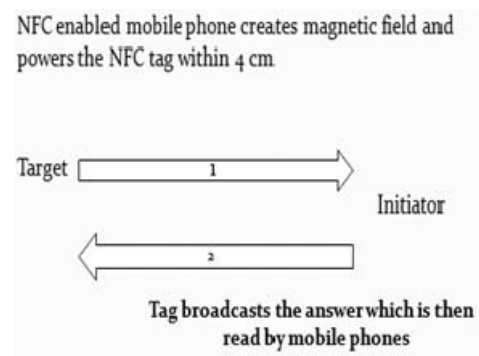


Fig. 1 : Reader/Writer mode[8]

B. Card Emulation Mode

In the card emulation mode, NFC device[1] acts as an RFID card and other NFC device can read data from this NFC device.

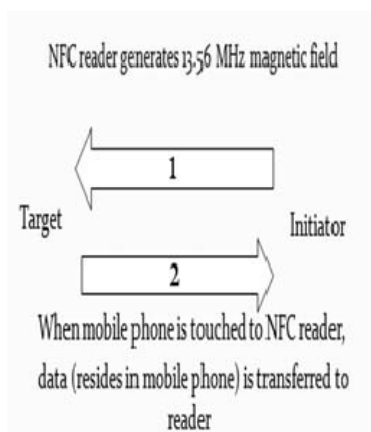


Fig. 2 : Card Emulation Mode[8]

The advantage of this mode is that there is not any need for NFC tag or a RFID card[3], and stored information in the NFC device is used for further operations.

C. Peer to Peer Mode

In P2P mode, two NFC devices can exchange data. For example, you can share Bluetooth or WI-FI link set up parameters, and exchange data such as virtual business cards or digital photos. P2P mode is standardized on the ISO/IEC standard. P2P is less used in when compared to other modes, though it is studied for device pairing, networking and file transfer operations. This mode is the classic NFC mode, allowing data connection for up to 424 kbps .

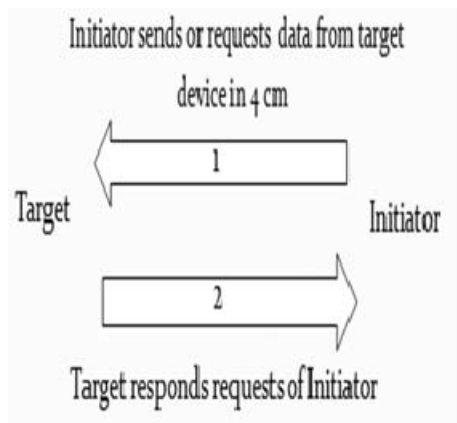


Fig. 3 : Peer to Peer mode[8]

III. MODULES OF NFC

A. Power Supply

A power supply is a device that supplies electric power to an electrical load. The term is most commonly applied to electric power converters that convert one form of electrical energy to another, though it may also refer to devices that convert another form of energy (mechanical, chemical, solar) to electrical energy. A regulated power supply is one that controls the output voltage or current to a specific value; the controlled value is held nearly constant despite variations in either load current or the voltage supplied by the power supply's energy source.



Fig. 4 : Power Supply Module

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. In this work, power supply makes an important role.

B. AVR Microcontroller Board

In this work, we are using AVR Atmega8 Microcontroller having 8 KB flash memory. The various features of AVR Atmega8 Microcontroller is as follows :-

- 8-bit Controller.
- Advanced RISC Architecture.
- 8 KB flash memory.
- 512 bytes of EEPROM.
- Two 8-bit timers/counters with separate prescaler and compare mode.
- One 16-bit timer/counter with separate prescaler, compare mode and capture mode.
- Low power consumption basically 250 μ A in Active mode and 0.1 μ A in Idle mode.

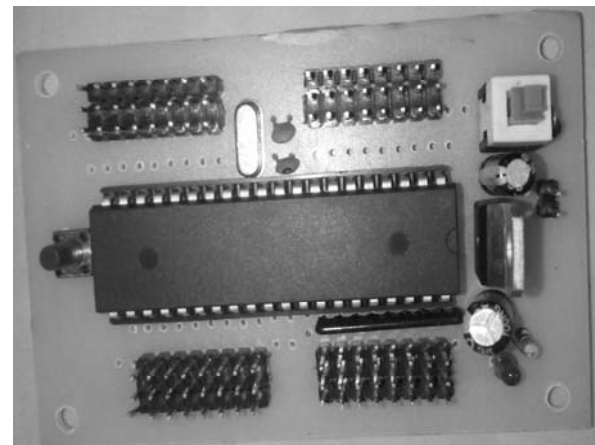


Fig. 5 : AVR Atmega8 Microcontroller Module

C. MAX 232

The MAX 232 is an IC that converts signals from an RS-232 serial port to signals suitable for use in TTL compatible digital logic circuits.

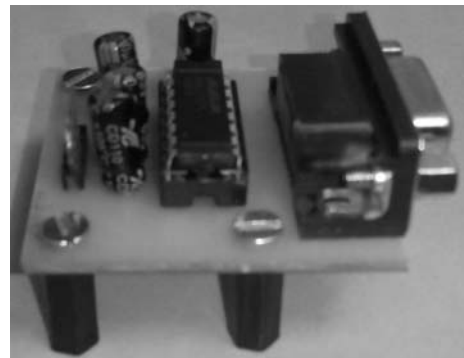


Fig. 6 : MAX232 Serial Module

The MAX 232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The MAX 232 is a dual driver/receiver and typically converts the RX, TX, CTS and RTS signals. The drivers provide RS-232 voltage level outputs (approx. ± 7.5 V) from a single +5 V supply via on-chip charge pumps and external capacitors.

This makes it useful for implementing RS-232 in devices that otherwise do not need any voltages outside the 0 V to +5 V range, as power supply design does not need to be made more complicated just for driving the RS-232 in this case. The receivers reduce RS-232 inputs (which may be as high as ± 25 V), to standard 5 V TTL levels. These receivers have a typical threshold of 1.3 V, and a typical hysteresis of 0.5 V. The MAX232(A) has two receivers (converts from RS-232 to TTL voltage levels), and two drivers (converts from TTL logic to RS-232 voltage levels). This means only two of the RS-232 signals can be converted in each direction. Typically, a pair of a driver/receiver of the MAX232 is used for TX and RX signals, and the second one for CTS and RTS signals. There are not enough drivers/receivers in the MAX232 to also connect the DTR, DSR, and DCD signals. Usually these signals can be omitted when e.g. communicating with a PC's serial interface. If the DTE really requires these signals, either a second MAX232 is needed, or some other IC from the MAX232 family can be used. Also, it is possible to directly wire DTR to DSR without going through any circuitry. This gives automatic (brain dead) DSR acknowledgment of an incoming DTR signal. In this work, this MAX 232 module is used which gives an interface between AVR Board and NFC receiver with PC or Laptop.

IV. RESULTS

In universal NFC Receiver, three applications GUI is being designed so far. The applications are for: Parking Payment, Ticket Booking, Restaurant Payment. The following are the snapshot of it.

If for the first time, new user using this NFC application has to be registered first. The following snapshot indicated by fig. 7 below is indicated the same.

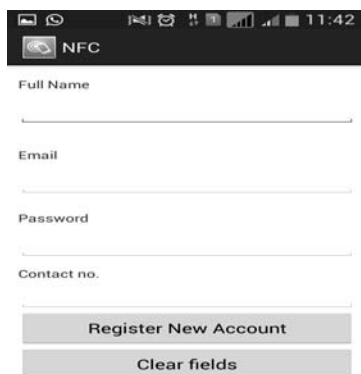


Fig. 7 : New user Registration

After filling all the required details indicated in fig.7 above, new user will get login id and password. So, with login id and password, user need to login to NFC application module. It is shown in Fig. 8 below.



Fig. 8 : User Login Procedure

While, login steps, user using NFC application will get three attempts. If he/she fails in attempting login for all three attempts provided, then their login details will be blocked for the same day. This is explained in fig. 9 below.

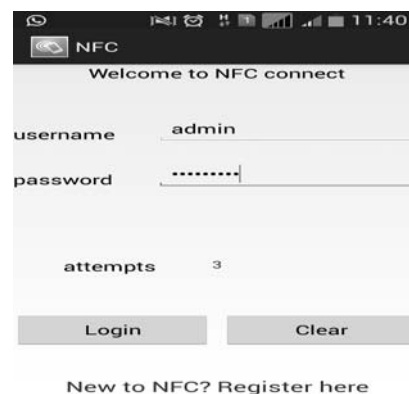


Fig. 9 : User Login attempts

After successful login, three application interface will come and user need to select it according to their needs. This is indicated by Fig. 10 below.

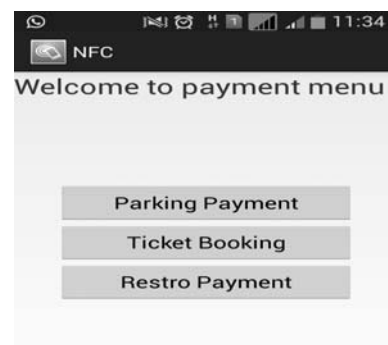


Fig. 10. NFC Applications

After selecting Parking Payment applications, the interface shown in fig. 11 below will look like this.

Fig. 11 : Parking Payment Application

After selecting Ticket Booking applications, the interface shown in fig. 12 below will look like this.

Fig. 12 : Ticket Booking Application

V. WORK TO BE IMPLEMENTED

In future, the different modules implemented that are discussed above is then combined and interfaced. The AVR board which consists of AVR Atmega8 Microcontroller along with NFC receiver module is then interfaced with PC or Laptop with MAX232 serial communication module. Power supply module also plays an important role. Also, the applications need to develop on Android platform which will be available on mobile phone.

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PERFORMANCE ANALYSIS OF SPECTRUM SENSING ALGORITHMS IN COGNITIVE RADIO

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ABSTRACT

This paper highlights brief on “PERFORMANCE ANALYSIS OF SPECTRUM SENSING ALGORITHMS IN COGNITIVE RADIO”. The Cognitive radio is one of the recent revolutionary advancement that promises to govern the future wireless world. The ultimate objective of cognitive radio is to use available spectrum efficiently in fair-minded and cost-effective manner and provide highly reliable communication for all users of the network, wherever and whenever needed. In this paper various non-cooperative spectrum sensing techniques are discussed and spectrum detection schemes for sensitive to noise uncertainty in lower signal-to-noise and large noise uncertainty environments; complexity is being analyzed for performance of detection.

Keywords: Cognitive Radio, Spectrum Sensing, Energy Detection, Matched filter detection, Cyclostationary detection, AWGN Noise, Power spectrum Density, Probability of detection.

I. INTRODUCTION

With the growth of communication applications the spectrum becomes more congested even though Federal Communications Commission (FCC) has expanded some unlicensed spectrum bands. However, radio spectrum is a limited resource, and the spectrum for each service has been allocated mostly through fixed spectrum assignment. Hence, spectrum scarcity is imminent. On the other hand, recent studies reveal that some frequencies allocated for some radio access technologies (RATs) are underutilized. [3]

Cognitive radio is one of the recent revolutionary advancement that promises to govern the future wireless world. The ultimate objective of cognitive radio is to use available spectrum efficiently in fair-minded and cost-effective manner and provide highly reliable communication for all users of the network, wherever and whenever needed. [1]

1.1 Need of Cognitive Radio

The motivation for Cognitive radio is a concept of reusing licensed spectrum in an unlicensed manner without causing interference. Spectrum sensing is an important part for efficient utilization of spectrum. Primary user can use the spectrum at any time.

Secondary users must sense the spectrum to detect whether it is available or not. Secondary users must be able to detect very weak primary user signals.

CR Consists four important Steps [9];

- Spectrum sensing is the process of a cognitive radio sensing the channel and determining if a primary user is present, detecting the spectrum holes
- Spectrum management is selecting the best available channel (for a cognitive user) over the available channels.
- Spectrum sharing is the allocation of available frequencies between the cognitive users
- Spectrum mobility is the case when a secondary user rapidly allocates the channel to the primary user when a primary user wants to retransmit again

1.2 Spectrum Sensing

Spectrum sensing, defined as the task of finding spectrum holes by sensing the radio spectrum in the local neighbourhood of the cognitive radio receiver. The term spectrum holes stands for those frequency bands of the radio spectrum that are underutilized. The spectrum sensing function enables the cognitive radio to adapt to its environment by detecting spectrum holes.

In many scenarios involving CR, a communication device needs to capture the current usage of the spectrum before establishing its own communication. This behaviour is referred to as detecting free bands, which means identifying frequency bands that are free of already established communications. Band Frequency band can be considered free if the signal received in this band BL is only made of noise. On the other hand, if signals are detected in the presence of noise, the band is declared occupied. Thus, the function the detector has to perform is that of detecting signals in the presence of noise, which can be stated as the following hypothesis:

Basic hypothesis model for transmitter detection can be defined as follows[2] ;

$$x(t) = \begin{cases} n(t) & 0 < t < T \quad \text{under } H_0 \\ s(t) + n(t) & 0 < t < T \quad \text{under } H_1 \end{cases}$$

$x(t)$ – Received signal from CR

$n(t)$ - Additive white Gaussian noise (AWGN)

$s(t)$ – Transmitted signal from Primary user.

H_0 – Spectrum is not occupied by Primary User

H_1 – Spectrum is occupied by Primary User

Where $x(t)$ is the signal received at the receiver. $s(t)$ is the transmitted signal of the primary user, $n(t)$ is the Additive white Gaussian noise (AWGN) and h is the amplitude gain of the channel. H_0 is a null hypothesis, which states that there is no licensed user signal in a certain spectrum band. On the other hand, H_1 is an alternative hypothesis, which indicates that there exists some licensed user signal. Three methods are generally used for the non-cooperative detection according to the hypothesis model. [Akil].

The most efficient way to detect spectrum holes is to detect the primary users that are receiving data within the communication range. In reality, however, it is difficult for a cognitive radio to have a direct measurement of a channel between a primary receiver and a transmitter. Thus, the most recent work focuses on primary transmitter detection.

Generally, the spectrum sensing techniques can be classified as [3]

Non-cooperative detection:- This form of spectrum sensing occurs when a cognitive radio acts on its own. The cognitive radio will configure itself according to the signals it can detect and the information with which it is preloaded.

Cooperative detection:- Within a cooperative cognitive radio spectrum sensing system, sensing will be undertaken by a number of different radios within a cognitive radio network. Typically a central station will receive reports of signals from a variety of radios in the network and adjust the overall cognitive radio network to suit.

II. NON-COOPERATIVE DETECTION METHODS

Basically, non-cooperative detection approach is based on the detection of the signal from a primary user. In the following we will present main three methods of non-cooperative detection. For efficient utilization of spectrum for cognitive radio, that have been of great interest in recent research. We will highlight some fundamental problems and present techniques for signal detection. [1,2]

1. Energy Detection Technique
2. Matched Filter Detection Technique
3. Cyclostationary Detection Technique

In this paper, we focus attention on the particular task on which the very essence of cognitive radio rests and performance analysis is done by **Energy Detection Technique** and **Matched Filter Detection Technique**.

The probability of detection is of main concern as it gives the probability of correctly sensing for the

presence of primary users in the frequency band. Probability of miss-detection is just the complement of detection probability.

2.1 Energy Detection Technique

Energy detector is well known spectrum sensing technique. It is based on the principle that the energy of the received signal to be detected is always higher than the energy of noise. Energy detector is said to be blind signal detector because it ignores the structure of received signal with known threshold. Threshold value can be fixed according to channel condition.

Energy Detection over AWGN Channels has been analysed in which ten carrier frequencies were used. [6]

Algorithm for energy detection is designed as follows.

1. First we have transmitted signals of primary user.
2. At the receiver, received signal 'y' is calculated by adding all received signals.
3. Then we have estimated power spectrum density of signal 'y' by using periodogram function in MATLAB. The integral of the PSD over a given frequency band computes the average power in the signal over that frequency band.
4. The signal power is then compared with a threshold and if it is above the threshold, then the result of the detector is that a primary user is present.
5. Plot the probability of detection by using Marcumq function.

2.2 Matched filter detection

We have seen previously in section --- that the best sensing technique in an AWGN environment, and without knowledge of the signal structure is the energy detector.

If we do some knowledge of the signal structure then we can achieve a better performance by using Matched filter detection. Matched filter detection achieves the optimal detection performance in AWGN channel, since it maximizes the SNR [9].

Matched filter has the interesting property that no matter what the shape, time duration or bandwidth of the input waveform maximizes the SNR ratio is simply twice the energy E contained in transmitted signal divided by N_0 . The matched filter prior knowledge of primary user waveform is required.

Algorithm for Matched filter detection is designed as follows.

1. First we have transmitted signals of primary user.
2. At the receiver, received signal $y(t)$ is calculated by adding all received signals.
3. Add AWGN in received signal.

$$Y_r(t) = y(t) + n(t)$$

4. Convolute the $Y_r(t)$ with impulse response $h(t)$ of Matched filter.

Here $h(t)$ is taken as the received signal of each primary user. For example if received signal $y_1(t)$ from first primary user then convolution becomes

$$Y_r(t) * h(t) = \int_0^t Y_r(T) h(t-T) dT$$

where $h(t) = y_1(t)$. Similarly it is done for all primary users.

5. By using convolution, matched filter will match the received signal with primary user signals. If it is matched it will show peak value at that particular carrier frequency of PU.
6. Draw the frequency spectrum of $Y_r(t)$ using FFT.
7. Peak values which are present in the frequency spectrum are then compared with a threshold and if it is above the threshold, then the result of the detector is that a primary user is present.

III. RESULTS AND ANALYSIS:

3.1 System Model:

Following parameters are considered for implementation of above methods in MATLAB.

Sr. No.	Parameters	Description
01	No. of Primary Users	06
02	No. of Secondary Users	01
03	Threshold Value V_T	30 dB
04	No. of Carrier Frequencies F_c	10

05	Value of F_c in KHz	2,4,5,6,8,10,12,17,24,25
06	Sampling Frequency F_s	54 KHz
07	Transmitted signal $X(t)$	$\cos(2\pi * 1000 t)$
08	Received Signal $Y(t)$	$Y(t) = Y_1 + Y_2 + Y_3 + Y_4 + Y_5 + Y_6 + Y_7 + Y_8 + Y_9 + Y_{10}$ (Transmitted signals of Primary Users)
09	Noise signal $n(t)$	AWGN

Table 1: Parameters used in MATLAB Program

3.2 Results & Analysis

The performance of the detection algorithm can be summarized with two probabilities [8]:

- a. Probability of detection P_d and
- b. Probability of missed detection.

P_d is the probability of detecting a signal on the considered frequency when it truly is present. Thus, a large detection probability is desired. Probability of detection can be obtained by averaging the MarcumQ- function over the probability distribution function of SNR.

$$P_d = \text{MarcumQ}(\sqrt{2\gamma}, \sqrt{\lambda}) \quad [5]$$

Where γ in (5) corresponds to the SNR of received signal and λ is mean value of received signal $Y(t)$.

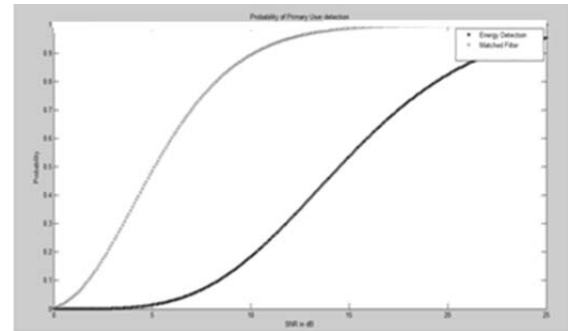


Fig. 1: Probability of User Detection

Figure 1— shows the probability of detection as a function of SNR for the three cases.

- i. Energy Detection
- ii. Matched filter Detection

It is observed that for Energy Detection and Matched filter Detection much higher SNR is required to obtain a detection.

Probability of missed detection means not detecting signal in presence of primary user.

Figure2 shows the probability of Missed detection as a function of SNR for the three cases.

- i. Energy Detection
- ii. Matched filter Detection

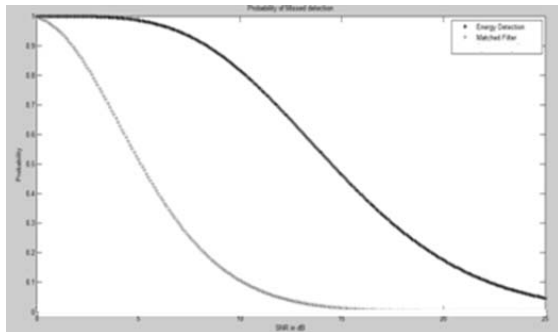


Fig. 2: Probability of Missed Detection

IV. CONCLUSION

Spectrum is a very valuable resource in wireless communication systems, and it has been a focal point for research and development efforts over the last several decades. Cognitive radio, which is one of the efforts to utilize the available spectrum more efficiently through opportunistic spectrum usage, has become an exciting and promising concept. One of the important elements of cognitive radio is sensing the available spectrum opportunities. In this paper, the performance analysis of two spectrum sensing methods is done using MATLAB and depending upon the SNR value we can easily decide the method to adopt. Energy detection method is very simple but SNR should be low whereas for Matched filter Detection much higher SNR is required to obtain detection.

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SURVEY FOR PSYCHOMETRIC ANALYSIS OF EMOTIONS

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ABSTRACT

In recent years, text mining and sentiment analysis have received great attention due to the abundance of opinion data that exist in social networks such as Facebook, Twitter, etc. Sentiments are projected on these media using texts for expressing friendship, social support, anger, happiness, etc. Sentiments extracted from the text can be useful in understanding the behavior of the individual. Sentiment analysis may also help an individual to introspect his improvement areas. This survey paper focuses on the usage of text mining for psychometric analysis. The aim is to extract useful information, about users' sentiments and behaviors with the help of the input they provide. This paper deals with the problem of sentence level use for emotion extraction. With the help of the dictionary created, individuals can be classified into the various categories (such as confident, depressed, happy, etc.) on the basis of the text extracted from the input.

Keywords: psychometric, sentiment analysis, text mining, emotions, classification.

I. INTRODUCTION

With the advancement in technology, the level of competition among individuals has reached a new height. As a result, individuals are under constant pressure which affects their behavior resulting in depression, frustration, etc.

Even peer pressure can affect the behavior of the individual. Only the one who can handle pressure and deal with his/her emotions properly will succeed.

Psychometrics is the field of study concerned with the theory and technique of psychological measurement, which includes the measurement of knowledge, abilities, attitudes, personality traits, and educational measurement. The field is primarily concerned with the construction and validation of measurement instruments such as questionnaires, tests, and personality assessments.

Emotion is a natural instinctive state of mind deriving from one's circumstances, mood, or relationships with others. Any of the particular feelings that characterize such a state of mind, such as joy, anger, love, hate, horror, etc.

Recent years have seen a growing interest in non-topical text analysis, in which characterizations are sought of the opinions, feelings, and attitudes expressed in a text, rather than just the facts [5]. A key problem in this area is sentiment classification, in which a document is labeled as a positive or negative. This survey paper explores the potential applications of text and sentiment mining techniques on analyzing patterns in emotions of individuals. Students and employees are selected as the target population. A questionnaire depicting various situations will be provided on the website which the individuals have to answer in the form of sentences. The keywords are extracted from the sentences and compared with the dictionary created which will help in the classification of words into positive or negative emotion.

This will help getting people classified into various emotional classes (such as happy, sad, frustrated, etc). This information can then be used by the concerned authority which can then think on various methods of improving the performance of the individuals. This can help make individuals more efficient and confident in this highly competitive world.

II. BACKGROUND

Sentiment analysis of text provided in natural language is a growing domain. Little work till now in sentiment analysis (classifying texts by 'positive' or 'negative' orientation) has attempted to use fine-grained semantic distinctions in emotions used for classification of users.

Two main approaches have been widely used in most of the works to date. The first ("bag of words") attempts to learn a positive/negative document classifier based on occurrence frequencies of the various words in the document; within this approach various learning methods can be used to select or weight different parts of a text to be used in classification. The other main approach ("semantic orientation") classifies words into two classes, "good" and "bad", and then computes an overall good/bad score for the text.

Nevertheless, such approaches have major loopholes. First, a more detailed semantic analysis of attitude expressions is needed, in the form of a well-designed taxonomy of attitude types and other semantic properties (as noted by Taboed and Grieve). Second, the “atomic units” of such expressions are not individual words, but rather appraisal groups: coherent groups of words that express together a particular attitude, such as “extremely boring”, or “not really very good”.

Kestrel’s implementation of the corpus and the Naïve Bayes classifier was used as a basis of the sentiment analysis service [3].

A sub-set of a data set containing nearly 3,800,000 tweets was used to train the classifier (Chang, Caverlee, Lee). This subset was imported into database and then two types of queries were executed; one which would return tweets containing “positive” key words and one that would return tweets containing “negative” keywords. The following keywords were used to return tweets that would be used to train the classifier. Both training sets had a sub-set of 50,000 records [3].

Positive Key Words : *love, like, beautiful, sweet, beautiful, pretty, joy*

Negative Key Words: *hate, dislike, bad, shit, fuck, horrible, ugly, disgusting.*

Both the training sets were analyzed to form conclusion about tweets containing one or more of specified key words contained other words of similar nature. In many cases, tweets contained both positive and negative key words and a combination of other words of the same nature.

III. METHODOLOGY

3.1 Raw data collection :

This step consists of designing a web page or user interface which consists of a questionnaire. The questionnaire consists of several questions based on situations which in help in understanding the behavior of the individual.

Students and employees from various age groups and various departments are asked to answer this questionnaire in form of sentences. This is then stored in a custom database.

3.2 Dictionary development

In this step, a set of words are chosen from various emotional domains which will be later used to classify the user responses.

3.3 Data preprocessing

The process of sentiment text preprocessing is similar with the traditional text preprocessing of text classification. The goal behind preprocessing is to clean the dataset by removing words and punctuations that don’t have an influence on sentiment classification. This increases the performance of the later the classification task.

3.4 Keyword extraction:

This step involves identification of those words from emotion. This is done with the help of the stored keywords the user response that express sentiment or.

3.5 Classification :

For the purpose of classification, usually machine learning techniques are used. A popular machine learning technique naïve Bayes is used in the system. A Naïve Bayes classifier is a probabilistic classifier based probability models that incorporate strong independence assumptions among the features. Our NB classifier assigns a given statuses the class. We choose to use a Naïve Bayes classifier because of its simplicity and its performance in previous studies on our chosen feature set representation.

3.6 Results :

The system user will be able to view three forms of the result:

1. A histogram will be generated depicting the total number of people present in the various classification categories.
2. The system user will be asked to provide the classification category he/she is interested in. The list of individuals falling in that category will be displayed.
3. The system user will be asked to provide the code for that particular individual of interest. The classification details of that individual will be displayed.

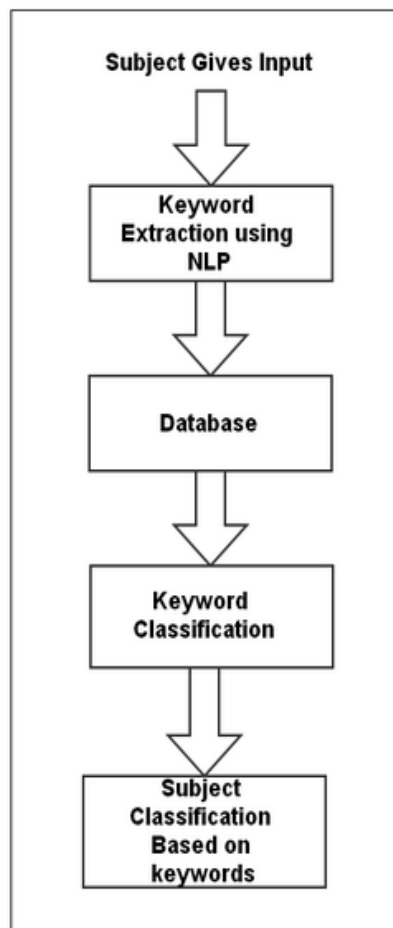


Fig 1: Proposed System

IV. EXPERIMENT

4.1 Experimental Setting

The experiments are divided into two phases: Training Phase and Testing Phase:

Training Phase:

- Train the classifier with the good training sets and then go for Testing.
- The result of classifier will point to a class which is nothing but a expected emotion. Proper data set should be collected; inputs have to be sent to training phase of classifier. Training phase include two modules (I) Keyword extracting (II) Keyword conversion.

Testing phase : In testing phase also Keywords extraction and keyword conversion occurs then testing set subject to predicting part of the classifier to predict the class. Few data sets are tested to measure the accuracy of the system and below table shows our accuracy results.

V. CONCLUSION

This paper has explored the utility of sentiment classification on text documents in natural language. Such type of classification of individuals based on their emotions will let the higher authorities manage them effectively. A methodology is proposed to perform the intended classification, involving majorly data in sentences from students.

The major challenge faced by the system is to develop the capability to learn new words used by the users and classify these words into the emotional classes. This would mean classification of any sentence given.

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AN ANALYSIS ON REAL TIME CONTROL, MONITORING AND ALERTS FOR SURVEILLANCE SYSTEM

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ABSTRACT

Recently, surveillance system is widely used all over the world. Peoples become more protective about their property. In this busy current world, awareness of efficient and easy surveillance and monitoring system is a need. So the implementation of real time alert system is important for users. In surveillance system control, monitors and alerts are required for home and industrial security. The prototype of a system uses wireless sensor networks and GSM modem for transmission of a data and to send alert notification to the user. The system uses the PcDuino platform is used which is a mini PC platform with ARM Cortex A8 processor. Devices are connected to pcDuino. PcDuino used for different applications like face recognition based authentication, video surveillance and home and industrial automation. Wireless sensor network receives a data and pass to the GSM modem. The GSM modem sends an alert message to user mobile phone in the form of SMS (short message service) and e-mail.

Keywords : Home Security and automation, Remote control and monitoring, pcDuino, GSM, WSN's

I. INTRODUCTION

The surveillance means to monitor or close observation. The security applied for homes and industries is restricted to limited to some area. The framing cameras are not suitable for surveillance system. The videos are more useful for keeping the eye on what activity is going inside or outside the selected area and to operate the camera to capture the activity. There are some challenges that are needed to overcome. The challenges are first, to capture the video higher data rates are needed and second, videos can capture the small area of views.

Consider the example of home surveillance. There are seven rooms in home. The camera is placed in each room. The main server is placed in ground floor room. And from this server room monitoring the entire house and keeping the eye on activities happening inside the each room become easy. Camera is also placed on the entrance, so that house owner has come to know who visited his/her house. House owner can also see these things from remote location.

Fig. 1 is the basic surveillance system diagram in which user can control his/her house remotely with the help of different wireless devices like PDA's, Mobile phones, Laptops etc. Our aim is to analyze the surveillance system. The most of the surveillance system uses GSM technology because it is not that costly, it is faster and it also provides security [1]. Different WSNs such as Infrared, Bluetooth, Zigbee and Wi-Fi are used for data transmission [3][4][5].

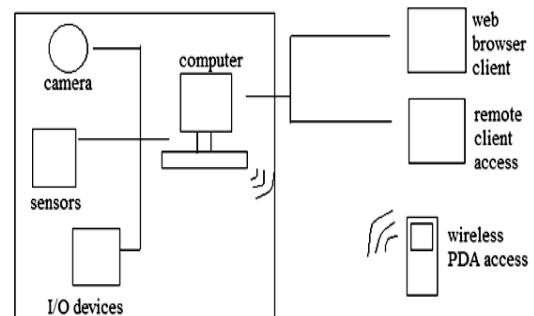


Fig. 1 : Basic surveillance diagram

Rest of the paper is organized as follows: Section II gives brief idea of Literature Survey. The proposed system is explained in Section III. Section IV gives various applications of surveillance system. Section V gives Analysis. Conclusion is discussed in Section VI.

II. LITERATURE SURVEY

In paper [1] Zazilah May proposed real time alerts for home surveillance. The real time implementation is achieved by using a GSM (global system for mobile communication) modem for alert notifications supplemented by email and SMS (short messaging service). Initially the devices are in standby mode. As soon as the motion is detected, the camera captures the images. The GSM/GPRS modem sends the SMS notification to user's phone as well as it send e-mail notification along with images attached to it. After this system goes to standby mode again.

The site [2] is the official site of pcDuino. Here on this site, we get all information about pcDuino such as basic information, tutorials, projects etc. The different tutorials of pcDuino with Java, C, and Python are shown.

Basically the pcDuino is a mini PC platform that runs OS such as Ubuntu and Android ICS. It outputs screen is connected to HDMI port. Moreover, it has hardware headers interface compatible with Arduino. The demand for pcDuino is increases from open source community.

In paper [3] Mohd Adib B. Saijari et al. used Zigbee for home security and automation. Zigbee technology provides a multi-hop communication for data transfer. Due to the multi-hop communication capability, it provides unlimited range of communication. In the home security system, as soon as some events (like fire or unauthorized intrusion) occur, the sensors captured it and send an alert signal to main controller through intermediate node using multi-hop communication. The main controller sends an alert signal to user via SMS by using GSM modem. In home automation system, user can control their house by sending the command through SMS to the main controller at home. Then the main controller sends the command to the destination node through intermediate node using multi-hop communication. In this whole system MikroC compiler is used. All the programming is done using C language.

In paper [4] Y. Zani and X. Cheng proposed a smart home monitoring system based on embedded system. The single chip expansion module is attached to the different sensors and household appliances. The USB camera collects the video. The GSM module is responsible for receiving short messages. Expansion module collects the sensors data and control household appliances switch. It also receives and processes the control information from Liod platform and sends feedback of sensor alarm information.

In paper [7] A. Ahmad et al. presents the implementation of home security monitoring and remote control system with the combination of Zigbee and GSM. The system can works by making SMS/call and by Alarm mode. In SMS or call mode, user gets the notification through SMS or by a call about breach. If user is already present in his/her premises and still he wants to surveillance then he can set the alarm mode and get informed. If any problem occurs with mobile phones then it sends an error message and then the system will automatically raise an alarm. In this the software is programmed using C-language.

III. PROPOSED SYSTEM

Our aim is to present such a universal reconfigurable embedded prototype model that can be easily adapted or reused for any type of customized applications with all the technologies available and built in it.

PcDuino is the universal reconfigurable embedded system. PcDuino [2] is a high performance, cost effective mini PC platform that runs like PC. PcDuino uses OS likes Ubuntu Linux. PcDuino uses ARM Cortex A8 processor.

It operates at 1GHz frequency. It takes lower power consumption i.e. 5V, 2A.

PcDuino supports programming languages like C/C++, Java, and Python. It outputs its screen to HDMI enabled TV or monitor via the built in HDMI interface. It is specially targeted for the fast growing demands from the open source community.

The platform could run full blown PC like OS with easy to use tool chain and compatible with the popular Arduino ecosystem such as Arduino Shields and open source projects etc. It can also run Android ICS 4.0.

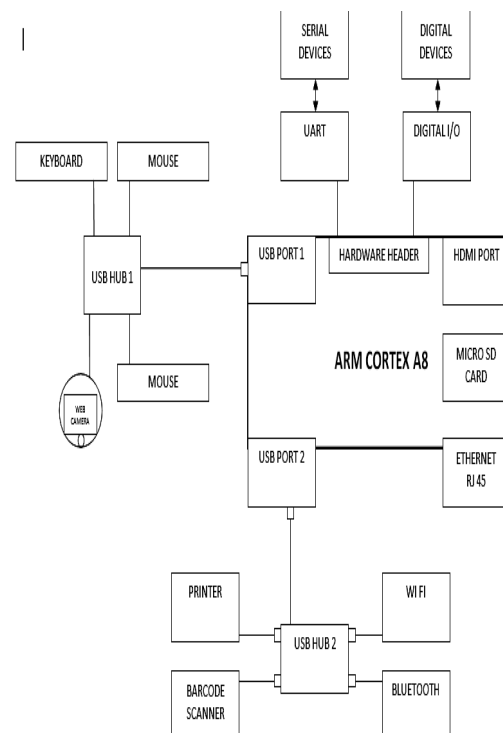


Fig. 2 : Proposed Surveillance System

The Fig. 2 shows the complete proposed surveillance system block diagram. The pcDuino contain ARM Cortex A8 processor, Ethernet port, USB port, Micro SD slot, HDMI port, hardware header etc. The ARM Cortex-A8 is a processor core designed by ARM Holdings. The ARM Cortex A8 processor has the ability to scale in speed from 600MHz to 1GHz. The Cortex A8 processor meets the requirements for power-optimized mobile devices needing operation in less than 300mW.

Ethernet RJ45 provides internet connectivity. UART translate data between parallel and serial forms. To this GSM/GPRS or others modem can connect. Digital devices can connect to digital I/O such as relays, sensors etc. An MMC (Multimedia Card) is used as a storage medium. HDMI port gives output to computer monitor, video projector, digital television, or digital audio device.

IV. APPLICATIONS

With the use of PcDuino different applications for the surveillance system are describe below.

A. Face Recognition Based Authentication

The Face recognition system is shown in Fig. 3. An identification process recognises a person by checking the entire database for a match. It compare captured image with each and every image stored in database. If the image matches then user is authenticate person otherwise not.

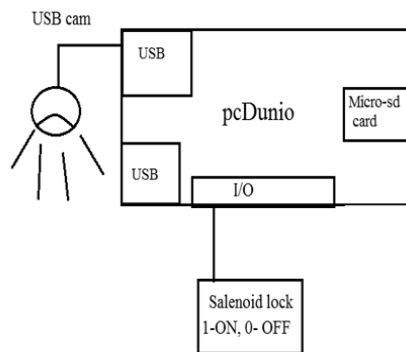


Fig. 3 : Face recognition system

The complete system is elaborated in flowchart of Fig. 4.

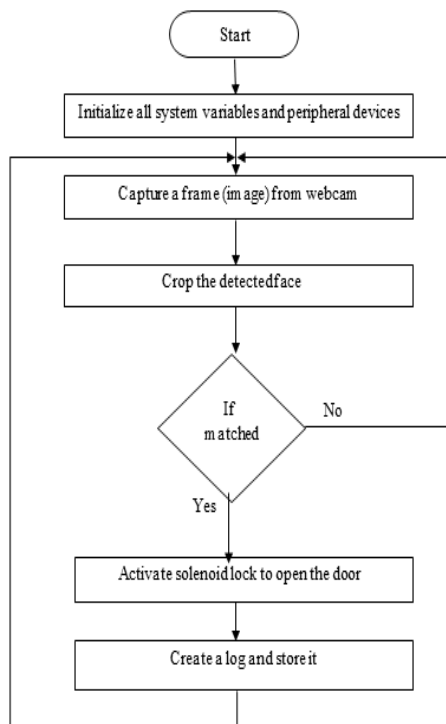


Fig. 4 :Flow chart of face recognition system

B. Video Surveillance

The video surveillance [4][8]system observes and captures the peoples and vehicles within area depending on the description of their actions and interactions. Video surveillance technical issues include:

- Moving object detection and tracking
- Human motion analysis
- Activity understanding

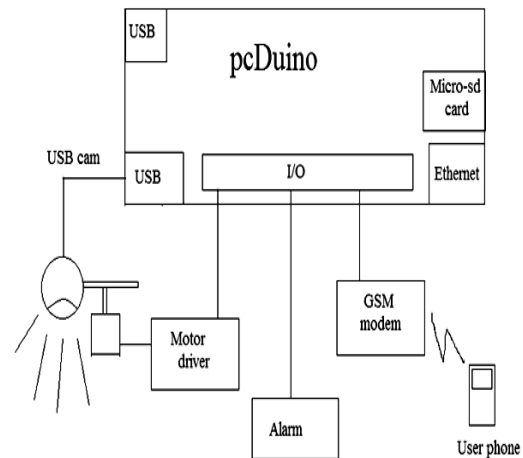


Fig. 5 : Video surveillance system

This offers two important features of smart security, real time monitoring and surveillance. The Fig. 5 shows the video surveillance system diagram.

There are two modes of video surveillance: IPCAM and motion detection.

1) Motion Detection

The goal of the system is be to detect object motion on the site under surveillance and inform the relevant person through email and message. Once the responsible person has been notified further safety action will be taken by person [1][8].

Fig. 6 shows the flowchart of motion detection based video surveillance system.

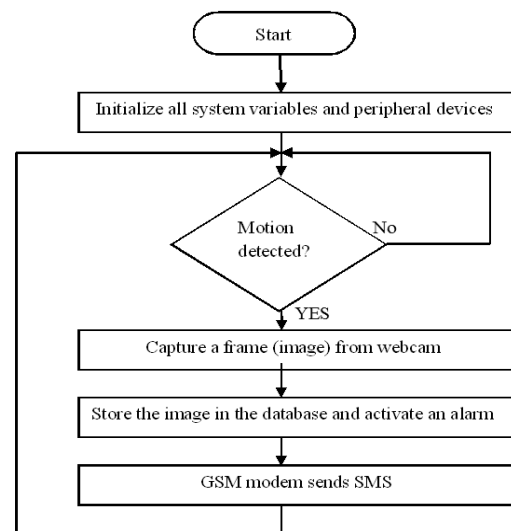


Fig.6 : Flow chart of motion detection based video surveillance system

2) IPCAM (Internet Protocol Camera)

It is an integrated wireless IP Camera. Its basic function is to transmit the videos remotely. It combines high quality digital video camera with the network connectivity and powerful web server. It bring clear picture to our mobile from anywhere over the Internet. Fig. 7 shows the flowchart of IPCAM based video surveillance system.

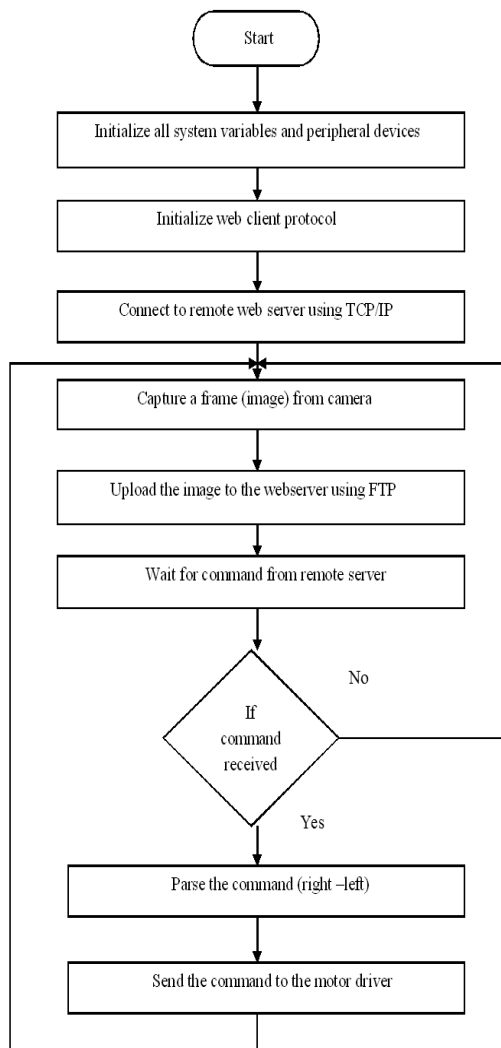


Fig. 7 : Flow chart of IPCAM based video surveillance system

A. Home and Industrial Automation

In home and Industrial automation [3][7][9], user can monitor or operate their devices from remote location. The Fig. 8 and Fig. 9 shows the automation system diagram and flowchart of automation system respectively. In this, the pcDuino is act as a web server. Different sensors and relays are connected to pcDuino. On the web client side user will see the output in graphical format as well as in digital format. The user can give the command to sensors from remote location.

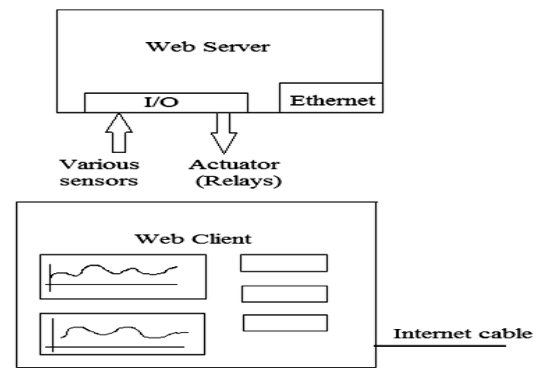


Fig. 8 : Automation System Diagram

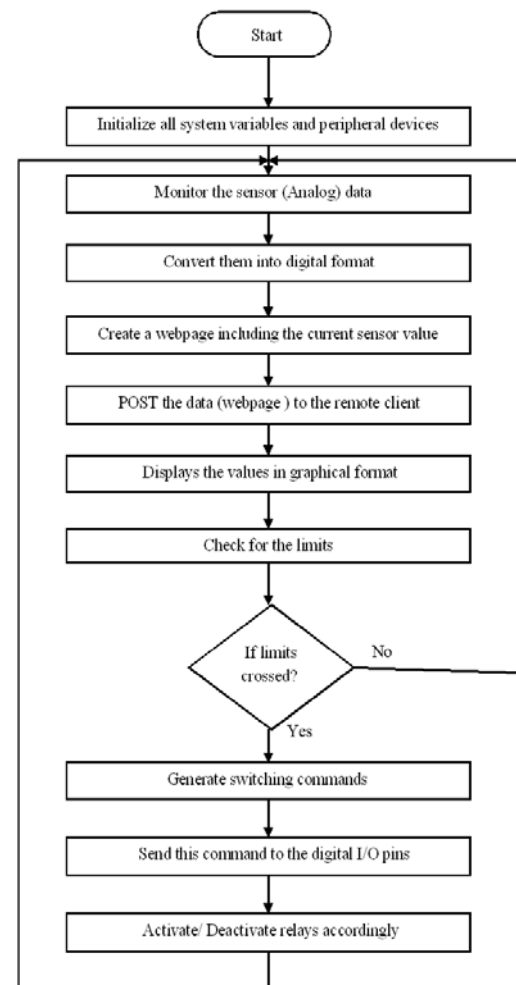


Fig. 9 : Flowchart of Automation System

V. ANALYSIS

The smart residential homes and industries are attracting towards the wireless monitoring and remote control, multi-media control and high speed data transmission. Recently, a research on the wireless intelligent home and industry security surveillance system is becoming a more popular due to its flexibility and convenience.

Standard	Bluetooth	Zigbee	Wi-Fi	Infra Red
IEEE Spec.	802.15.1	802.15.4	802.11 a/b/c	-----
Frequency Band	2.4GHz	868/915 MHz; 2.4GHz	2.4GHz; 5GHz	800-900 nm
Data Rate	1Mb/s.	250 Kb/s.	54 Mb/s	115Kb/sec.
Nominal Range	10 m	10-100 m	100 m	<10 Meters (line of sight)
Power consumption	Medium	Very low	High	Low
Number Of RF Channels	79	1/10; 16	14 (2.4 GHz)	-----
Channel Bandwidth	1 MHz	0.3/0.6 MHz; 2MHz	22 MHz	-----
Cost	\$5	\$3	\$9	\$1
Networking Topology	Ad-hoc, Very small network	Ad-hoc, peer to peer, star & mesh	Point to hub	Point to point
Complexity (device & application impact)	High	Low	High	Low
Applications	Wireless connectivity between devices like phones, PDA's, laptops & headsets	Industrial control & monitoring, sensor network, building automation, home control & automation	Wireless LAN, connectivity, broadband internet connection	Remote control, phone, Pc, Laptop Links.

Table 2 : Different Wireless Sensor Network Technologies Used In Surveillance

The different wireless communication technologies for home and industry include: Infrared technology, Bluetooth, Zigbee technology and Wi-Fi and so on.

VI. CONCLUSION

The system can use any one of the WSN technology from Infrared, Bluetooth, Zigbee and Wi-Fi technology. The GSM modem is used to send SMS alert and e-mail notification to user. Here we analysed the real-time remote home and Industrial surveillance alert system in which most of the surveillance systems use computers. These computers are used for live monitoring as well as to record the views. For these it is needed to keep the computers on for 24×7. This takes 100-240V of power. It means this will increase the cost. Hence the overall cost of the surveillance system also gets increased. So here we used pcDuino.

PcDuino is used because it acts as a PC or computer, it requires 5V of power, it is very easy to use and it is very small circuit. PcDuino used for different applications like face recognition based authentication, video surveillance and home and industrial automation. The user can use any device like mobile phones, PDAs, Laptops, and Computers to receive the notification and to remotely monitor the surveillance area. Users can also control their appliances remotely.

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AN APPROACH TOWARDS INTERACTIVE PROJECTOR

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ABSTRACT

Current projector technologies do not provide flexibility to users to operate from distant location. In this paper, effort has been made to develop a technique to convert a simple projector into an interactive projector by using a LASER pointer. This paper mainly focuses on transformation, namely projective transformation, for calibration purpose, detecting laser pointer from color image and java commands to perform mouse operations. An interested part of a captured image is manipulated to match its coordinates with screen resolution. To locate co-ordinates of pointer, the new grey scale image is subtracted from the previous image coordinates. After locating the pointer, mouse operations are performed accordingly.

Keywords : Projective Transform, Calibration, Color Detection, Pointer Detection.

I. INTRODUCTION

As compared to traditional projectors which gives less or no flexibility to the user, Interactive Projector provides flexibility by adding new features to the existing projectors. The new feature allows user to interact with the projector without using mouse. Mouse operations like click, double click events can be achieved through Laser pointer.

The need for an interactive projector arises because one has to stick with the mouse and the keyboard during presentations in a classroom or an auditorium. There are many interactive projectors available in the market; here this project introduces one of the cost effective way to transform a simple projector into an interactive projector.

This paper focuses on three main methods to achieve an interactive projector. These methods are Calibration Process, Color Detection and Embedded java commands to control mouse operations. First of all Projective Transformation is performed on the captured image and after this, the second step is to detect the color pointer on the projector screen and finally mouse operations are performed using MATLAB and Embedded Java Commands.

II. EXPERIMENTAL METHODS

This section of the paper defines the studies and researches have been done to achieve an Interactive

Projector. This study mainly consist of following topics.

A. Projective Transformation

Whenever an image is being captured by a webcam, it is not necessary that the captured image will be in the required format. There are chances that the image appears in the tilted form. The projective transform between two images is required for normalizing the image variation due to different angles of cameras.

Input image



Output image



Fig 1: Projective Transformation

B. Calibration Process

To perform calibration in this method, one first generates an image of the same size as screen resolution. That image is projected on a projector screen and captured by a camera and taken into the computer. In that captured image, an algorithm identifies that image and calculates the interested part from the acquired image. This procedure helps us to detect projector screen.

The starting pixel of the projective screen is located on the captured image. This detection helps us to generate a transformation matrix. As discussed earlier, this transformation matrix could be generated by projective transformation. To manipulate a complete calibrated image, one needs to multiply this transformation matrix with the detected pixel coordinates of the captured image. As a result of all these processes, one receives a perfect rectangular image of the interested part and from that one can correlate the screen resolution with the interested portion.

Calibration process needs to be performed only one time when the camera is set up at one position; whenever the camera is moved, calibration needs to be performed again.

C. Color Detection

In image processing color detection is the most important part. Color detection process detects the required color from the captured image. The interested color can be detected by many techniques like threshold boundary, HSV color space converting color image in grey scale, etc. Need for color detection is generated because in an image one has to work on particular colors. The color detection algorithm scans every pixel of the image and gives required color output according to the threshold value.

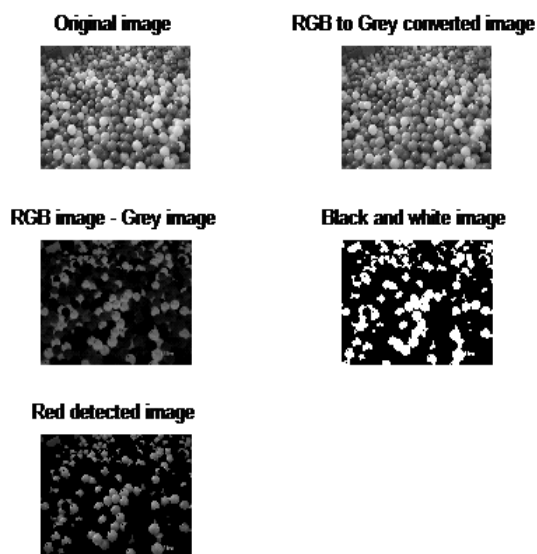


Fig. 2: Red Color Recognition[5]

HSV color model represents image in better prospect than RGB color model because it separates image intensity. One of the detection techniques is shown in Figure 2.

D. Controlling Mouse Operations

After the identification of laser pointer, the next process to be followed is mouse operations. Now, in pointer detection one cannot obtain only one pixel value though the algorithm was good in accuracy because laser pointer is so much powerful, so one gets group of pixels in this detection. However, to perform mouse operations one needs to give a particular pixel's coordinates.

To find out only one pixel value, one finds centroid of that group of pixels and according to that one is able to perform various mouse operations easily. After finding out centroid, multiply it with already calculated transformation matrix to correlate this pixel location with screen resolution.

According to that location, the mouse has to be moved in every frame of the video. Whenever color of the laser pointer changes for several frames, it is denoted as a click event, and on stored location one performs according to events of the mouse. Now if that color change occurs for more number of frames that one is deciding then one takes that event as a double click on that location. In a similar way, one can act upon different mouse operations.

E. Embedded Java Commands

The java class "java.awt.Robot" has ability to control mouse pointer position, motion and click events. Java class is used to create applications where mouse and keyboard control is needed. Java commands are also interfaced with MATLAB. These commands can control various internal operations of both mouse and keyboard. To operate any event related to mouse operation one needs to give a pixel value as input argument of these commands. Similarly, for events related to keyboard operation the user has to assign the particular key name. In "java.awt.Robot" command, one can control mouse operation by assigning the value of robot as mouse, similarly as one has to assign the value of robot as keyboard to use key operation.

III. PROPOSED METHODS

This section of the paper defines the methods and techniques applied to bring the interactive projector in reality. Step by step procedures followed to accomplish the task is been defined here. On the basis of studies and researches carried out, following section specifies the way in which the process will flow.

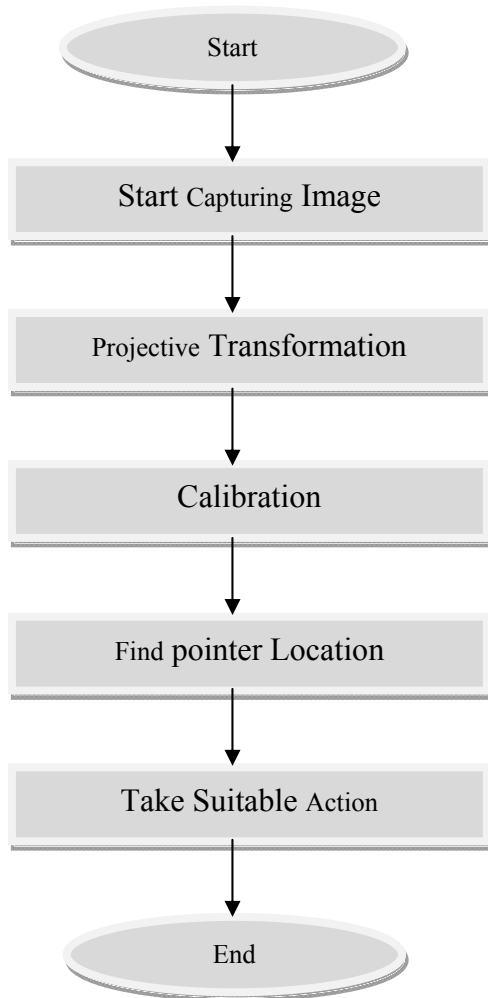
A. Process Flow

Fig. 3 : A Process Flow

- **Image Capturing**

The working of the project starts with capturing the image through webcam which is placed on the computer system. The captured image is then stored for further processing

- **Projective Transformation**

Projective Transformation is then performed on the captured image in order to achieve transformed image from tilted image.

- **Calibration Process**

After the image has been transformed, it has to be mapped with the screen resolution of computer. For this, Calibration process is required.

- **Detecting Pointer Location**

Locating the coordinates of pointer with minimal error is the main task. For this, proper algorithm must be implemented.

- **Take Suitable Action**

Once the pointer location has been detected, the required keyboard or mouse click operations are performed by Java Commands.

VII. CONCLUSION

From the work carried out, a simple projector can be easily converted to an interactive projector using proposed algorithms. In this method, the process of calibration can provide mobility to a camera. One can put the camera at any place at any viewing angle that can cover the projector screen. Resolution of the camera also affects the speed of the algorithm.

Interactive projector is useful in seminar halls, classrooms, auditoriums where mobility is required and the Implementation of such interactive projector is currently under process.

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HORIZONTAL AGGREGATION- GOLD IN COAL MINE.

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ABSTRACT

Datasets are widely used data mining, with columns in horizontal tabular layout to efficiently analyze the data. To extract trends and pattern from the historical data to prepare the future strategies, Data mining is the widely used domain. And this is a tedious task as it requires many complex queries, aggregation columns and joining tables. For statistical analysis, information gathered and represented in a summary form in data aggregation process. With one variable per column, surplus records plus horizontal layouts with data sets are the requirement of many algorithms. Data mining tools will create a SQL code representing horizontal aggregation as a template is the first advantage of horizontal aggregation, which cuts shorts the human work in data preparation mode of data mining. End user written SQL code is inefficient then the code generated automatically is the second advantage plus this takes less time. Next advantage is that the data sets can be created in the DBMS.

Keywords : Aggregation, SQL(structured query language), SPJ, PIVOT, CASE, Data set.

I. INTRODUCTION

Vertical aggregation functions in SQL are the SUM, MIN, MAX, COUNT and AVG, these functions gives single row output on the column in the table. Aggregation will always support to give us the summary of data. Results of vertical aggregation can be fruitful for computation purpose but cannot for data mining operations [2]. Many data mining algorithms like PCA, regression, classification and clustering expects one dimension per column, data sets with a horizontal layout and several records as inputs [1]. Without DBMS, it is a difficult task to manage the large data sets. Using operator will help in performing horizontal aggregation same as select, project and join inside a query processor. There are three horizontal aggregation operators PIVOT, SPJ and CASE. Data analysis, data presenting, exchange rows and enable data transformation in data modeling is easily done with PIVOT operator in tabular data [1]. As horizontal aggregations are capable of producing data sets that can be used for real world data mining activities. With help of construct with standard SQL operation SPJ aggregation is developed. Built in pivoting facility provided by SQL is used in PIVOT while based on the SQL CASE construct the CASE, works on. SPJ provides condition output while the PIVOT does not provide output of any such fashion.

SPJ is simple to implement but very slow in performance while Pivot is faster in performance but difficult to build. CASE is a combination of SPJ and PIVOT. It picks up the advantages of both the method to build its own. Combined with GROUP BY clause and the required number of columns to store the transposed table is decided by the PIVOT method [3]. CASE operator is evaluated by GROUP BY and CASE statements. Space occupied by the end user details can be reduced by this method [4].

SELECT columns, Aggregate Function
(CASE WHEN Boolean expression THEN
result ELSE result expression END)

FROM table GROUP BY column.

In SPJ method all tables are joined to create a table containing horizontal aggregation [4]. The difficulty and time consuming are the two factors behind developing data sets for data mining, which give a motivation to horizontal aggregation. For this reason we have extended the functionalities of CASE, SPJ and PIVOT operators in such a way that they produce data sets with horizontal layouts.

2. Related work

From scientific data to business transaction, from satellite pictures to military intelligence is far huge to handle. To take decision by retrieving information is simply not enough anymore now. Xiang Lian and Lei Chen [5] analyzed cost models for evaluating dimensionality reduction in high-dimensional Spaces. In this model to evaluate the query performance over reduced data sets, methods like GDR, LDR, ADR is used. Specifically a novel (A) LDR method uses partitioning based on Randomized Search (RANS). LDR approach, PRANS, which is based on the cost model and can achieve good query performance in terms of the pruning power. Exhaustive experiments has proved the correctness of this cost model when compared to the existing LDR method and resulting partitions with low cost query. C.Ordonez [6] invented a way to efficiently compute fundamental statistical models inside a DBMS by exploring UDFs(User Defined Functions). The quadratic sum of cross products of points and linear sum of points, these two summary matrices on the data set are reseeded. The straight forward translation of K-

shown mathematically and essential for all models. Scoring the data sets can be achieved by introducing efficient SQL queries to compute summary matrices. Introduced UDFs that works in a single table scan is based on SQL framework. Scoring data sets is accomplished by a set of primitive scalar UDFs and aggregated UDFs to compute summary matrices for all models. C.ordonez [7] had put forwarded a technique combination of K-means clustering with relational DBMS using SQL. Three SQL implementation makes this technique works. First step is a straightforward translation of K-means computations into SQL, and an optimized version based on improved data organization, efficient indexing, sufficient statistics, and rewritten queries, and an incremental version that uses the optimized version as a building block with fast convergence and automated means computation into SQL, works as a framework to build a second optimized version with superior performance. To introduce an incremental K-means implementation with faster convergence and automated reseeding this optimized version is taken as a building block. Conor Cunningham [8] using two operator he came up with a technique of Optimization and Execution strategies in a RDBMS. The two operators are PIVOT on tabular data which exchanges rows and columns which transforming data helps in data analysis, data presentation and data modeling. Implementing inside a query processor system is easy just like select, join and projector operator. Both during query execution and query optimization, such design provides better opportunities for better performance. Pivot is an extension of Group By with unique restrictions and optimization opportunities, and this makes it very easy to introduce incrementally on top of existing grouping implementations. H Wang C. Zaniolo [8] proposed a complete SQL Extension for Data Mining and Data Streams. A complete data intensive application in SQL can be developed by writing table functions and new aggregates instead in procedural language. This technique is a powerful database language. The ATLaS system consist of applications including various data mining functions, that have been coded in ATLaS" SQL, and execute with a modest (20–40%) performance overhead with respect to the same applications written in C/C++. Using the schemas of continuous queries and Query Repository Queries can be handled by this system.

III. AGGREGATION

To eliminate the limitations of SQL operator a new database language ATLaS was developed. ATLaS [11] can perform aggregations that are not possible with standard SQL. Only basic aggregation operations are performed by standard SQL. INITIALIZE, ITERATE and TERMINATE are the three functions into which the entire SQL statement is divided to perform operations in ATLaS.

INITIALIZE section takes care of the declaration part, the ITERATIVE sections performs the major operation and the TERMINATE section takes care of the final statement to execute. It can also support online aggregation which is its major benefit. But its main drawback is that it consumes more space then the normal SQL plus results are not to be seen in horizontal tabular format.

C. Horizontal and vertical percentage: Using vertical and horizontal aggregation this method helps to calculate the percentages for the operations. Entire 100% results on the same row is seen in the A new class of functions which aggregates numeric expressions and the transposed results of data sets with horizontal layout, is brought by horizontal aggregation. A number of data mining tasks such as separately modeling and analyzing, segmentation of large mixed data sets into smaller uniform subsets and unsupervised classification and data summation needs operation. Efficient summary of data sets are needed to create data sets for data mining related works. Database by itself is a large amount of data and with the help of SQL information can be retrieved. Aggregation of huge amount of data is carried by SQL and aggregation helps to aggregate details of one table with another. Normal aggregation functions are sum(), min(), max(), count() and avg().

K	D1	D2	A
1	3	X	9
2	2	Y	6
3	1	Y	10
4	1	Y	0
5	2	X	1
6	1	X	NULL
7	3	X	8
8	2	X	7

Fig. a) Input Table

1) Vertical aggregation.

It is not at all different from standard SQL aggregation. It contains more number of rows and result is produced in vertical format. Some other methods can also produce results in vertical aggregate form.

D1	D2	A
1	X	Null
1	Y	10
2	X	8
2	Y	6
3	X	17

Fig. b) Traditional Vertical Aggregation

2) Horizontal Aggregation.

The difference between vertical and horizontal aggregation is that horizontal produces result in horizontal tabular format. By help of any data mining tool data sets for all operations are produced and then on these data sets the aggregation operations are applied [10]. Small syntax extensions to normal SQL syntax is needed to produce the result in horizontal layout. The syntax for horizontal aggregation is given below.

*SELECT columns, Aggregation Function
(Measure column BY Aggregating Parameters)
FROM GROUPING columns*

In a horizontal aggregation there are four input parameters to generate SQL code:

- 1) The input table F1,F2.....,Fn
- 2) The list of GROUP BY columns L1, . . . , Lj ,
- 3) The column to aggregate (A),
- 4) The list of transposing columns R1, . . . ,Rk.

D1	D2 X	D2Y
1	NULL	10
2	8	6
3	17	NULL

Fig. c) Horizontal Aggregation.

There is a common field K in fig. a and fig. b. In fig. b D2 consist X and Y distinct values used to form a transpose table. The sum() is used as the aggregate operation. The values within D1 are repeated, 1 appears 3 times, for row 3, 4 and, and for row 3 & 4 alue of D2 is X & Y. So D2X and D2Y is newly generated columns in fig. c.

IV.COMPARATIVE STUDY

Different methods performing horizontal aggregation are compared in the following.

A. Grouping Combinations

To handle grouping of high dimensional data and the aggregation this operator was developed. All the drawbacks of normal grouping operator are overcome by this operator. ROLLUP, CUBE and GROUPING SET produce tabular results plus perform aggregation. If available data sets are huge this are not used. Long complex SQL queries can only help when huge input dataset is available. The ROLL UP operator can perform aggregation on smaller datasets and produce tabular results vertical format [4]. And this is not sufficient for mining methods. This drawback is overcome by the CUBE

operator, which can perform aggregation even on large datasets. The main limitation of the CUBE operator is that it eliminates some of the details after performing aggregation. Hence GROUPING COMBINATION was developed to over the drawback of CUBE operator. Since, it operates on highly complex algorithms its performance is low while execution.

B. Atlas

To eliminate the limitations of SQL operator a new database language ATLaS was developed. ATLaS [11] can perform aggregations that are not possible with standard SQL. Only basic aggregation operations are performed by standard SQL. INITIALIZE, ITERATE and TERMINATE are the three functions into which the entire SQL statement is divided to perform operations in ATLaS. INITIALIZE section takes care of the declaration part, the ITERATIVE sections performs the major operation and the TERMINATE section takes care of the final statement to execute. It can also support online aggregation which is its major benefit. But its main drawback is that it consumes more space then the normal SQL plus results are not to be seen in horizontal tabular format.

D. Interpreted Storage Format

To handle the null values in both horizontal and vertical layouts the Interpreted Storage Format was developed. All the space data management complexities are taken care by this method. Large number of null values makes horizontal aggregation require more space. Nothing is for the null values in this method. A attribute identifier (attribute_id) and a length field is given as value in the row, when the row has value for an attribute. This value is stored with a particular head. This value is not easily accessible is its major disadvantage.

E. UNPIVOT Operator:

Opposite to PIVOT is UNPIVOT operator which means transformation of columns into rows is done where which is exact opposite to the PIVOT operator. This in turn will increase the rows for the columns resulting in a big table. The mining algorithms which require horizontal table as input cannot use this method. This operator is commonly used for the statistical computation of some data mining approaches [12]. The general syntax is as follows: SELECT columns

FROM table UNPIVOT (Measure Column for Pivot Column IN (Pivot Column Values))

Table 1

Comparative study of aggregation methods

Methods	Aggregations	Feature
Grouping Combination Operator	Vertical and Horizontal	Complex Algorithms
Atlas	Vertical	Solves limitations of normal SQL
Vertical and Horizontal Percentage Aggregation	Vertical and Horizontal	Operates only On percentages
Interpreted Storage Format	Vertical and Horizontal	Difficult to retrieve data
Unpivot	Horizontal	Small syntax extensions in Select

5. Conclusion.

Using horizontal aggregation is main requirement for the retail industry. The strategy of business can be modeled keeping the results on horizontal aggregation in mind. This will in turn only help the business to grow. The horizontal aggregation results and proper business strategy will help to prosper. One more thing she be also taken care of is, which operator to use with which system.

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SMS COMPRESSION

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ABSTRACT

The text messaging system used currently has a limit of 160 characters per message .But this limit is generally not sufficient for normal day to day communication and many of times we need to send multiple concatenated messages. In SMS compression it is possible to compress more text into a single message. Now every message can carry more than 160 characters in a single message which make a message sending very cost effective.

Keywords : SMS, messaging, Huffman encoding

I. INTRODUCTION

Mobile service providers provide different types of data messaging services, the most common ones being SMS (Short Messaging Service) and MMS (Multimedia Messaging Service). Messages may also be classified as Binary and Text messages. Simple text messages contain ASCII 7-bit characters while Binary messages contain information in binary form.

SMS is a part of the Global System for GSM series of standardized communication protocols which exchange text messages between different mobile phones for sending text messages up to 160 characters between two mobile devices which using GSM technologies. SMS messaging is the most popular tool of communication and around 4.1 billion SMS messages are sent daily [6]. Current messaging technology allows transmission of messages exceeding 160 characters by dividing them into 160 characters chunks, at the sending side and automatically combining all the chunks at the receiver. The protocol used currently allows SMS to contain data of 140 bytes in single message. Each character is coded by seven bits and because of that it allows 160 characters per SMS. This limit is many of times falls short of convenience to normal user. The next section define this problem and give the solution to solve this using an algorithm [3].

II. PROBLEM DEFINITION

Transmission of messages between Short Message Service Centre (SMSC) and the handset is done using the Mobile Application Part (MAP) of the Signalling System 7 (SS7) protocol. When different messages are sent, its payload length is limited to precisely 140 octets (140 octets = $140 * 8 \text{ bits} = 1120 \text{ bits}$). Short

The default GSM 7-bit alphabet, The 8-bit data alphabet, and The 16-bit UTF-16 alphabet. Because on this the maximum size of 160 7-bit characters, 140 8-bit characters, or 70 16-bit characters.

Larger content can be sent using concatenated messages, in which every message will start with a user data header (UDH) which contains segmentation information. As UDH is part of the payload, the number of available characters per segment is low i.e.153 for 7-bit encoding, 133 for 8-bit encoding and 67 for 16-bit encoding. The receiving phone is responsible for assembling the messages and displaying it to the user as one large message. While this concept permit up to 255 segments but 6 to 8 segment messages are the practically maximum , and long messages are often cost as multiple SMS messages.

The count of SMS text messages sent all over the globe in 2009 was 4.1 billion. The number of texts being sent is on the rise, especially among teenagers age 13 to 17. According to study, the average teenager now sends 3,339 texts per month. There's more, though: teen females send an incredible 4,050 texts per month, while teen males send an average of 2,539 texts. Teens are sending 8% more texts than they were this time last year [8].

The current message character limit is too small for SMS users. The old protocols of 8-bit characters which allows 140 characters, was changed, mainly to accommodate more characters. The main demand among different mobile phone users is for more character count in a single message. Hence a new system is required that will expand the limit without changing the capacity of message. In order to increase the data sending capacity we develop a new way for encoding characters and creating new standard other than ASCII to perform encoding to simple text messages.

III. COMPRESSION TECHNIQUES

Compression is mainly used because it helps to reduce the consumption of expensive resources, like bandwidth of transmission. On other side, compressed data should be decompressed and this extra processing may disturb other applications running in parallel. The design of data compression schemes hence involves trade-offs between different

factors, including the compression degree, amount of distortion, in case of lossy compression, and the computational resources which are used to compress and decompress the data [2].

We studied various encoding techniques and select the Huffman Encoding technique for compression [5]

IV. HUFFMAN ENCODING

Huffman coding is an entropy encoding algorithm used for lossless data compression in computer science and information theory. The term refers to the use of a variable-length code table for encoding a source symbol (such as a character in a file) where the variable-length code table has been derived in a particular way based on the estimated probability of occurrence for each possible value of the source symbol [4].

Huffman coding uses a specific method for choosing the representation for each symbol, resulting in a prefix-free code (that is, the bit string representing some particular symbol is never a prefix of the bit string representing any other symbol) that expresses the most common characters using shorter strings of bits than are used for less common source symbols. Huffman was able to design the most efficient compression method of this type: no other mapping of individual source symbols to unique strings of bits will produce a smaller average output size when the actual symbol frequencies agree with those used to create the code. A method was later found to do this in linear time if input probabilities (also known as weights) are sorted.

Huffman encoding uses a strictly binary tree where each non leaf node has two children. The Huffman algorithm works as follows [4]

Creating the tree

1. Start with as many leaves as there are symbols.
2. Enqueue all leaf nodes into the first queue (by probability in increasing order so that the least likely item is in the head of the queue).
3. While there is more than one node in the queues:
 - 3.1. Dequeue the two nodes with the lowest weight.
 - 3.2. Create a new internal node, with the two just removed nodes as children (either node can be either child) and the sum of their weights as the new weight.
 - 3.3. Enqueue the new node into the rear of the second queue.
4. The remaining node is the root node; the tree has now been generated.

From this tree, codes are generated for each symbol by the following rules [1]

1. Start from the root node. For each down left

traversal, add a '0' to the code and a '1' for each down right, add a '1'.

2. When you reach a leaf node, the current code is the code for that character.
3. When travelling to the parent of a node, delete the last added bit from the code.

Let's consider an example

Message to be Encoded:

“dad ade fade bead ace dead cab bad fad cafe face”

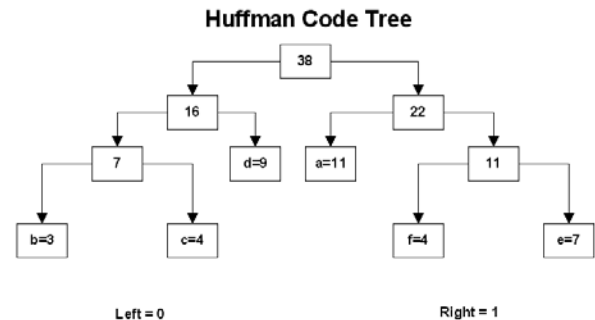


Fig. 1: Huffman code tree

Element	Frequency	Huffman Code
A	11	10
B	03	000
C	04	001
D	09	01
E	07	111
F	04	110

Table 1: Huffman code generation

Encoded Message:

01 10 01 10 01 111 110 10 01 111 000 111 10 01 10
001 111 01 111 10 01 001 10 000 000 10 01 110 10
01 001 10 110 111 110 10 001 111

The Huffman encoding of the message is 94 bits long. The Huffman encoding saves 20 bits. The compression ratio is 1.21 to 1. The compression rate is 17.5%. The main intention of our application is to improve the compression, our algorithm uses various predetermined prefix trees on both sender and receiver modules and it is pseudo adaptive form of Huffman encoding [7].

SMS Compression uses Huffman encoding algorithm to compress text for reducing size of the text. we create an application for cost efficient communication over the wireless network, in which by using the compression technique we reduce the data size of the message and transfer it over the network.

Following are the various activities used in SMS Compression

1. *User enters a text message*
In this, the user of the system enters a simple text message on his/her mobile phone, which he/she wants to compress and send it to the receiver.
2. *Text passes through compression algorithm*
In this, the entered text message will go under the compression algorithm and the encoded code will get generated by the algorithm
3. *Text sent after compression to receiver*
After compression of the text, the generated encoded code will get sent to the recipient of the message
4. *Text passes through decompression*
At recipient end, the encoded text will undergo decompression process to produce the original plain text message
5. *Text displayed at receiver end*
After decompression the original plain text will get displayed at the recipient mobile terminal.

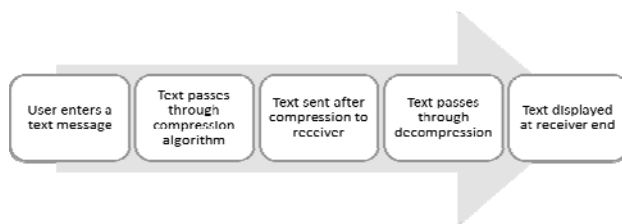


Fig. 2: Process diagram of application

In this application we created different sets of codes for different character to get short and effective codes

V. RESULTS ACHIEVED

To prepare the encoded bit-strings, we studied over different text messages, researches and technical papers. Using these statistics, we observed the frequency of each character and analysed different trends in the use of alphabets, numbers and special symbols.

To observe the compression in different situations and considering different types of users, we created multiple sets of codes primarily classified into two categories, ones that use all small characters and the others that use a mix of capitals and small characters. Further, depending on the use of certain characters, we created sets of codes, which would help generate the shortest bit-strings for different situations that varied in terms of the characters used.

Frequency table of characters from text messages:

Character	Frequency (In Percentage)
-----------	---------------------------

SPACE	18.75
!	0.40
"	0.47
.	2.95
?	0.34
A	1.06
a	7.11
b	1.13
c	1.42
d	2.40
e	6.90
f	1.07
g	1.29
h	3.58
i	4.95
n	4.28
o	4.34
q	0.05
r	3.87
s	3.93
u	2.38
w	1.18
x	0.10
y	1.86

Figure 3-2: Bit-string generated codes using frequency

Hence, by studying the statistics we can say that we can compress data up to 60-70 percent which allows around 220-250 characters can be sent in single message.

VI. APPLICATIONS

The very common application of our research application extends to the field of mobile computing. A basic model can easily develop using our algorithm which will become popular to the end user since it can save money. It also can be used to modify current protocols and develop a new system of compressing text messages in mobile phones.

Our application uses a unique bit-string for different character which making it possible to efficiently compress a wide range of characters, and hence it can also be easily extended to any other language.

VII. CONCLUSIONS

In today's world, many projects and applications are being developed to overcome boundaries such as limits of simple text messages. While incredible progress has been made in the field of mobile communication, support for increasing various end user demands remains a concern. Various advanced techniques are necessary in order to meet the challenges of business. SMS Compression comes up with a new model which can revolutionize the way SMSs are sent all over the country. It can help messaging become cheaper and economical and thus can made a good boost in mobile industry.

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IMPLEMENTATION OF ONLINE-ASSIGNMENT SUBMISSION WITH FEATURE OF ANTI-PLAGIARISM

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ABSTRACT

It is a system that gives the ability to submit an assignment online, in an easy method for the student and the lecturer who will receive and evaluate the student work; also it gives the ability for the student to submit the assignment from different locations for example from home or from college. The proposed model is based on identifying the submitted assignment and checking its content to find whether it is copied or not using Anti-Plagiarism system. The expected result from this model is will help the faculty to assess the genuine assignment and depending upon the result and content the assignment can be assessed.

Keyword : VIOLA, Web Portal, Online-Assignment Submission, Anti-Plagiarism.

I. INTRODUCTION

Almost all universities include some form of assignments in their courses. The assignments are either carried out either in groups or individually. To effectively manage these submitted assignments, a well-designed assignment submission system is needed, hence the need for an online assignment submission system to facilitate the distribution, and collection of assignments. For an effective course, the assignments must be processed and graded quickly so that students receive useful feedback that can benefit their progress. The solution to this problem, as has been recognized by several institutions, lies in the potential for the processes of submission and assessment of programming assignments to be automated, at least in part. In essence, there are two important aspects here that can be labeled as information management relating to the submission and organization of assignments, and assessment techniques relating to the testing of the submitted assignments.

VIOLA: (Vidyalankar Online Application) vidyalankarlive.com(Vlive) is an education portal based on the forum-interaction concept initiated by the Students' Branch, Computer Society of India(CSI) of VIT.

The concept of a forum/community portal, though popular in many universities abroad as a means to resource sharing, maintaining a repository and for interaction, is a rare occurrence in colleges across India. Thus it is a new tech idea implemented in VIT, to provide a better interaction and resource sharing between faculty or management and students.

As compared with other networking sites it is only developed for student and by student. It is maintained by a group of students called as VIOLA i.e., Vidyalankar Online Applications.

Some statistics regarding vidyalankarlive.com:

Current total member	6,152
Current total threads	12,959
Daily visitors	2,986
Load time	Approx. 1.907 secs

II. RELATED WORK

Other organizations have tried to achieve the same goals through various systems designed by them. The most prominent of them is [3] Moodle-a courseware management system, [4] Sakai-online assignment submission system, Turnitin-Anti-plagiarism system. It is basically used in terms of handling all assignments in U.S based universities

In this system the lecturer will be able to upload assignment questions, assess the assignment submitted by student with the help of plagiarism detection module which will give the percentage of plagiarism done by the student. The student will be able to create, submit assignment in various formats as specified by lecturer, check the graded assignments, and download it on his system. The journal will also be generated for the student to ease the process of file generation for submissions.

The features in current system with our proposed system can be compared as:

Table :-1 Comparison of Current System and our Proposed System.

Current System	Proposed System
Two different web-based modules & One Plugin: 1. Assignment Submission 2. Anti-Plagiarism 3. Plugin to connect both.	Assignment Submission and Anti- Plagiarism system both are combined No plugin required.
Questions uploaded given by faculty are mandatory for every student.	Random distribution of questions to every student.
Journal submission is not provided.	Journal submission is provided.
Notification system regarding the assignment submission is not supported	Notification system regarding the assignment submission is supported.

III. PROPOSED SYSTEM

Our system will be having online assignment submission system and it will be integrated with Anti-Plagiarism sub-system.

Online Assignment Submission System:

This module will have two separate interfaces for Professors and students. The Assignment will be created for the particular subject based on the questions submitted by the respective professors of that subject. Professor can also specify the factors such as references, type of submission, due date, grade type etc. related to the particular assignment. Professor can be able to assess the assignments submitted by students and grade them with remarks if any. The Students can view the assignment questions and then can create their respective assignment solution in respective type of submission specified like in text editor, doc file or media (image/video) file. The Students can then view the status of their submitted assignments and can also download the corrected assignments.

Anti-Plagiarism Sub-System:

Anti-Plagiarism is the process of locating instances of plagiarism within a work or document. The widespread use of computers and the advent of the Internet has made it easier to plagiarize the work of others. Systems for text-plagiarism detection implement one of two generic detection approaches, one being external, the other being intrinsic. External PDS compare a suspicious document with a reference collection, which is a set of documents assumed to be genuine. Based on a chosen document model and predefined similarity criteria, the detection task is to retrieve all documents that contain text that is similar to a degree above a chosen threshold to text in the suspicious document. Intrinsic PDS solely analyze the text to be evaluated without performing comparisons to external documents. This approach aims to recognize changes in the unique writing style of an author as an indicator for potential plagiarism.

IV. TECHNOLOGY USED

The following are the hardwares and software or programming languages we are going to used :

Servers:

Setting up a Linux based perfect CentOS 5.5 web server having ISPConfig 3 with Apache web server, Postfix Mail Server, MySQL, MyDNS Name Server, PureFTPD, SpamAssassin, ClamAV, php5, phpMyAdmin

PHP & MySQL:

PHP is an open-source server-side scripting language designed for Web development to produce dynamic Web pages. PHP is a general-purpose scripting language that is especially suited to server-side web development where PHP generally runs on a web server.

jQuery:

jQuery is a free, open source cross-browser JavaScript library designed to simplify the client-side scripting of HTML.

CSS:

CSS is a style language that defines layout of HTML documents. For example, CSS covers fonts, colours, margins, lines, height, width, background images, advanced positions and many other things.

HTML:

HTML can be (mis-)used to add layout to websites. But CSS offers more options and is more accurate and sophisticated. CSS is supported by all browsers today.

vBulletin(ContentManagement System):

[2]vBulletin is one of the best platforms for development of interactive forums. The following topics are being studied:

vBulletin API Basics: Variables, Functions, Objects

Basics of vBulletin Debug Mode

Creating our own vBulletin Page

TinyMCE Editor:

TinyMCE is a platform independent web based Javascript HTML WYSIWYG editor control released as Open Source under LGPL.

TinyMCE has the ability to convert HTML TEXTAREA fields or other HTML elements to editor instances

V. IMPLEMENTATION

System Flow:

The proposed system is going to be implemented with vidyalankarlive.com and thus to use the system they have to be an authenticated user of vidyalankarlive.com.

In the below diagram the left hand side blocks are handle by faculty and right hand side block is handle by student and rectangular block is the system itself.

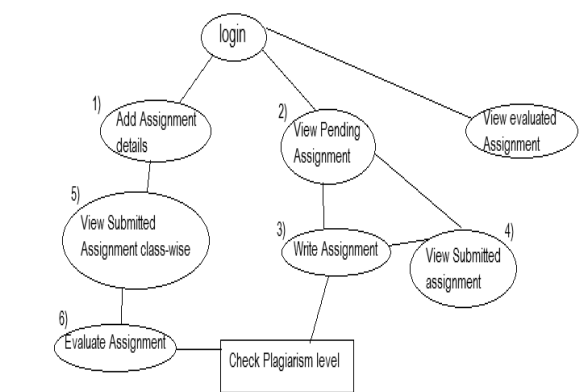


Figure no-1: System flow

Snapshot:

The following are the snapshots of the implemented part of the system and are in the steps as shown in system flow:

Step 1: Add Assignment details by faculty:

[1][5][6][7] Faculty will enter the assignment details and ten compulsory question from which randomly five questions will be uploaded to each and every student of that class

Add View Assignment Review Assignment Permissions

Figure no-2: Add Assignment details by faculty

Step 2: View Pending Assignment by student:

Student can view the assignment and then can start assignment by clicking on Write Assignment. Once student submits the assignment it will be removed from the list.

Figure no-3: View Pending Assignment by student

Step 3: Write Assignment by student:

Student can write assignment using the below interactive multi-step form.

Since some student will find difficult to write full assignment at once we also provide partial submit option to the student so that they can write the assignment from where they had stop again.

Figure no-4: Write Assignment by student

Step 4: View Submitted Assignment by student:

Student can view and download the submitted assignment.

Title	Assignment No	Semester	Submission Date	Attachment	Inline
Robotics Assignment	3	III		attach	4024 Remove
Mobile Computing	1	III		attach	4024 Remove
SS	0	III		attach	4024 Remove
ADBMS	1	III		attach	4024 Remove
sc	1	III		attach	4024 Remove
hgdyj	1	III		attach	4024 Remove

Figure no-5: View Submitted Assignment by student

Step 5: View Submitted Assignment Class-wise for faculty:

Faculty can view the student who have submitted the assignment class-wise n who don't.

Figure no-6: View Submitted Assignment for faculty

Step 6: Evaluate Assignment by faculty:

Faculty can evaluate the assignment on plagiarism basis and can view that assignment.

Add View Assignment Review Assignment Permissions

Title	Assignment No	Class	Semester	Open Date	Due Date	Grade Scale	Submission Type	Download All	
SS	0	CMPH-3	III	06-12-2013	07-12-2013	ungraded	Inline and Attachments	View	Remove
Robotics Assignment	3	CMPH-3	III	07-12-2013	14-12-2013	Checkpoint	Inline Only	View	Remove
Mobile Computing	1	CMPH-3	III	25-01-2014	31-01-2014	Letter Grade	Inline and Attachments	View	Remove
sc	1	CMPH-3	III	29-01-2014	12-02-2014	Letter Grade	Inline and Attachments	View	Remove
hpdy	1	CMPH-3	III	30-01-2014	31-01-2014	Points	Inline Only	View	Remove
addgdy	2	CMPH-3	III	18-02-2014	21-02-2014	Letter Grade	Inline Only	View	Remove
Web engg	4	CMPH-3	III	12-02-2014	21-02-2014	Letter Grade	Inline and Attachments	View	Remove
eachpghpghpghj	3	CMPH-3	III	19-02-2014	20-02-2014	Pass Fail	Attachments Only	View	Remove
asdhfjd	3	CMPH-3	III	17-02-2014	20-02-2014	Letter Grade	Inline Only	View	Remove

Figure no-7: Evaluating Assignment by faculty

VI. ADVANTAGE

Assignment handling all in one place and accessible from anywhere. Reduced paper handling , less to photocopy and post , simpler archiving. Tracking of who submitted what and when. Simple to use interface.

Detection of plagiarism to prevent malpractice of copying.

VII. CONCLUSION

So in this paper, we have presented the aspect regarding the implementation of the system, technology used in it, view of the system, etc.. The system implemented will make the tedious job regarding assignment submission like uploading, submitting, evaluation like uploading, submitting and evaluation easy and interesting for faculty and students.

We will make the system in future as a complete Assignment Management System giving personalized services. Can be extended to accumulate online assignment submission in any college across the world. Fully automated grading system. Email and SMS alerts on due dates of submission of assignments.

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6. <http://stackoverflow.com/>
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APPROACHES TO HUMAN DETECTION – AN OVERVIEW

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ABSTRACT

Detecting humans in images is a challenging task owing to their variable appearance and the wide range of poses that they can adopt. The first need is a robust feature set that allows the human form to be discriminated cleanly, even in cluttered backgrounds under difficult illumination. In this paper we compare the various techniques and the papers written in the fields of human detection. The histogram of oriented gradients descriptor is one of the best and most popular descriptors used for pedestrian detection [dalal]. Unfortunately this technique suffers from one big problem: speed. The various techniques like head and shoulder detection, the omega shape head and shoulder detection can be used for face detection. Like most sliding window algorithms it is very slow, making it unsuitable for any real time application. The HOG detector is a sliding window algorithm. This means that for any given image a window is moved across at all locations and scales and a descriptor is computed. For that window a pre trained classifier is used to assign a matching score to the descriptor.

Keyword: HOG, Harr feature, image segmentation, video segmentation and retrieval, omega shape detection.

I. INTRODUCTION

The study about of feature sets for human detection, showing that locally normalized Histogram of Oriented Gradient (HOG) descriptors provide excellent performance relative to other existing feature sets including wavelets. The proposed Descriptors are reminiscent of edge orientation histograms, SIFT descriptors and shape contexts, but they are computed on a dense grid of uniformly spaced cells and they use overlapping local contrast normalizations for improved performance. The comparative study about the various detection algorithms to detect humans is studied. For simplicity and speed, we use linear SVM as a baseline classifier throughout the study. The new detectors give essentially perfect results on the MIT pedestrian test set, a more challenging set containing over 1800 pedestrian images with a large range of poses and backgrounds. On-going work suggests that our feature set performs equally well for other shape-based object classes.

HOG DESCRIPTOR AND USAGE FOR OBJECT DETECTION

The histogram of oriented algorithm for object detection was introduced in [1]. An example of detection results for pedestrians and heads is visible in Figure 1. The HOG detector is a sliding window algorithm. This means that for any given image a window is moved across at all locations and scales and a descriptor is computed. For that window a pre trained classifier is used to assign a matching score to the descriptor.



Figure 1: Example results after applying the HOG detector for pedestrians (left) and heads (right)

Gradient orientations and magnitude are obtained for each pixel from the pre-processed image. If a color image is used the gradient with the maximum magnitude (and its corresponding orientation) is chosen. This is done by convoluting the image with the 1-D centred kernel $[-1 \ 0 \ 1]$ by rows and columns.

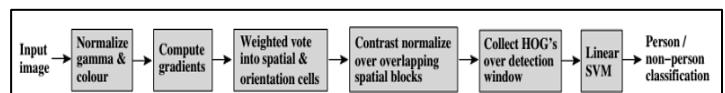


Fig 2. Human detection Chain

masks) but the simple 1-D centred kernel gave the best performance (for pedestrian detection).

Each detection window is divided into several groups of pixels, called cells. For each cell a histogram of gradient orientations is computed. For pedestrian detection the cells are rectangular and the histogram bins are evenly spaced between 0 and 180 degrees.

The contribution of each pixel to the cell histogram is weighted by a Gaussian centred in the middle of the block and then interpolated tri linearly in orientation and position. This has the effect of reducing aliasing.

THE DALAL-TRIGGS ALGORITHM

We start with a short description of the Dalal & Triggs algorithm. Each detection window is divided into cells of size 8×8 pixels and each group of 2×2 cells is integrated into a block in a sliding fashion, so blocks overlap with each other. Each cell consists of a 9-bin Histogram of Oriented Gradients (HOG) and each block contains a concatenated vector of all its cells. Each block is thus represented by a $36 - D$ feature vector that is normalized to an L2 unit length.

Each 64×128 detection window is represented by 7×15 blocks, giving a total of 3780 features per detection window. These features are then used to train a linear SVM classifier

HOG RE-WEIGHTING USING GLOBAL IMAGE SEGMENTATION

The proposed approach consists in re-weighting the HOG descriptor for each one of the cells while it is computed. Basically, HOG consists in an intelligent grouping of gradient information (cells and blocks), as well as well-engineered histograms of gradient orientations (weighting by gradient magnitude, bin interpolation, histogram normalization and outliers clipping are the major steps 1). The window of interest is covered by overlapping blocks; therefore, the HOG descriptor of the whole window usually ends up being thousand-dimensional.

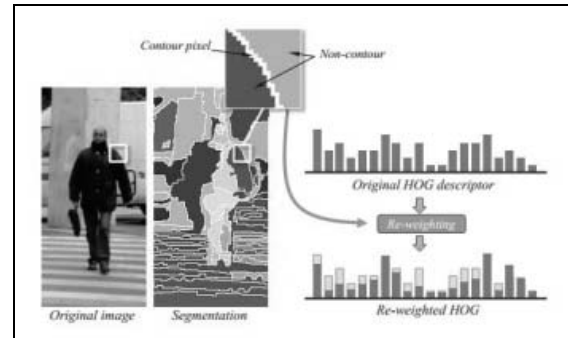


Fig. 3: Re-weighting of the HOG descriptor according to the image segmentation cues.

A linear SVM is used for learning the human classifier works in such high dimensional space. Accordingly, the obtained classifier is just a weighted summation running on such number of dimensions.

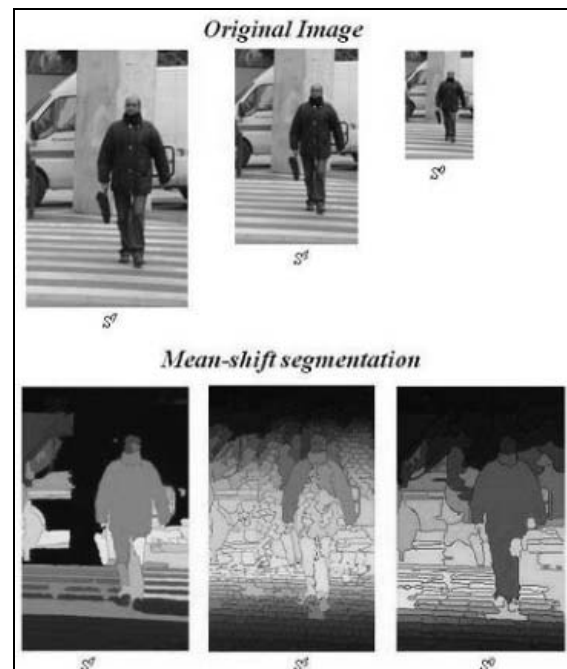


Fig. 4: Pyramid-segmentation. The scale of the slice in the pyramid affects the segmentation

When computing HOG, the gradient orientation θ_P at a given pixel P is weighted by the corresponding magnitude μ_P , i.e., μ_P is accumulated in the histogram bin corresponding to θ_P . Notice that the gradient at P , only encodes local differences in intensity or color, i.e., differences between adjacent pixels. In this paper, we want to incorporate differences based on a wider spatial support into the process in order to assess if they allow obtaining a human detector with higher performance.

In particular, we want to weight μP by a given ωP coming up from an image segmentation process, i.e., the vote of θP in the histogram will be the re-weighted magnitude λP instead of μP .

Here, in order to compute the weighted HOG, we apply the selected image segmentation algorithm (i.e., S) to each level of the pyramid. Thus, we obtain a sort of multi-scale segmentation of the original image (Fig. 5).



Fig 5. Some sample images from our new human detection database. The subjects are always upright, but with some partial occlusions and a wide range of variations in pose, appearance, clothing, illumination and background.

RAPID AND ROBUST HUMAN DETECTION AND TRACKING BASED ON OMEGA-SHAPE FEATURES

Human detection and tracking can be widely used in many applications, including people counting and security surveillance in public scenes. However, full-body human detection [1] often suffers from occlusions among individuals and scenes in which people are not necessarily standing. Hence, much recent research instead is focused on the upper part of human body. Much work has been done on head based human detection and tracking. In [2], heads are detected by contour segmentation and ellipse fitting on the moving regions, and then each detected head is tracked by a particle filter tracker. In [3], heads are located by fast Hough transform and shape matching and tracked by decentralized trackers. However, these methods have some limitations because heads are often too small to be detected in surveillance scenes and their shapes vary greatly due to different hair-styles.

As shown in Fig. 6, the head-shoulder part has a distinctive omega-like shape in almost all view angles, thus some researchers focus on head-shoulder based human detection and tracking. However, this detection based tracking method is very time-consuming. In [6], an effective head-shoulder detection method based on boosting local HOG features is proposed and shows good performance in crowded scenes.

However, it needs several seconds to process a 320×240 image, which is too slow for real application. Fig. 1. Head-shoulder samples and their omega-like shapes. In this paper, we propose a novel method for rapid and robust head-shoulder based human detection and tracking. First, based on the work in [6], a rapid detection module combining a Viola-Jones type classifier and a HOG feature based AdaBoost classifier is used to detect head-shoulders rapidly in the predefined "Entrance" zones.

Then, each detected head shoulder is tracked by a particle filter tracker using local HOG features to model target's appearance, which shows great robustness in scenarios of crowding, background distractors and partial occlusions.

2. HEAD-SHOULDER DETECTION

It is known that Haar feature based Viola-Jones type classifier can work very fast [7], but has poor classification performance [6] in head-shoulder detection. On the contrary, HOG feature based Thus, as shown in Fig. 2, we reduce a detection strategy which can tremendously increase its working speed of the head-shoulder detector proposed by [6] while keep its classification performance. First, a Viola Jones type classifier with very high detection rate (nearly 98%) as well as relatively high rate of false positives (more than 2% False Positive per Window) is used to exclude the obvious non-head-shoulder image patches rapidly. Then, the remaining sparse image patches are classified by a local HOG feature based Ada Boost classifier with much better classification performance. Final results are obtained by averaging the positive windows around each object.

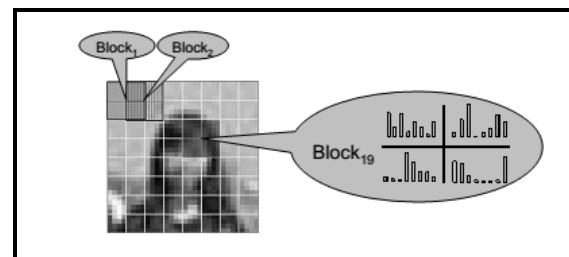


Fig. 6. The flowchart of our head-shoulder detection module

Details of how to train a Viola-Jones cascade classifier can be seen in Fig. 7 illustrates the process of local HOG feature extraction: 1) each sample is divided into 64 cells; 2) 4 adjacent cells form a block and the block stride is one cell (49 blocks in total); 3) for each cell in each block, a histogram of 8 gradient

orientation bins (in $0^\circ - 360^\circ$) is calculated and normalized within this block. Details of how to train the local HOG feature based Ada boost classifier can be seen in [6].

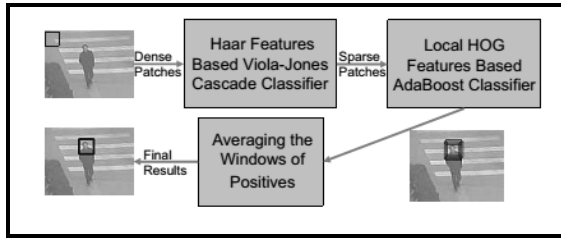


Fig. 7. Illustration of local HOG feature extraction

INRIA Person Dataset: The INRIA person dataset [5] provides both training and testing sets containing positive samples of size 64×128 pixels and negative images (containing no humans). To estimate weight vectors (PLS model) and train the quadratic classifier we employ the following procedure. First, all 2416 positive training samples and 5000 of the negative detection windows, sampled randomly from training images, are used. Once the first model is created, we use it to classify negative windows in the training set.

The misclassified windows are added into the 5000 negative windows and a new PLS model and new classifier parameters are estimated. This process is repeated a few times and takes approximately one hour. Our final PLS model considers 8954 negative and 2416 positive samples, using 20 weight vectors.

DaimlerChrysler Pedestrian Dataset:

This dataset provides gray scale samples of size 18×36 pixels [18]. We adapt our feature extraction methods for these image characteristics as follows. For co-occurrence feature extraction, we use block sizes of 8×8 and 16×16 with shifts of 2 pixels for both. Co-occurrence matrices are estimated using the brightness channel quantized into 16 bins. For HOG feature extraction, we adopt the same approach used for the INRIA person dataset; however, block sizes now range from 8×8 to 18×36 . Due to the lack of color information, the color frequency feature cannot be considered in this experiment.

ETHZ Dataset: We evaluate our method for uncropped full images using the ETHZ dataset [7]. This dataset provides four video sequences, one for training and three for testing (640 $\times$ 480 pixels at 15 frames / second). Even though a training sequence is provided, we do not to use it; instead we use the same PLS model and QDA parameters learned on the INRIA training dataset. This allows us to evaluate the generalization capability of our method to different datasets.

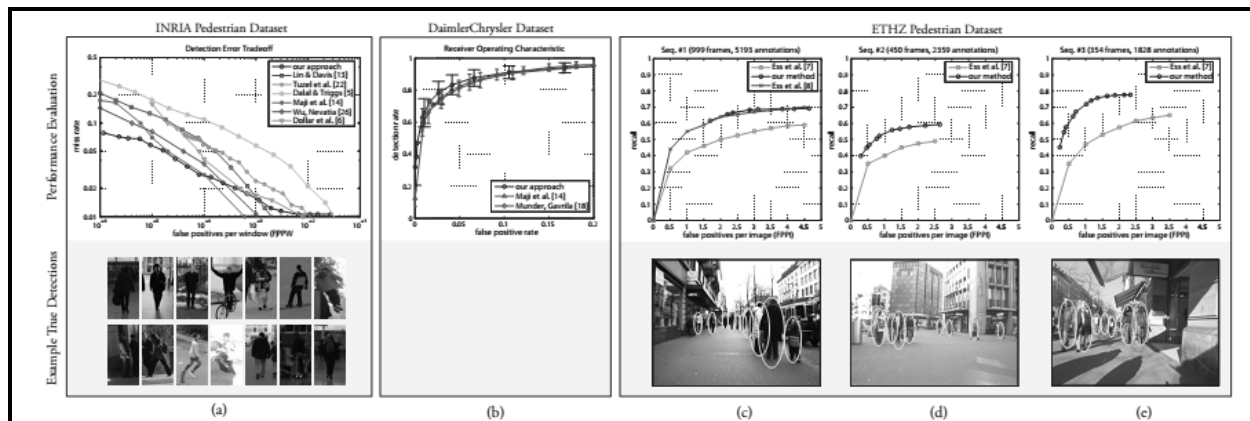


Fig 6. Evaluation of method on multiple pedestrian data sets. First row shows performance and comparisons with state-of-the-art methods. Second row shows some sample true detections for each dataset (best visualized in color).

CONCLUSION

We demonstrate a near real-time human detection system that matches the detection performance of previous methods with upto 70X speedup. This is achieved by integrating the cascade-of-rejecters concept with the Histogram of Oriented Gradients (HOG) features. Central to the success of our approach is that the features are chosen from a large set of blocks at multiple sizes, locations and aspect ratios. A human detection method using a richer descriptor set including edge-based features, texture measures and color information, obtaining a significant improvement in results

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MITIGATING EMAIL SPAMS BASED ON CONTENTS AND IMAGES

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ABSTRACT

In the Internet world, Management of Emails is a huge task. This is because more than 100 trillion emails are sent per year and 90% of the trillions of email messages are spam or viruses. Spam costs businesses over \$20 billion in decreased productivity and technology expenses. Average email campaign increases by 20-25% every year. There are many feasible spam detection algorithms to filter the spam emails. Most of these algorithms can be categorized as metadata based, content based, behavior based, etc. The existing algorithms focus more on the text and the association between the texts to classify the spam emails. This paper proposes the algorithm which is based on both the text as well as images present in the spam mails and also bloom filters can be employed to save the network bandwidth. This method can effectively detect and filter the spam mails with the precision and the recall up to 0.97 and 0.96.

Keywords : Content based spam filter , bloom filter, email spam detection machine learning , Image based spam, Electronic-mail abstraction

I. INTRODUCTION

Spam is defined as an unsolicited e-mail, often of a commercial nature, sent indiscriminately to multiple mailing lists, individuals, or newsgroups; junk e-mail. Spamming is the scourge of electronic-mail and newsgroups on the Internet. It can seriously interfere with the operation of public services, to say nothing of the effect it may have on any individual's e-mail mail system. ... Spammers are, in effect, taking resources away from users and service suppliers without compensation and without authorization. The primary challenge of spam detection problem lies in the fact that spammers will always find new ways to attack spam filters owing to the economic benefits of sending spams. Note that existing filters generally perform well when dealing with clumsy spams, which have duplicate content with suspicious keywords or are sent from an identical notorious server. Therefore, the next stage of spam detection research should focus on coping with cunning spams which evolve naturally and continuously.

Spam filtering is a difficult classification task for a variety of reasons. Spam is constantly changing as spam on new topics emerges. Also, spammers attempt to make their messages as indistinguishable from legitimate email as possible and change the patterns of spam to foil the filters. Another serious issue is the problem of false positives, i.e. a legitimate email classified as spam. For many email

users, false positives are simply unacceptable; thus the requirements on the spam filter are very exacting. As new types of spam emerge and spammers change their behaviour to avoid detection, a content-based system will require updating. Features that are predictive of the new types of spam and rules to handle these features are required. There is a fair deal of interest in using Machine Learning (ML) techniques to automate this process

Link spam includes changes into the link structure of the sites, by creating link farms. A link farm is a densely connected set of pages, created explicitly with the purpose of deceiving a link-based ranking algorithm. The targets of link-based spam-detection algorithms are the pages that receive most of their ranking by participating in link farms. A page that participates in a link farm may have a high in-degree, but little relationship with the rest of the graph. Link farms can receive links from non-spam sites by buying advertising, or by buying expired domains used previously for legitimate purposes

Web Content Mining deals with the application of data mining techniques to un-structured or semi structured text, typically html documents. Web Content Mining is a process designed to explore large amounts of data by capturing consistent patterns and relationships between data objects. Its finds its applications in various areas such as information retrieval from large databases, search engines[18], Automated answering systems and E-Mail Sorting applications etc. Web Structure Mining uses the hyper-link structure of the web analyzing its structural properties. Some issues in email spamming are

- The growing sophistication of phishing attacks.
- Attachment based Spam/Phishing emails.
- Image-based Spam.
- Use of botnet for delivering spam.

The purpose of this algorithm is to improve the accuracy and the performance of the previously proposed algorithms. This algorithm has different levels for its filtering such as control level, warning level, and alarm level so as to filter the mails dynamically. By using OCR, text from the image spams could be extracted and mining algorithm can be employed to classify whether it is spam or not.

II. ANTI-SPAM TECHNIQUES

Anti-spam techniques may be classified as illustrated in Fig 1.

A. CONTENT BASED FILTERING

This technique attempts to computationally distinguish between a spam e-mail and a legitimate e-mail using machine learning techniques and the identification of spam and phishing emails are quite different. A spammer advertises a product while the phisher has to deliver a message that has an unsuspecting look and pretends to come from some reputable institution. Abu-Nimeh et al. [13] discussed above the various statistical filters such as SVM, K-NN and BART etc to identify phishing mails based on specific keywords. The machine learning techniques includes decision tree, naïve Bayesian [1] [4], SVM (Support Vector Machine), BART (Bayesian Additive Regression Trees), K-Nearest neighbor algorithm [1] and artificial neural networks. Naïve Bayes Filters plays a very important role but it suffers from the limitation of Bayesian Poisoning (word obfuscation) by adding irrelevant words which are not in the Spam database.

B. CASE BASED FILTERING

The steps involved in case based filtering are

Step 1. Gather training sets of spam and non-spam mail messages.

Step 2. Remove stop-words and stem the remaining words.

Step 3. Generate vocabularies of words occurring in the spam and non-spam emails. Count the frequencies of each word in the training data and update the vocabularies with this count.

Step 4. Sort the vocabularies based on the odds-ratio described below.

Step 5. Select the top l terms (typically 40) from each vocabulary to be part of the feature representation.

Step 6. Augment this feature list with some features (currently 6) extracted from the mail header.

The odds-ratio is calculated as follows:

$$OR(w, c_i) = \frac{P(w | c_i) \times [1 - P(w | \bar{c}_i)]}{[1 - P(w | c_i)] \times P(w | \bar{c}_i)}$$

where $P(w | c_i)$ is the probability of word w occurring in category (i.e. spam or non-spam) c_i . When a word does not occur in a category the associated probability is assigned a small fixed value so that the odds-ratio can still be calculated. Words that are equally likely to occur in spam and non-spam have an odds-ratio close to 1 while words that are indicative of a category have a value greater than one. Thus the feature selection process described in Steps 4&5 above selects the top l features predictive of spam and the top m features predictive of non-spam. So each mail message is represented by a feature vector of length $l+m+n$ in the classification process (n is the number of features extracted from the header).

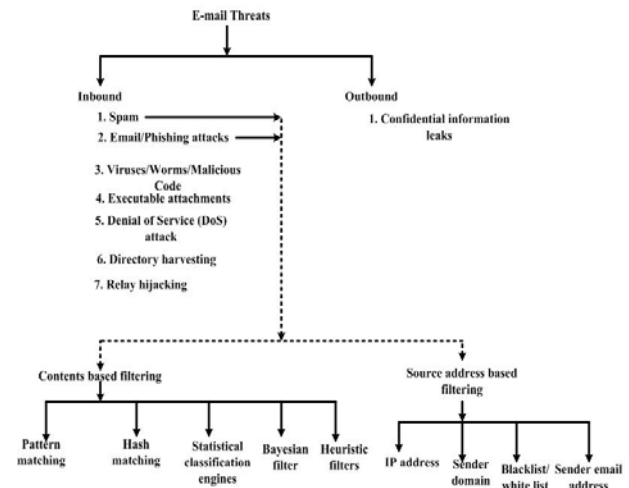


Fig 1. Classification of Email Threats

C. SOURCE ADDRESS BASED FILTERING

A variety of techniques exist to trace the source of the E-Mail such as Blacklist/white list IP addresses and E-mail addresses. By tracing the source of the E-mail w.r.to their sending domain and authorized senders. Some techniques involves identification of Spoofed E-Mails [2] based on various techniques such as SPF (Sender Policy Framework), Framework), Sender ID, Domain Keys Identified Mail (DKIM)

Blacklists. A blacklist (BL) is a list of N unique malicious source IP addresses that send malicious traffic towards the victim. Identifying which sources are malicious and those IP addresses should be blocked to avoid the spams to enter to the network and to save the network bandwidth and to improve the performance of the network

III. PROPOSED ALGORITHM

Generally, an email consists of a header, and the body. The header includes the electronic addresses of the sender and the recipient(s) and the subject of the email. The body contains all the information that the email is composed for in html or text format. The following are preprocessing steps.

A. Preprocessing Procedure:

- 1) Email sort: emails are sorted by time assuming that the vocabulary of each e-mail is similar.
- 2) Tokenization: The words in the e-mails are separated from each other, and each word is considered as a token.
- 3) Stop word removal: Stop words such as "to", "a", and are deleted.
- 4) Html removal: All the html tags are cleared.
- 5) Attachment removal: All the attachments are removed and instead we write <attachment>.
- 6) Lemmatization: All words are returned to their root. For example the word "receiving" is changed to "receive".
- 7) Representation: The words are changed to the usable forms for algorithms. In other words, text classification is performed.

- 8) Feature selection: Features of all emails are extracted and saved in feature vector. By feature selection, the measure of efficiency is increased. Hence, feature selection has important role on reducing the dimension of the vectors and there are any algorithms available for generating the proper subset

True positives (TP), true negatives (TN), false positives (FP), and false negatives (FN), are the four possible outcomes when an email is associated by the system. A false positive is when the email is incorrectly identified as spam, when it is in fact non-spam. A false negative is when the email is incorrectly identified as non-spam when it is in fact spam. True positives and true negatives are correct detections.

Table no:1 Actual association Vs Predicted Association

	SPAM	NON-SPAM
SPAM	TP	FN
NON –SPAM	FP	TN

The Preprocessing step extracts the data which is required to acquire the knowledge. A database is maintained with the keywords which may be usually present in the spam mails and with the help of machine learning algorithms, the database can be dynamically updated for the efficient results. Three levels such as basic level, warning level and alert level could be provided to analyze the data so the database could be properly updated

In case of Image spams, the text should be extracted from the Image for further processing. In order to extract text from images, it is to be provided to high quality OCR software. The software then cleans the image of scratches, specks and other noise and aligns it into a portrait position. Finally, it uses a proprietary recognition engine in order to perform the extraction, and sends the output into the text editor and these texts could be processed in the same fashion that of the text spams. The significance of this anti spamming techniques is to reduce the cost for spam management, save memory space, increase employee productivity and to be as eco friendly

Dynamic Drift Detection algorithm could be used to update the database which is used to detect the spams . This algorithm stores training examples in short-term memory. The memory slightly improves the predictive accuracy immediately after the rebuild of the online classifier. First W is defined as the length of window size. Data are classified by the base

learner algorithm. Results feed to the proposed algorithm [19].

Bloom filters may be employed to detect the spamming bots. We use a Bloom filter to maintain the REAs from each individual internal host. A Bloom filter consists of an m -bit array to store n objects, which are the REAs of the outgoing mail messages in this work. The bits in the array are all initialized to 0. Each REA A_i of an outgoing message is stored into the Bloom filter for the host sending the message by setting the bits at the positions $h_1(A_i), h_2(A_i), \dots, h_k(A_i)$ to 1, where $h_1, h_2, \dots, h_k$ are k independent hash functions. We also check whether the same REA has been in the Bloom filter before storing A_i . If one of the bits at the positions $h_1(A_i), h_2(A_i), \dots, h_k(A_i)$ is equal to 0, A_i must be unique in the Bloom filter. Otherwise, A_i may have been in the Bloom filter because some of the bits may be set by the hash functions of the other REAs [20].

As per the past evaluation, the comparison of classification of case based and content based is carried out and the Case-Based approach outperforms Naïve Bayes probably because of the different subtypes of spam. Naïve Bayes is trying to learn a unified spam *concept* whereas the Case-Based approach will classify an email as spam if it looks like *any* spam in the training data.

The comparison focuses on the following measures.

1. Noise: feature selection with low degree of changes during long period of time.
2. Sudden changes: feature selection with high degree of changes during short period of time.
3. Kappa statistics: the consistency between predicted and the true value.
4. Recall: The fraction of all spam messages classified by the filter to be spam.
5. Precision: The fraction of messages classified by the filter as spam that actually are spam.
6. F-measure: The value of F measure can show how accurate the algorithm has been.

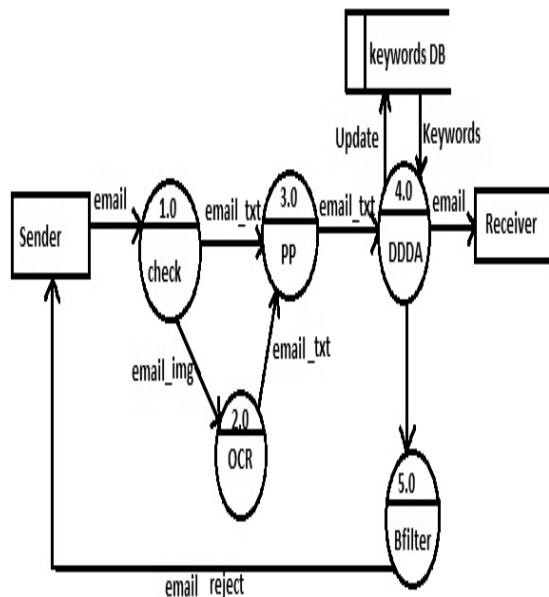


Fig 2. DFD of the Proposed Algorithm

IV. FUTURE EXTENSION

This proposed algorithm could be planned to use for mobile services and also in the cloud environment . In this internet world, cloud environment has spreaded everywhere and the various services provided by cloud . spams content may be available in various other languages . so the algorithm can be explored for regional languages also other than English. Social Networking sites are the major platform to spread the advertisements of user's choice. Therefore this concept can be effectively implemented to filter and increase the productivity by reducing the operational cost which is incurred for spam filters

V. CONCLUSION

In this paper, spam filtering is able to adapt to the dynamic nature of spam emails and accurately handle the spammer's tricks by identifying informative patterns, which are automatically extracted from both text and images content of spam emails. The majority of research in the domain of email spam filtering has focused on the automatic extraction and analysis of the text contents but in this method , images are also considered . When these tricks are used in combination, traditional spam filters are not sufficient to detect and classify it. By considering patterns from the text and images simultaneously, the spam filter will have better performance in detecting and classifying the spam emails. The spam mails will be evaluated and presented for the experimental result analysis.

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CONTEXT BASED LOSSLESS IMAGE COMPRESSION BY IDENTIFYING STRUCTURAL AND NON-STRUCTURAL COMPONENTS

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ABSTRACT

Images has very significant role in digital media. However, generally digital imaging generates large amounts of data it need to be compressed, without loss of relevant information or simply lossless compression. This paper presents a lossless image compression technique in spatial domain. The proposed algorithm develop an efficient image compression scheme based on super-spatial prediction and context adaptive lossless image codec by identifying structural and non-structural components. This so-called super-spatial prediction breaks this neighborhood constraint, attempting to find an optimal prediction of structural components within the whole image domain. Our extensive experimental results demonstrate that the proposed scheme is very competitive and even outperforms the state-of-the-art image compression methods.

Keywords: *Lossless image compression, Context based lossless image coding, super-spatial structure prediction, structure components, nonstructural components*

I. INTRODUCTION

To explore source correlation is the most important part in efficient image compression. We can find a compact representation of image data through source correlation. We can often separate a natural image into two types of image regions structure and nonstructure regions. Smooth image areas are called nonstructure regions. They can be efficiently represented with conventional spatial transforms, such as KLT (Karhunen Loeve transform), DCT (Discrete Cosine Transform), and DWT (Discrete Wavelet Transform). Edges, contours, and texture regions are called structure regions. They cannot be efficiently represented by these linear spatial transforms. They consist of high-frequency structure components and curvilinear features in images. They are always hard to compress and consume a majority of the total encoding bit rate. At various locations and scales these structure components may repeat themselves. So, to exploit this type of image correlation development of an efficient image prediction scheme is needed.

Researchers have recently developed different methods and algorithms to efficiently explore image correlation within these structural components and incorporate them into existing image/video compression systems. Sequential data compression [1], [2] and vector quantization for image compression predicts image and improves coding

sequential data compression, a substring of text is represented by a displacement/length reference to a substring previously seen in the text. Storer extended the sequential data compression to lossless image compression. But this algorithm is not competitive with the state-of-the-art such as context-based adaptive lossless image coding (CALIC) [3], [4] in terms of coding efficiency.

During vector quantization (VQ) [5] for lossless image compression, the input image is processed as vectors of image pixels. The encoder takes in a vector and finds the best match from its stored codebook. The address of the best match, the residual between the original vector and its best match are then transmitted to the decoder. The decoder uses the address to access an identical codebook, and obtains the reconstructed vector. Recently, researchers have extended the VQ method to visual pattern image coding (VPIC) [6] and visual pattern vector quantization (VPVQ) [7]. The encoding performance of VQ-based methods largely depends on the codebook design. But, these methods still suffer from lower coding efficiency, when compared with the state-of-the-art image coding schemes.

In the intra prediction scheme proposed by Nokia, there are ten possible prediction methods: DC prediction, directional extrapolations, and block matching. DC and directional prediction methods are very similar with those of H.264 intra prediction [8]. The block matching tries to find the best match of the current block by searching within a certain range of its neighboring blocks. This neighborhood constraint will limit the image compression efficiency since image structure components may repeat themselves at various locations. In fractal image compression [9], the self-similarity between different parts of an image is used for image compression based on contractive mapping fixed point theorem. However, the fractal image compression focuses on contractive transform design, which makes it usually not suitable for lossless image compression. Moreover, it is extremely computationally expensive due to the search of optimum transformations. Even with high complexity, most fractal based schemes are not competitive with the current state of the art [1].

Local Structure Learning and Prediction [10] is an efficient lossless image compression algorithm based on structure prediction. It determine the best set of basis functions from previous reconstructed image data in the neighborhood and use this basis function set to efficiently represent and predict the image data

to be encoded. Using singular value decomposition, it finds a small number of basis vectors whose linear combinations are able to closely approximate local image patches. By extrapolating these linear combination coefficients, it efficiently predicts neighboring pixels of the local image patch. But this method is computationally complex due to expensive structure prediction. Also the classification threshold is manually chosen and may not be optimal in terms of the overall coding efficiency.

Our main idea is to classify the image components as structure and nonstructure components and then structure components are encoded with super-spatial prediction whereas nonstructure components can be efficiently encoded with conventional image compression methods, such as CALIC. Super-spatial structure prediction breaks the neighborhood constraint and then attempts to find an optimal prediction of structure components within the previously encoded image regions [10]. It borrows the idea of motion prediction from video coding, which predicts a block in the current frame using its previously encoded frames. As the best matches of structure components are simply searched within encoded image regions, no codebook is required in this compression scheme.

II. PROPOSED ALGORITHM

We observe that a natural image often consist of significant amount of structural components which evolve slowly from regions to regions. These structure components may repeat themselves at various locations and scales. It is, therefore, important to exploit this type of data similarity and redundancy for efficient image coding.

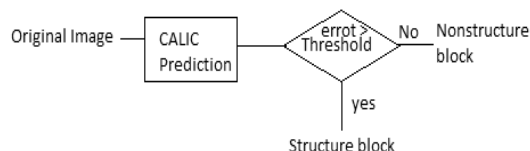


Figure 1: classification of structure and non-structure blocks

Fig. 1 shows the overview of the proposed image compression scheme based on super-spatial prediction of structural components. First, we classify the input image as structural components and nonstructural components. We use block-based classification. The super-spatial structure prediction and conventional lossless image compression systems encode the structural components and nonstructural components respectively.



Figure 2: Labeling of neighbouring pixels in GAP.

After CALIC prediction, we compute the prediction error. If the prediction error is larger than a threshold, this block is considered as a structure block, otherwise, a nonstructure block. The threshold is chosen based on the percentage of structure blocks that we want to encode with super-spatial prediction. CALIC Prediction in Fig. 1 is the Gradient-Adjusted Prediction (GAP) [4]. In GAP, the gradients of the intensity functions of the current pixel, which is shown as “?” in Fig. 2, are first estimated with its neighbouring pixels. These neighbouring pixels are decoded as north, west, northeast, northwest, north-north, west-west, and north-northeast then made according to its estimated gradients following a procedure given in [4].

III. SUPER-SPATIAL STRUCTURE PREDICTION

In this section, we explain the basic idea of super-spatial prediction and how it can be used for efficient image compression. The proposed super-spatial prediction borrows the idea of motion prediction from video coding, as illustrated in Fig. 3. In motion prediction, we search an area in the reference frame to find the best match of the current block, based on some distortion metric. The chosen reference block becomes the predictor of the current block. The prediction residual and the motion vector are then encoded and sent to the decoder. In super-spatial prediction, we search within the previously encoded image region to find the prediction of an image block. The reference block that results in the minimum block difference is selected as the optimal prediction. For simplicity, we use the sum of absolute difference (SAD) to measure the block difference.

As in video coding, we need to encode the position information of the best matching reference block. To this end, we simply encode the horizontal and vertical offsets, between the coordinates of the current block and the reference block using context-adaptive arithmetic encoder. The important parameter in the super-spatial prediction is size of the prediction unit.

When the unit size is small, the amount of prediction and coding overhead will become very large. However, if we use a larger prediction unit, the overall prediction efficiency will decrease. In this work, we try to find a good trade-off between these

two and propose to perform spatial image prediction on block basis.

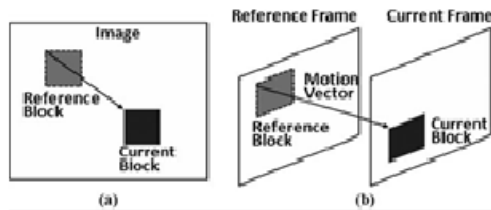


Figure 3(a): Super spatial prediction. (b) Motion prediction in video coding

A. Image Block Classification

Structure prediction works very efficiently for image regions with a significant amount of structure components. However, its efficiency will degrade in nonstructure or smooth image regions because it needs to encode and transmit overhead information about the prediction. In addition, its computational complexity is relatively high. Therefore, we propose a content separation scheme to separate the image data into two regions: structure and nonstructure regions. A block-based image classification scheme is used here. The image is partitioned into blocks of 4x4. We then classify these blocks into two categories: structure and nonstructure blocks. Structure blocks are encoded with super-spatial prediction. Nonstructure blocks are encoded with conventional lossless image compression methods, such as CALIC.

B. Estimation of Threshold

The threshold is required while comparing the current block with the previous encoded region. This threshold value should be so decided that it will give best compression performance. The selection of threshold is such that it gives a good trade-off between overall coding efficiency and computational complexity. Note that a binary classification map with “1” for structure blocks and “0” for nonstructure blocks needs to be encoded with arithmetic coding.

C. Structure Block Prediction

As the proposed approach of prediction is motivated from motion prediction in video coding, we used SAD (Sum of absolute difference) to compare current block with previously encoded structure blocks. Most structure blocks can find its best match in the structure regions which will reduce computational complexity.

According to block classification map, first block always taken as nonstructure block. Super spatial structure prediction approach starts from second block where it compares the current block with previous blocks. As our approach is designed to compare structure block with only previously encoded structure blocks, even if it finds nonstructure block it ignores and only performs the prediction with structure block and calculates

SAD between current structure block and previously encoded all reference structure blocks.

D. Nonstructure block prediction using CALIC

The Context Adaptive Lossless Image Codec (CALIC) [3], [4] scheme uses both context and prediction of the pixel values. CALIC employs a two-step (prediction/residual) approach. In the prediction step, CALIC employs a simple new gradient based non-linear prediction scheme called GAP which adapts itself to the gradients of horizontal and vertical edges and adjusts prediction coefficients based on estimates of local gradients. By modeling of prediction errors and feedback of the expected error conditioned on properly chosen modeling contexts, predictions made context-sensitive and adaptive. The modeling context is a combination of quantized local gradient and texture pattern, two features that are indicative of the error behaviour. The net effect is a non-linear, context-based, adaptive prediction scheme that can correct itself by learning from its own past mistakes under different contexts.

CALIC encodes images in raster scan order with a single pass through the image. The coding process uses prediction templates that involve only the previous two scan lines of coded pixels. Consequently, the encoding algorithms require a simple double buffer that holds two rows of pixels that immediately precede the current pixel, hence facilitating sequential build-up of the image.

The continuous-tone mode basically has four major components.

- Prediction
- Context selection and quantization
- Context modeling of prediction errors
- Entropy coding of prediction errors.

CALIC is a spatial prediction based scheme, in which GAP is used for adaptive image prediction [3].

Here GAP prediction is performed on the original image and the prediction error for each block is computed. If the prediction error is larger than a given threshold, then it is considered as a structure block. Otherwise, it is classified as a non-structure block.

IV. RESIDUE ENCODING

The implemented image compression scheme is purely lossless; the residues need to be transmitted along with the image. The residues are encountered in two places: - The CALIC Algorithm and the SAD residues. Arithmetic coding [12], [13] schemes are to be used to transmit the residues to further reduce the size of the overhead data per block.

Arithmetic coding is especially useful when dealing with sources with small alphabets, such as binary sources, as well as alphabets with highly skewed probabilities. In arithmetic coding a unique identifier or tag is generated for the sequence to be encoded. This tag corresponds to a binary fraction, which becomes the binary code for the sequence.

To distinguish a sequence of symbols from another sequence, it has to be tagged with a unique identifier. One possible set of tags are the numbers in the unit interval (0, 1). Because the number of numbers in the unit interval is infinite, it should be possible to assign a unique tag to each distinct sequence of symbols. In order to do this we need a function that will map sequences of symbols into the unit interval. A cumulative distribution function maps random variables and sequences of random variables into the unit interval which is used in developing the arithmetic code.

V. IMPLEMENTATION OF PROPOSED APPROACH

A. Encoder

The original gray scale image of size 512 x 512 is partitioned into 4 x 4 blocks. By applying GAP prediction on each block, the image is classified into structure and nonstructure blocks using threshold and maintained block classification map. Sum of absolute difference (SAD) of structure block is calculated to find repetitive structure blocks by using SAD threshold and SAD residual factor is maintained. Nonstructure blocks are taken as it is. SAD satisfied structure blocks and nonstructure blocks are stored in lossy data. Then CALIC is applied on every single pixel of lossy data. Coding process is done with the help of arithmetic encoding. SAD residual and arithmetic encoder output forms compressed data.

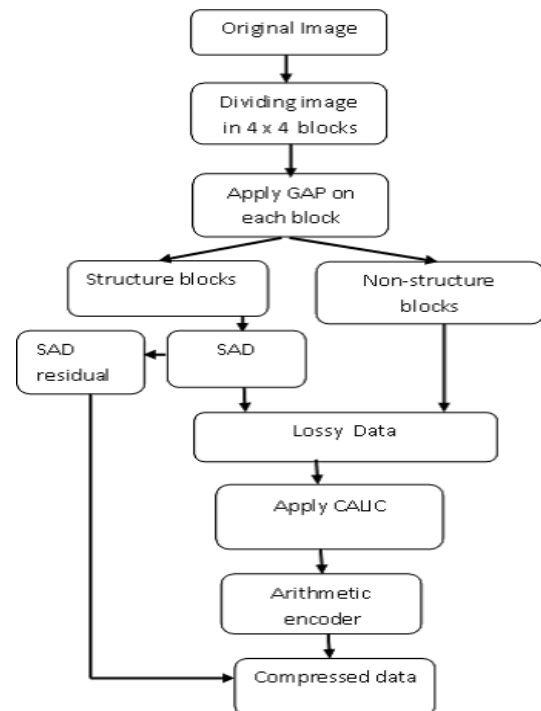


Figure 4: Proposed Encoder

B. Decoder

The compressed data received from encoder is separated as SAD residual and arithmetic encoded output. Arithmetic encoded output is given to decoder which gives lossy data. By using block classification map, structure blocks are repositioned using SAD residual and original lossless image is reconstructed.

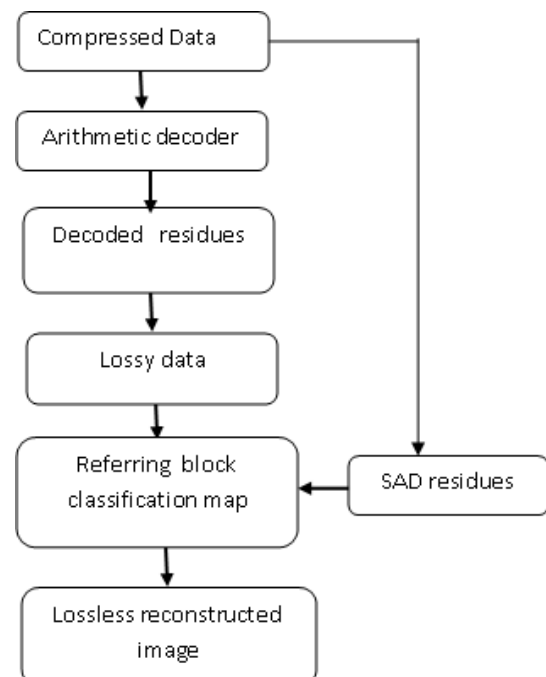


Figure 5: Proposed Decoder

V. SIMULATION RESULTS

All the simulation results were done on standard grayscale images like Lena, Barbara, and Baboon having the size of 512x512pixels.

In this section, we implemented the proposed algorithm and compared its performance with CALIC and LSIP (Local Structure Learning and Prediction) [11]. We can see that the proposed scheme outperforms CALIC and Local Structure Learning and Prediction. It saves the bit rate by up to 13%, especially for images with significant high-frequency components. In the following experiments, we used a block size of 4 x 4.

Table I: Coding bit rate comparison with CALIC, and LSIP (bit rate in bpp).

Image (256 KB) (512 X 512)	CALIC	LSIP	Proposed algorithm
Lena	4.097	4.084	3.4375
Barbara	4.586	4.522	3.5
Baboon	5.898	5.722	4.625

From the graph as shown in Fig. 6 shows performance analysis of proposed approach with CALIC and LSIP using bit rate parameter. Note that the threshold value in the proposed encoder is manually chosen and set 0.5 for all images.

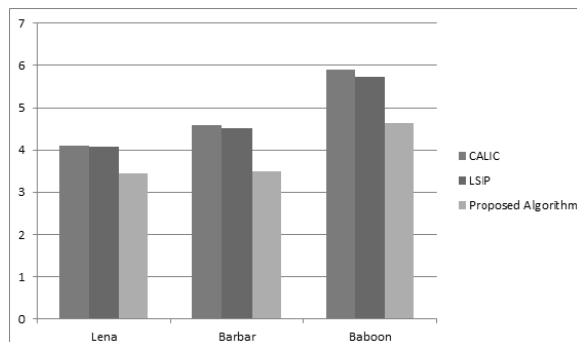


Figure 6: Comparison of Coding bit rate

VII. CONCLUSION

In this attempt a simple yet efficient lossless image encoder based on super spatial structure prediction has been successfully designed and tested. It is induced by motion prediction in video coding, attempting to find an optimal prediction of a structure components within previously encoded image regions. The image was classified into various regions by taking CALIC as the base code and they were encoded accordingly. Our extensive experimental results demonstrate that the proposed scheme is very efficient in lossless image compression, especially for images with significant structure components. As our future work, we will

apply our super-spatial prediction to lossy image compression with some necessary modifications.

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AUDIO RETRIEVAL BASED ON CONTENT

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ABSTRACT

Search of audio file is according to the name with which those files are saved i.e. caption of file. But suppose we require the audio file according to its content. Many times the files are saved with general names like 'audio001', 'audio002'. These captions are irrelevant to the content of that particular audio. In such cases we don't obtain the appropriate file in the results of search engine. If a person need information on 'Mahatma Gandhi' but the audio file is saved with the name 'History'. So it becomes essential to search the audios based on the content and not on its title. If the search is made based on the content of the audio then the results will be more efficient. All the audios of the system will be first retrieved at the initiation of the system. Then the pre-processing will take place. In pre-processing step, all the retrieved audios will be processed by a speech recognition system. These audios will be converted to text using speech recognition algorithms. Thus a text file is obtained containing the content of the text file. The text thus obtained will be parsed and all the non-keywords i.e. articles, prepositions, conjunctions, interjections, etc. will be eliminated. Thus a file containing only the keywords is obtained. Later when user wants to search an audio, only the keywords will be matched with the input of search engine. Whichever files have the input word present in the list, that particular audio file will be displayed as the result of search.

Keywords : speech recognition; keyword spotting.

INTRODUCTION

For every student aspiring education needs to find relevant information in minimum possible time. If anybody wants some information on a particular topic, he will try to find text, audio or video file about the same. If the desired result of search is in text format then it is quite simple as the search engines scans through the entire text file and display the information. So whatever is the input of the search, one will get a file containing information most closely related to it. But this is not the case with audio or video files.

The search of audio file is according to the name with which the file is saved i.e. caption or title of the file. Many times the files are saved with general names like 'audio001', 'audio002'. These captions are irrelevant to the content of that particular audio. And due to which such files don't get displayed in the result of search engine even if it has the relevant data.

Instead, if the search is made based on the content of the audio then the results will be more efficient. The audio will typically be processed by a speech recognition system in order to identify word that is likely to occur in the spoken content. This content will be converted into text. The text thus obtained will be parsed and only the keywords of that particular audio will be retained. While the words like prepositions, articles, conjunctions, interjections will be eliminated from the text file. Also the repetitive keywords will be eliminated thus reducing the size of the text file. Later only these obtained keywords will be matched with the input of search engine provided by user and accordingly the results will be displayed. Whichever audio file has maximum number of keywords will be the topmost result of search followed by others.

Therefore, this paper will review a way to develop an application which will serve the user to access audio lecture which are retrieved on the basis of keyword which were found from the text document obtained of the original audio file.

I. SURVEY

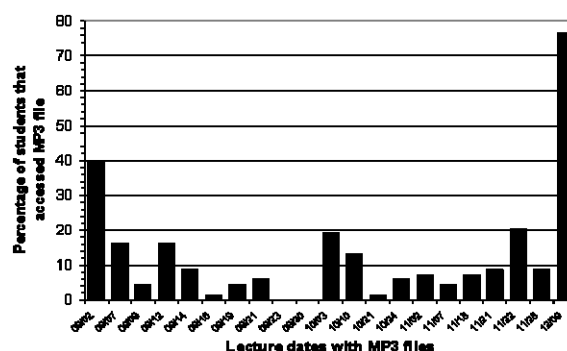


Fig.1 Survey of students watching audio lectures

Above bar chart illustrates the survey conducted in the month of September to December regarding the percentage of students listening to audio lectures. As seen above, approximately 10% of students view video lectures and this number differs every month. One of the reasons for so less response to audio lectures is students doesn't find the appropriate audio file. If ARC application is used, then the number of students accessing audio lectures will increase as they will find appropriate file with less amount of effort.

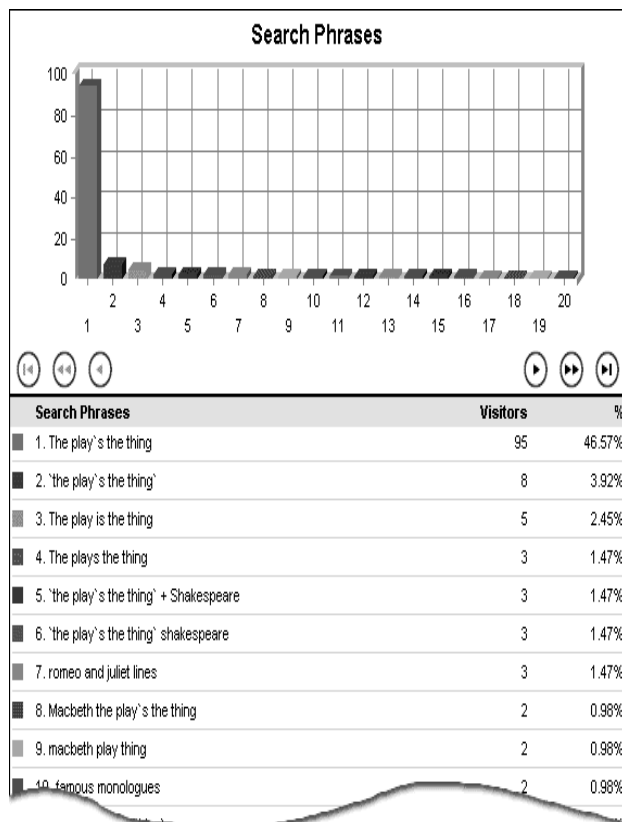


Fig.2 Various inputs given by user for same audio file

People search a particular audio file with various names. As the results show in fig., multiple phrases were used to search same file. Now, as per the traditional technique user will get the audio file only if the phrase and the title of file match. But by using ARC application, all these users will find their desired file as the file is searched on the basis of content present in it and not just the title of file.

II. FLOW OF PROJECT

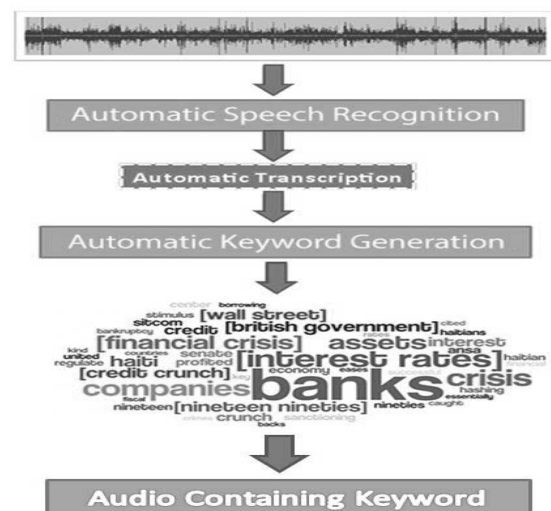


Fig.3 Flow of project

Audio files present on the system are converted into text using automatic speech recognition. Microsoft Visual Studio provides a speech engine using which speech to text conversion can be done. Then keywords are extracted from the text file obtained. Now the file containing only keywords will be used to compare with the user input. When user fires a query, the path of audio file having the keyword will be displayed. This audio can be clicked and played in VLC player directly from the ARC interface itself.

III. PREPROCESSING

Before generating a query based on user input, System must know what kind of files it must use for required specific operation and at the same time where they are placed on system.

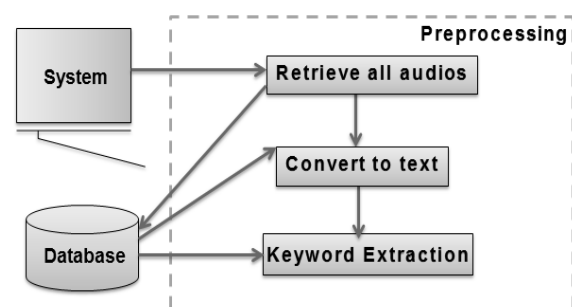


Fig.4 Methodology

A. Retrieve all Audios

To retrieve all audios system must parse all drives and folders and sub-folders. Search all *.wav files or any audio files like .mp3. While searching through all drives recursion must be used to traverse through all files and sub-files and sub folders. Preorder traversing technique is used for traversing through all drives which is optimum compared to other two.

B. Store path of an audio in Database

Maintain path of an audio in database so that it will be easy to search and play particular audio by only issuing a simple database query using keywords found in an audio.

C. Speech Recognition

While spotting keywords from an audio file, analog signal must be converted into text as text matching is efficient and accurate than audio matching. So every audio file retrieved from system is converted into text. Speech recognition can done using many methods available, every methods has its own advantages and disadvantages.

Accuracy of speech recognition varies based on vocabulary that is used by speech recognition engine, Vocabulary will be hard to recognize because of ambiguity created due to pronunciation and accent. [1] Vocabulary sizes of 200, 5000 or 100000 may have error rates of 3%, 7% or 45% respectively. Environmental disturbances like noises and acoustical disturbances also speed and spontaneity of speaker creates huge problem of recognizing the exact word that is spoken to be accurate.

Even speech input in a totally quiet environment using a high-quality noise-cancelling headset only gets you 90-95 percent recognition accuracy.

D. Keyword Spotting

Keyword spotting can be done by eliminating the non-keywords from the text file of a particular audio. Initially the audio file is converted into a text file of type string. Words from this string will be separated on the basis of delimiter i.e. space or hyphen. Thus we get a file containing words spoken in the audio file. Then another file of non-keywords will be matched with this file and if the words don't match, only those words will be selected as keywords. At the end, if the keywords are repeated multiple times those will also be eliminated. Thus a file containing only keywords is obtained.

The input file is given in the following image. The output containing only keywords is obtained using above logic. As seen in Fig.6, all the non-keywords are eliminated and also the repetitive words are eliminated. Thus the words to be parsed in later phases of processing will tremendously reduce thereby increasing the efficiency of the application.

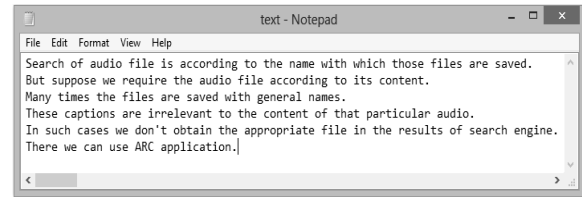


Fig.5 Input file

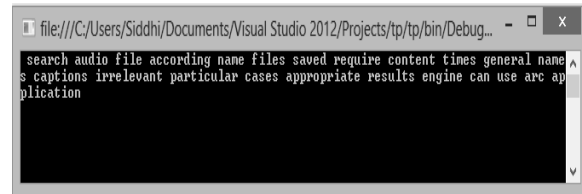


Fig.6 Output file

E. Generate Complete database with path and keywords

After generating keywords for all audios, path of audio and corresponding keywords must be stored as seen in fig.7. This will be used to query the audio selection as per the request.

audio_id	audio_name	path	keywords	size
1	complex	C:\Program Files\Java\jdk1.6.0_29\bin\javaw.exe 1 2...	C:\Users\Aditya\Documents\Visual Studio 2012\...	16
2	signature1	C:\Program Files\Java\jdk1.6.0_29\bin\javaw.exe 1 2...	C:\Users\Aditya\Documents\Visual Studio 2012\...	0
3	awoooga	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	5
4	blower	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	1
5	boosexplosion	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	2
6	bowling	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	2
7	bowlingimpact	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	4
8	bowlingimpact2	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	1
9	bungee_scream	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	0
10	bungee_scream2	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	3
11	cherrybomb	C:\ProgramData\PopCap Games\Plants vs Zombies\cach...	C:\Users\Aditya\Documents\Visual Studio 2012\...	1

Fig.7 Database entries

IV. USER INTERFACE

After the pre-processing is done, the main user interface appears on screen. User has to input the searching phrase in the text box provided. After entering the text, user must press "Search" button. If the text box is left empty and "Search" button is pressed then system displays a message saying "please enter something". If user wants to input the phrase in form of speech than he/she can click on audio symbol beside the text box. This speech gets converted to text and appears in the text box. Or user can also manually type the searching phrase. After user inputs some text and "Search" button is pressed, the query is fired on the database. All the audio files containing that particular phrase are retrieved from the database. The audio files are then listed in the list box below as shown in the fig.8. These files contain the text as input by the user irrespective of the title of that audio file. This list of audio files has the path of files linked to it so user can simply click on the audio file listed to view the respective audio.



Fig.8 Audio file obtained on basis of content

As soon as user selects the file and clicks on “play” button, the VLC player opens which plays that particular audio file as seen in fig 9. If the user wants to open the ‘containing folder’ of the audio file than he can click on “Folder” button which open the folder containing that particular audio file. And if the user is interested in viewing the text document then he can click on “Text” button. There is also a “wave” button which facilitates the user to view the wave form of the selected audio as seen in fig.10.

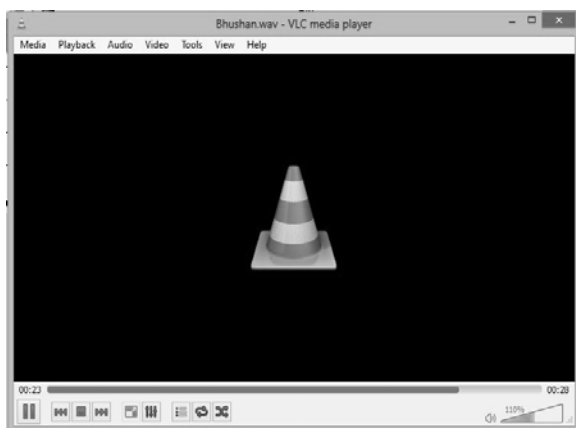


Fig.9 Audio file obtained on basis of content

There is a separate bar on top which has “Browser” option provided. It allows the user to search files online if they are not present on the system which provides connection to Google homepage. “Help” option contains the user manual of the application for a newbie to understanding the interface and use it with minimal efforts. This button navigates to Firefox browser which has detail description of every component on GUI.

Below to the rightmost corner user can see the “status bar” which shows the current progress of any operation taking place. If the progress is completed successfully then it displays “done” or if the user has selected wrong option then it displays “invalid option”.

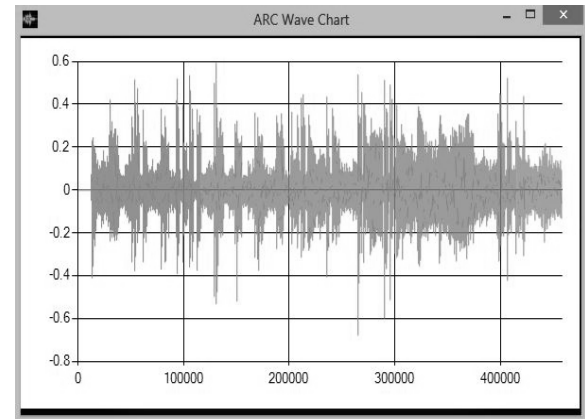


Fig.10 Waveform of audio

V. METHODOLOGY

Interface of the application is Windows form which takes in the input in the form of text. Option of audio input is also available if required. This audio input will also be eventually converted to text. Based on user input, query will be generated i.e. the desired audio which is to be searched built using C#. Search button will create an event. This event which will be handled by database query which will try to map input keyword with lists of keywords present in a particular audio which are stored as attribute in database. According to the input, the search will be made in the database.

If the input is only a single word then that particular word will be searched in the list of keywords. Further whichever file has that word at greater frequency will be given as the result of the search.

The output will contain all the audio files which have the word entered by user. Output form displays the list of audio files of grid of audio files along with the size of each audio file. It is the result of query fired by search event at input end containing the keyword in which user is interested in. Thus all the audio files displayed in data grid contain the information of user's interest i.e. it will enhance the performance of system as user can get more information by list of audio which are retrieved using ARC application.

VI. ANALYSIS

F. Performance analysis

Performance evaluation was conducted mainly on two major behaviors of ARC application. They are the search performance in database and the retrieval accuracy. They are discussed as follows:

- Search performance in database
Database is mainly used to store the path of all the audio files and thus retrieve the entire file in very few timestamp. The overall performance of searching all the available audio files from the drives is good enough as it takes only few seconds time.
- Retrieval accuracy
Once the path to all the audio files is obtained then the next phase is of part of speech recognition and keyword spotting. Here audio file is converted to text file and keywords are retrieved. This retrieval of keywords take few seconds of time.

G. Function Point analysis

Function Point Analysis (FPA) is an ISO recognized method to measure the functional size of an information system. The process of performing Function Point Analysis is called a 'Function Point Count' and it involves the identification, classification and weighting of each of these transactions and data components. The weightings are combined to give the functional size as an Unadjusted Function Point Count. An additional step, involves assessing the technical and quality features embedded in the software product and adjusting the functional size accordingly. The result is referred to as the Adjusted Function Point Count.

- EI - external inputs, which are the components responsible for introducing changes in system's internal data.
- EO - external outputs, which are the ways system's internal data can be presented, but beware - there are a few similarities with EQ components, though.
- EQ - external inquiries, which are the methods for reading system's data without modifying it.
- EIF - external interface files, which are responsible for exchanging data with other systems.
- ILF - internal logical files, which are files that are being used by the system itself.

Component:	Complexity:		
	Low	Average	High
EI	3	4	6
EO	4	5	7
EQ	3	5	6
EIF	5	7	10
ILF	7	10	15

Table 1: Function point estimation

Once all the 14 GSC's have been answered, they should be tabulated using the IFPUG Value Adjustment Equation (VAF)

$VAF = 0.65 + [(Ci) / 100]$ where:

C_i = degree of influence for each General System Characteristic

i is from 1 to 14 representing each GSC.

$\sum_{i=1}^{14} C_i$ = is summation of all 14 GSC's.

The final Function Point Count is obtained by multiplying the VAF times the Unadjusted Function Point (UAF).

$FP = UAF * VAF$

Estimated cost for ARC:

$VAF=62$

$UAF=0.87$

$FP = VAF*UAF = 50.84$

VII. CONCLUSION & FUTURE SCOPE

In this paper, we discussed the application which helps the user to retrieve all the audio files on basis of keywords which are present in text file obtained from the original audio file. Thus audio search is purely on the basis of content and not its title.

Future Scope:

- Efficiency can be increased when the processor speed and memory of computer will increase further.
- The speech recognition rate can be improved by including better dictionaries and appending libraries.
- This application can also be extended for audio files on web servers.
- To decrease the time consumption of spotting process specialised keyword sets can be used.

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12. <http://electronics.howstuffworks.com/gadgets/high-tech-gadgets/speech-recognition.htm>
13. <http://www.dotnetspider.com/convert/csharp-to-vb.aspx>
14. <http://social.msdn.microsoft.com/Forums/vstudio/en-US/ce864f19-25c1-4601-a1ff-6019c703ccdb/opening-a-folder-from-c>
15. <https://www.tomsplanner.com/?template=new>
<http://naudio.codeplex.com/documentation>

GESTURE BASED 3D MODELING

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ABSTRACT

Human hand gestures have been a mode of non-verbal interaction widely used. The vocabulary of hand gesture communication has many variations. It ranges from simple action of using our finger to point at and using hands to move objects around for more complex expressions for the feelings and communicating with others. Also the hand gestures play a prominent role in teaching, considering the explanations and exemplifications being highly dependent on hand gestures. Naturalistic and intuitiveness of the hand gesture has been an immense motivating aspect for the researchers in the field of Human Computer Interaction to put their efforts to research and develop the more promising means of interaction involving human and computers.

The limitations faced due to the lack of technology for 3D modelling can be overcome by using Gestures for performing various functions. This project designs a simple, natural system for gestural interaction between the user and computer for 3D Modelling purposes. The gesture recognition system uses image processing techniques for detection, segmentation, tracking and recognition of hand gestures for converting it to meaningful commands. In this way the interface will be with less number of buttons and toolbars thus providing more screen space. Basic gestures will be efficient enough for the system to understand the 3D model panning. This project will be using the standard webcam that is available on any laptop and desktop eliminating the need for any external specialized hardware.

Keywords-hand gestures, 3D modeling, gesture recognition

I. INTRODUCTION

Since the introduction of the most common input computer devices, not a lot have changed. This is probably because the existing devices are adequate. It is also now that computers have been so tightly integrated with everyday life, that new applications and hardware are constantly introduced. The means of communicating with computers at the moment are limited to keyboards, mouse, light-pen, track-ball, keypads, etc.

Vision based interfaces are feasible and at the present moment, the computer is able to “see”. Hence users are allowed for richer and user friendlier man-machine interaction. This can lead to new interfaces that will allow the deployment of new commands that are not possible with the current input devices. Plenty of time will be saved as well.

Recently, there has been a surge in interest in recognizing human hand gestures. Hand gesture recognition has various applications like computer games, machinery control and thorough mouse replacement. One of the most structured sets of gestures belongs to sign language. In sign language, each gesture has an assigned meaning.

Computer recognition of hand gestures may provide a more natural-computer interface, allowing people to point, or rotate a CAD model by rotating their hands.

Therefore, this paper will review a way to develop an application which will serve the user to develop 3D models without much hustle, just by the use of various hand gestures.

II. LITERATURE SURVEY

Face detection has attracted a great amount of interest and many methods relying on shape, texture, and/or temporal information. Texture-based approaches in particular have yielded the most universal result.

Most attempts to detect hands from video place restrictions on the environment. For example, skin color is surprisingly uniform, so colour-based hand detection is possible. This by itself is not reliable as hands have to be distinguished from other skin-coloured objects.

Motion flow information is another modality that can fill this gap, but for non-stationary cameras, this approach becomes quite complex. The number of classification methods for the purpose of view independent hand posture recognition. However, detection without the help of skin colour information and real-time performance were not considered.

Hand Gestures, along with methods for hand usage in human-computer interaction were presented as valid for human-computer interaction. A huge variety of recognition methods has been documented to reduce computation time, but this required a large training set.

By 1988, one of the first papers describing model-based tracking for gesture recognition was presented; the main problem with model-based tracking is that its computation algorithm weight does not allow for a real-time recognition.

By the end of nineties, the main research paths were defined, one used model-based recognition, while the other pursued appearance-based approaches.

In the early 2000s, some work focusing on tracking fingertips as a gesture recognition strategy. These techniques require two steps, fingertip detection and gesture recognition, hence slowing down the system. However, this strategy has proven successful. Systems where fingertips are not needed, the first step may be redundant.

Initial Gesture Recognition involved the following steps:

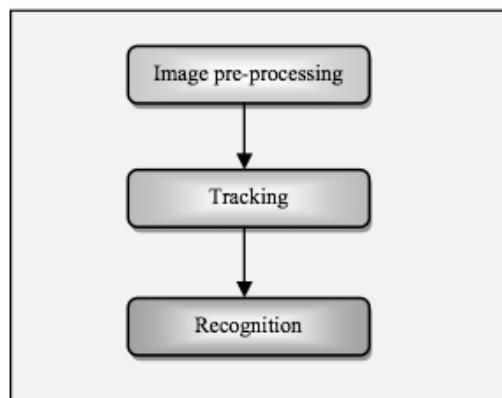


Fig.1-Initial System

III. PROPOSED SYSTEM

- The proposed system takes into consideration such as, illumination invariance, temporal and spatial changes.
- It takes input image using a standard webcam.
- The system then segregates the Human Hand from the rest of the image. The Hand Segmentation is the most important step, as the motion of the hand will be used for Gesture Recognition.
- After the movement of the hand in the 3D space is recorded, the Tracked movement is then compared with patterns stored in the database. The Gesture pattern which has the least deviation from the stored pattern is selected, and the respective function is performed.

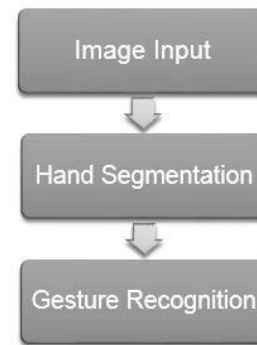


Fig.2-Proposed System

IV. METHODOLOGY

A. Hand Segmentation

The proposed System will be using the Random Forest Classifier to segment the hands region from the image. We adopt segmentation methods which assign labels to superpixels. To extract superpixels for every frame we use the Simple Linear Iterative Clustering (SLIC) algorithm, as it is memory efficient and highly accurate segmentation method. This allows a complexity reduction of the problem and also gives better spatial support for aggregating features that could belong to the same object. To discriminate between objects with a similar colour distribution of skin we include following gradient information: Gabor feature obtained with 27 letters (nine orientations and three different scales: 77, 1313, 1919) and a simple histogram of gradients with nine bins.

B. Hand Status Recognition

Given a sub region of the image space whose pixel are likely to be a segmented hand, we want now to recognize the hand configuration, picking from a finite set of possible gestures. Thus, we use the Exemplar SVM (ESVM). This method involves two steps: first, for each class an independent training of a finite and small set of positive examples (the "exemplars") versus a huge set of negative examples is performed. After the training stage each independent SVM classifier is tuned to detect its specific positive exemplar, thus a further step to aggregate classifiers of each class is necessary.

In the second stage, since the outputs of each classifier are not comparable, a calibration by putting a probability distribution to a holdout set of negative and positive samples is performed, as described in. The calibration can be interpreted as a simple scaling and shifting of the decision boundary, and does not affect the ordering of the score, allowing comparing the outputs of multiple independently trained Exemplar- SVMs. Thus, multiple Exemplar-SVMs can be combined to provide a model for each class.

V. ANALYSIS

C. Process Model

Often, a customer defines a set of general objectives for software, but fails to identify the detailed input, processing, or output requirements. In some cases, the developer may be unsure of the efficiency of an algorithm, the adaptability of an operating system, or the way in which human-machine interaction, should take. In such situations, a prototype model may offer the best approach.

It is more commonly used as a technique that can be implemented within the context of any one of the process model regardless of the manner in which it is applied. The prototype model assists the software engineer and the customer to better understand what is to be built when the requirements are fuzzy.

In spiral model, initially the requirement gathering is done. Developer and the customer define the overall objectives and identify the areas that need more requirement gathering. Then, a quick design is prepared which represents all the elements that will be visible to the user in input and output format. From the quick design a prototype is prepared. The customer evaluates the prototype and refines the requirement. When working prototype is built, the developer uses the existing program fragments to rebuild the system to a higher quality. A cycle is created and until the final product is made, the customer keeps on evaluating the system, refining it as per their needs.

D. Cost Analysis

Function Point Calculation:

The estimated FP is derived using the formula:

$$FP = COUNT_TOTAL * [0.65 + (0.01 + \sum Fi)]$$

where, $\sum Fi$ = Sum of all complexity adjustment values computed by estimating the weight factors.

Software Project estimation is a form of problem solving; i.e., developing a cost and effort estimate for a software project. Since LOC based estimation are programming languages dependent, they penalize well designed but shorter programs and their use in estimation models requires a level of detail that is difficult to achieve before the analysis and design is to be completed. Hence we are considering the FP based estimation that considers the functionality delivered by the application as a normalization value.

PARAMETERS	WEIGHT
Data Backup and Recovery	4
Data Communication	2
Distributed Processing	1
System Performance	5
Existing Operating Environment	4
Online Data Entry	2
Input Transactions over Multiple Screens	1
Master File Updated Online	2
Inputs, Outputs, Files or Enquiries are complex	3
Internal Processing Complex	5
Code Designed Reusable	4
Conversion and installation included in design	3
Multiple Installation	2
Application Designed to facilitate Change	4

$$\sum Fi = 42$$

$$\text{Complexity Adjustment Factor } [0.65 + (0.01 * \sum Fi)] = 1.07$$

Finally the estimation of FP is derived as:

$$FP = COUNT_TOTAL * [0.65 + (0.01 + \sum Fi)]$$

$$FP = 98 * 1.07$$

$$\square \square \square \quad FP = 104.86$$

VI. CONCLUSION AND FUTURE SCOPE

In this paper, we discussed the application which helps the user to design 3D models by the use of hand gestures. This would help amateur users to design 3D models without much hustle.

This project has many applications in future. It will work more efficiently when the processor speed and memory of computer will increase further. The hand gesture recognition rate can be improved by including better quality webcams and other video detecting devices. Also to decrease the time consumption of average user for building a 3D model.

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DC DEFIBRILLATOR WITH USER END VIRTUAL INTERFACE UEVI DEFIB

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ABSTRACT

Cardiac defibrillation, as accomplished nowadays by automatic, implantable devices (ICDs), constitutes the most important means of combating sudden cardiac death. While ICD therapy has proved to be efficient and reliable, defibrillation is a traumatic experience. Thus, research on defibrillation mechanisms, particularly aimed at lowering defibrillation voltage, remains an important topic. Advancing our understanding towards a full appreciation of the mechanisms by which a shock interacts with the heart is the most promising approach to achieve this goal. The aim of our project is to assess the current state-of-the-art in ventricular defibrillation modeling, focusing on both numerical modeling approaches and major insights that have been obtained using defibrillation models, primarily those of realistic ventricular geometry. The project showcases the contributions that modeling and simulation have made to our understanding of the defibrillation process. It thus provides an example of computational modeling of the heart (i.e., cardiac defibrillation) using LabVIEW to give a virtual instrumentation that has advanced the understanding of cardiac electrophysiological interaction at the organ level and has the potential to contribute to the betterment of the clinical practice of defibrillation.

Index Terms : Defibrillator, CPR, Arrhythmia, Virtual Instrument, LabVIEW, DAQ.

I. INTRODUCTION

Arrhythmic beating of the Heart results in cardiological disorders called as Arrhythmias. If not treated they might decrease the physiological performance as well as could be fatal if not treated within a stipulated time period. Arrhythmia results into fibrillation which are treated by devices using a high voltage, high energy delivering shock called as Defibrillators.

Defibrillation is the definitive treatment for the life-threatening cardiac arrhythmias, ventricular fibrillation and pulse-less ventricular tachycardia [1]. Defibrillation consists of delivering a therapeutic dose of electrical energy ranging from 60-360 Joules to the affected heart with a device called a defibrillator. This depolarizes a critical mass of the

heart muscle, terminates the arrhythmia, and allows normal sinus rhythm to be re-established by the body's natural pacemaker, in the sino atrial node of the heart.

The project aims at creating a user friendly interface using Virtual Instrumentation (VI) in LabVIEW for the critically operating D.C. Defibrillator Instrument. The Virtual Instrument receives the simulated patient ECG which is continuously monitored, and the fibrillation detection algorithm will decide whether to deliver the shock or wait for natural rhythm to occur. Feedback signal sent from the defibrillator will indicate the success of defibrillation hardware and will generate the appropriate test and shock reports.

Besides operating in completely automatic mode the instrument will be semi-automatic, so that the decision of VI can be overridden in case of faulty detection or if the physician needs to check for some other critical parameters. It induces a feedback from the instrument back to the virtual Instrument allowing the user to check the success rate of defibrillation. The hardware section can be controlled by making use of the virtual instrument controls. Integrating the advantages of auto and semi-automatic mode defibrillation eliminating the disadvantages of both at the same time allowing even common people to utilize it, reducing fatalities and failure rate and also by making the instrument more cost effective. The project revolves around controlling a device using a Virtual Instrument panel that will control the working as well as measure the parameters [5].

II. SYSTEM DESIGN

The idea of the project is to create an accurate scaled down prototype version of DC Defibrillators that would be operated by using virtual Instrument and to ensure that the hardware delivers accurate amount of energy by obtaining the feedback. The system design takes into consideration the workflow of how the device operates. With reference to Figure 6 the workflow starts with the ECG simulator that offers

various faulty rhythms. Fibrillation detection algorithm compares parameters between the reference ECG signal and the acquired abnormal ECG signal from the patient.

With the result of the fibrillation detection algorithm, the decision is taken as to whether the shock is to be delivered or the device operation is to be terminated. If there is a shock to be delivered, the user can select from the available modes viz Automatic or Semi-automatic and then proceed to deliver the shock as communicated by LabVIEW through the National Instruments Data Acquisition System (DAQ) USB 6008. The output is then compared to check if the magnitude of the shock actually delivered matches with the present value or not. In either case, the VI is programmed to display an appropriate message to the user.

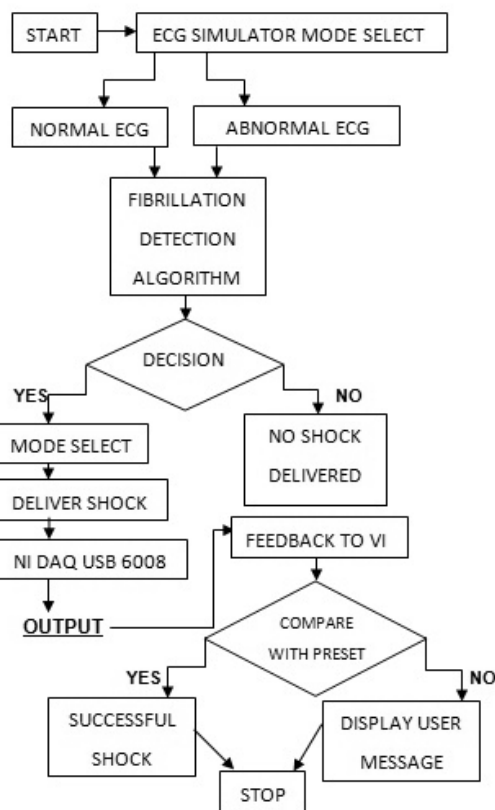


Figure 1. Flowchart of the device operation

III. PROTOTYPING VIRTUAL INSTRUMENT

The front panel of the instrument is designed using graphical programming in LabVIEW. The front panel consists of all the controls for DC Defibrillator and Patient Monitoring System. It is designed to incorporate all the functions that actual instrument possess.

The data flow is programmed such that user selects the simulated ECG waveform and checks for fibrillation using ECG wavelet decomposition. If the Patient monitoring system detects fibrillation, message is prompted to the user in case of semi-automatic mode or delivers the shock directly in case

of automatic mode [2]. There are controls and indicators to troubleshoot any malfunction which may occur during emergency operation of the machine the ECG simulation module is present to simulate and rectify the ECG waveform instead of obtaining from the patient.

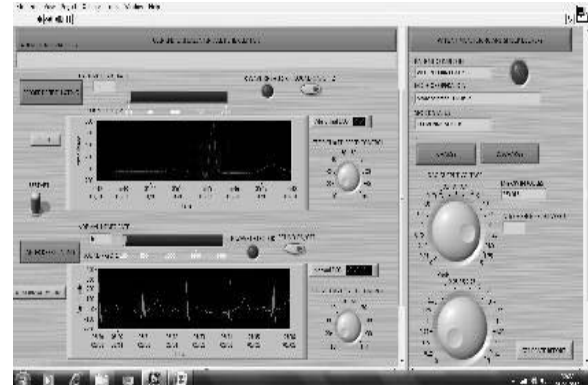


Fig. 2. Virtual Instrument Front Panel

IV. ARRHYTHMIA DETECTION

The most sensitive part lies in detecting the fibrillation appropriately and accurately and reducing the false alarms caused due to noise and other filter insensitivities. The arrhythmia detection code is written in MATLAB. By using wavelet decomposition of ECG waveform, the feature extraction algorithm is performed to process segment intervals and their corresponding amplitudes [11]. MIT-BIH Arrhythmia database is used for obtaining such waveforms and for processing. On decomposing an ECG waveform following outputs is generated. Waveforms obtained from the MIT-BIH Arrhythmia are characterized into shockable and non-shockable rhythms. Following are the included arrhythmic waveforms in the database of the Virtual Instrument. These standard templates can be used for further template matching for more accurate analysis of the fibrillation.

1. Atrial Flutter
2. Atrial Failure
3. Congestive cardiac failure
4. Atrial Fibrillation
5. Bradycardia
6. Complete Heart Failure
7. Ventricular Hypertrophy
8. Myocardial Ischemia
9. Heart Rigor.
10. Normal ECG Waveform.

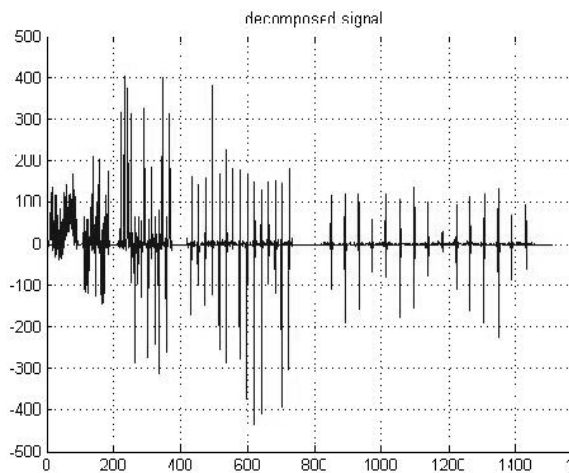


Figure 3. Decomposed Signal

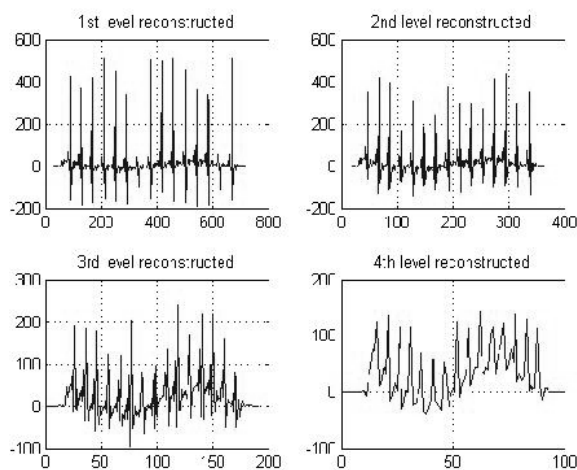


Figure 4. Four Level Reconstructions

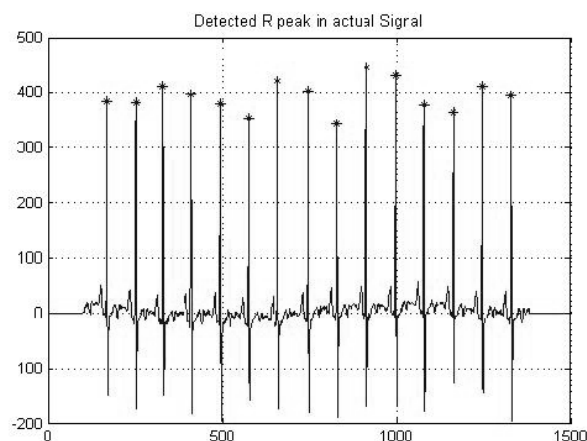


Figure 5. 'R' Peak Detected

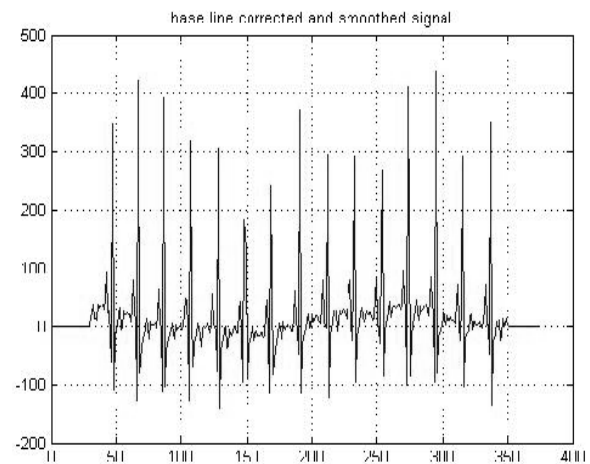


Figure 6. Base Line Corrected Signal

The LabVIEW block diagram incorporates this algorithm to detect and alter the fibrillation of the patient. Using this it is possible to characterize the heart rhythm into physiological abnormalities. Once a waveform is characterized by its features, Energy of shock in joules, number of shocks to be delivered and the time interval between these shocks are determined.

IV. HARDWARE DESIGN

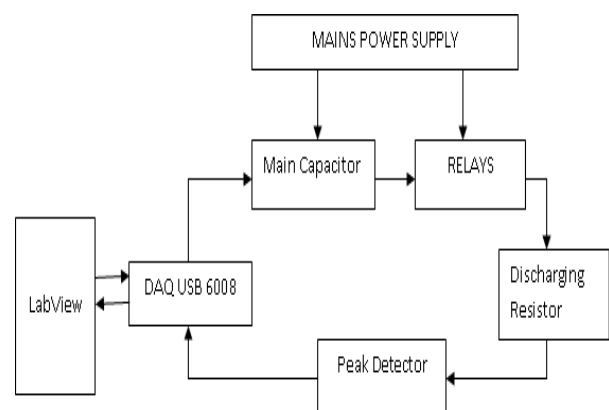


Figure 7. Hardware Design

The Hardware circuitry gets the input from the LabVIEW through DAQ USB 6008 which is an interface between the hardware and the software whether the shock is to be delivered or not. If so, a voltage is given to charge the capacitor to the magnitude of the shock required. The relays in the circuit are incorporated to function with respect to the mode selected (automatic or semi-automatic). Once the user selects the appropriate mode, the relays operate to allow the capacitor to discharge through the discharging resistor or the load which is connected to the peak detector which detects the peak of the shock and communicates with LabVIEW through DAQ USB 6008 to decide if the shock delivered matches the pre-set value and then displays

the appropriate message. The amount of shock to be delivered can vary with respect to the type of fibrillation that occurs.

Since energy varies directly with respect to voltage, different magnitudes of shock can be delivered by varying the magnitudes of voltage keeping the capacitor value constant. LabVIEW is programmed to contain knobs which vary the voltage supplied to the capacitor thus letting it charge and discharge to deliver the corresponding energy of shock.

The following table shows the relation between voltage supplied and energy delivered.

Capacitor Voltage (Volts)	Reference voltage (Volts)	Time taken for capacitor charging (sec)	Energy delivered (Joules)
8V	7.5V	2.2	0.0704
7V	6.5V	2.2	0.0539
6V	5.5V	2.2	0.0396
5V	4.5V	2.2	0.0275
4V	3.5V	2.2	0.0176
3V	2.5V	2.2	0.0099
2V	1.5V	2.2	0.0044

Table 1. Relation between Voltage supplied and Energy delivered.

V. DATA ACQUISITION AND SYSTEM INTEGRATION

A. Data Acquisition Device

The virtual control of the instrument is brought about by using a Data Acquisition device from National Instruments-USB 6008: A low cost data sampling device. The major role of the device is to communicate between the virtual front panel and the hardware through analog and digital channels. The prototyped instrument uses three Analog Input-Output channels and six digital channels.

B. System Integration

- The entire integrated system consists of the Operating Virtual Instrument, the DAQ, hardware components for generating the energy interconnected together.
- Once appropriate power supply is provided to the hardware and DAQ is connected via USB, user needs to switch on the device virtually and follow the instructions mentioned to operate the instrument.

- DAQ assistants are placed within the block diagram and interconnected to acquire and generate the signals to other blocks present.

Analog Channels :

- **Analog Output (AO 0)** - This channel is used to generate the analog voltage for the inverting terminal of the comparator of LM 358 through Voltage Doubler circuit.
- **Analog Output (AO 1)** - This Analog Output channel is used to generate analog voltage for the non-inverting terminal of the comparator by charging the capacitor on the way through Voltage doubler circuit. It is ensured that the analog voltage output of channel 1 is greater than the analog output voltage of channel 0 by 0.3 V so as to trigger +Vsat and -Vsat from the comparator output.
- **Analog Input (AI 0)** - This analog channel is used to obtain the input from the peak detector to verify the appropriate voltage is delivered by the Defibrillator. It acts like Defibrillator Analyzer meant to check the success of Defibrillation. It serves the useful purpose of signaling the user whether shock is appropriately delivered or not.

Digital Channels :

- **P0.0** - This digital output channel is used to drive 5V relay through Relay Driver ULN 2003a.
- **P0.1** - This digital output channel is used to indicate the status of 'Shock' option of the machine.
- **P0.2** - This digital output acts as R Pulse Detector for abnormal rhythm and drives a LED.
- **P0.3** - This digital output pin acts as R Pulse Detector for normal ECG rhythm and drives a LED.
- **P0.4** - This digital output pin is used as a Pulse generator to drive the voltage doubler connected to LM 358 pin 2.
- **P0.5** - This digital output pin is used as a Pulse generator to drive the voltage doubler connected to LM 358 pin 3.

Each of these pins have corresponding block present in the block diagram that determines:

1. Whether signal is to be generated or is it to be acquired.
2. Number of samples to be present in these signals.

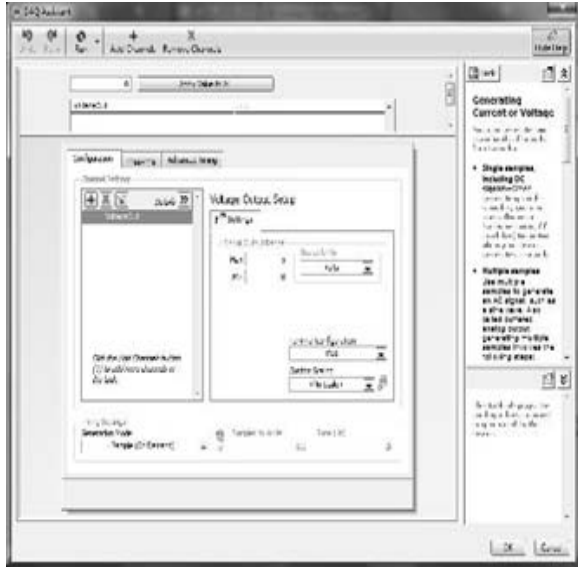


Fig. 8. DAQ Assistant Configuration Window

VI. CONCLUSION

Advancements in UEVI Defibrillator are required, since the proposed design in the project will not be in compliance with Medical Regulatory norms. Moreover the front panel of the machine can be altered to also include the option for displaying the history of shocks and patient ECG data for physician to refer while conducting a complete check. Prototype of this machine can be modified to complete real environment operating instrument by shifting from a low cost Data acquisition device to a more sophisticated DAQ with built-in capabilities for more number of channels and high sampling rate. With advanced power electronics implemented after the data is being processed, actual operating voltages can be implemented in Kilo Volts. By developing android based application or windows based application, the operating virtual machine can be installed on PDA's and can pocket-fit, making the fibrillation detection a more simple process as well as reducing the ambulatory period.

VII. ACKNOWLEDGMENTS

Today as we stand on the verge of completion of

our degree, we are glad to convey our thanks to the people who guided us at every stage and gave their valuable services during our project on "Dc Defibrillator with User End Virtual Interface". We would like to express our sincere thanks to respected principal Prof. Seema Shah. We would like to thank our Head of Department Prof. Swapna Jaywant for guiding us throughout the project and believing in the project from the very start.

As our project is based on defibrillators, we would be remiss if we did not mention Jean-Louis Prévost and Frédéric Batelli for giving the idea of the defibrillators to the world. For his generous assistance in the research of the project, we would like to acknowledge Prof. Harish Ojha for rendering support at all time. It was because of him, that we could modify the project from time and again to our satisfaction. We cannot thank enough Prof. Akhil Masurkar and Prof. Shrikant Welankar for their timely assistance with respect to the software part of the project. Our sincere appreciation to the whole teaching and non-teaching staff of biomedical department, for providing good infrastructural help which proved to be of great help and which had a lion's share in the success of our project.

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STATISTICAL ANALYSIS OF NAA AND Mi CONCENTRATION LEVELS IN CINGULATE GYRUS IN NON-ALZHEIMERS' TYPE SUBJECTS

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ABSTRACT

*The subject data is obtained from Nanavati hospital. The concentrations of Sodium Acetyl Aspartate (NAA) and Myoinositol (Mi) of the subjects have been obtained from the cingulate gyrus by performing Magnetic Resonance Spectroscopy. 1cm*1cm*1cm voxel has been selected across the grey matter of occipital region and PRESS (Point Resolved Spectroscopy), Single Voxel Spectroscopy technique has been utilized on 1.5T MRI machine at Nanavati. The subjects have been diagnosed for non-Alzheimer's type subjects on the basis of the concentration levels of NAA and MI from the spectrum obtained via PRESS. The same has been validated using statistical software R.*

Index Terms : NAA, Mi, Variance, hypothesis, statistical software R

I. INTRODUCTION

Alzheimer's disease (AD) [1] [2] is a neurodegenerative disease which is the primary cause of dementia in the old adults. It has become one of the major disorders in the world, which is threatening the health of human being. Aging of the population will lead to more and more people developing AD. The diagnosis of AD is becoming important in aging societies. Many studies of magnetic resonance imaging (MRI) have demonstrated that volumetric atrophy of the hippocampus, amygdala, etc. appear in the early stages of Alzheimer's disease[3][4]. In the past, the method based region of interest[5](ROI) was usually used in the structure measurement of AD patients, which could provide objective imaging data for early diagnosis of AD by measuring brain structures in vivo. But the method has the shortcomings of manual drawing, fussy operations and dependence on the operator. At the same time, the manual drawing could cost a lot of time, and reduce the efficiency. It is difficult to extend in clinical. Voxel-based morphometry(VBM)[6][7] method could objectively and thoroughly analyze the structural changes of gray matter in the brain, which provides an ideal tool for the research of gray matter changes in pathological state. It has the advantages of objectivity, comprehensiveness and automation as compared with ROI method. Alzheimer's is marked by abnormal clumps (called senile plaques) and irregular knots (called neurofibrillary tangles) of brain cells. For reasons not well understood, these plaques and tangles take over healthy brain tissue, devastating the areas of the brain associated with intellectual function[8]. The greatest known risk

factor for Alzheimer's is increasing age. Most individuals with the illness are 65 and older. The likelihood of developing Alzheimer's approximately doubles every five years after age 65. After age 85, the risk reaches nearly 50 percent [9]. The patients of Alzheimer's offer various symptoms, some of them are mentioned below:

- Memory changes that disrupt daily life like forgetting recently learned information.
- Challenges in planning or solving problems.
- Difficulty completing familiar tasks at home, at work or at leisure.
- Confusion with time or place.
- Trouble understanding visual images and spatial relationships.
- New problems with words in speaking or writing.
- Misplacing things and losing the ability to retrace steps.
- Decreased or poor judgment.
- Withdrawal from work or social activities.
- Changes in mood and personality.

II. METHODS

Alzheimer's Dementia is diagnosed by various methods. Some of them are listed below:

1. **Structural Imaging:** This technique furnishes information such as shape, position or volume of brain tissue. These techniques include magnetic resonance imaging (MRI) and computed tomography (CT).
2. **Functional Imaging:** This technique reveals the working of cells in various regions of brain by "...showing how actively the cells use sugar or oxygen." The techniques include positron emission tomography (PET) and functional MRI (fMRI) (15).
3. **Magnetic Resonance Spectroscopy:** MRS allows doctors to obtain biochemical information about the tissues of the human body in a non-invasive way. The techniques oftenly used are STEAM (Stimulated Echo Acquisition Mode) shown in Fig.1.1 where 1 90° pulse and 2 180° refocussing pulses are used and PRESS (Point Resolved Spectroscopy) shown in Fig.1.2 where 3 90° pulses are used [10][11].

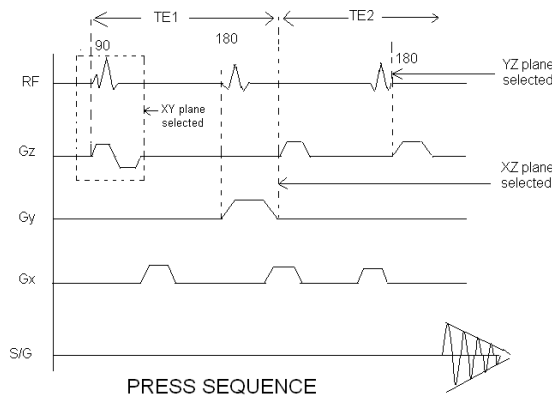


Fig. 1.1 Point Resolved Spectroscopy Sequence

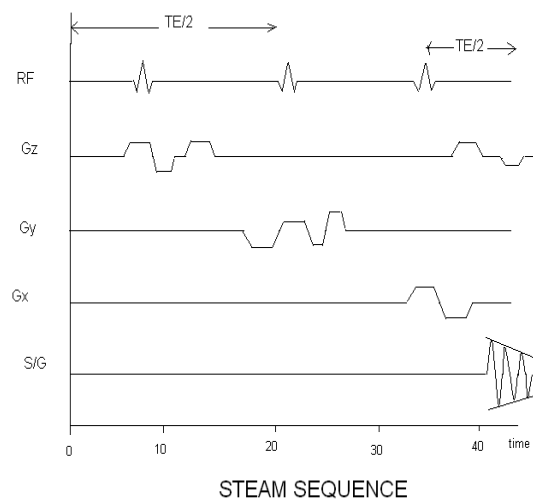


Fig. 1.2 Stimulated Echo Acquisition Mode

Single Voxel Spectroscopy in which PRESS was performed using a short TE sequence (35 ms), Repetition time (TR) = 1500ms and 128 averages were taken. A 1*1*1 cm sized voxel has been placed in the cingulate gyrus. The spectrum is of good quality with adequate water suppression. NAA (Sodium Acetyl Aspartate), Cho (Choline), Cr (Creatine) And Mi (Myoinositol) peaks are identified. MRI of the brain was performed using T1 and T2 weighted sequences in multiple planes, in a quadrature head coil on 21 subjects, their demography is shown in Table 1.1.

Table 1.1. Demography of the subjects showing their clinical details

Data: Population X : < 65 years of age

Population Y: >above 65 years of age.

Assumption: NAA and Mi levels of population X and population Y follow Normal distribution.

Sample from Population X			
Sr. No.	Age	NAA concentration	Mi concentration
1.	58	1.53	0.72
2.	53	1.43	0.68
3.	49	1.45	0.62
4.	47	1.47	0.72
5.	59	1.27	0.67
6.	59	1.43	0.70
7.	52	1.24	0.76
8.	56	1.48	0.57
9.	62	1.41	0.66
10.	45	1.5	0.67
11.	48	1.32	0.68

Sample from Population Y			
Sr. No.	Age	NAA concentration	Mi concentration
1.	66	1.13	0.62
2.	80	1.09	0.56
3.	66	1.30	0.63
4.	69	1.33	0.62
5.	74	1.33	0.67
6.	81	1.21	0.62
7.	81	1.34	0.62
8.	81	1.34	0.79
8.	81	1.34	0.79
10.	66	1.43	0.7

III. DIAGNOSIS

MRI Scan of the brain was performed using quadrature head coil using 1.5 T MRI Scanner. Magnetic Resonance Spectroscopy module was used in which fourier transformation of MRI Scan gives a spectrum. The spectrum was taken from Occipital Gray matter with TE (Time to Echo) = 35 ms which is very small to gain a high amplitude of the signal, TR (Repitition Time) = 1500 ms, NAV (Number of Averages) = 128 ms. PRESS (Point Resolved Spectroscopy) is used where 3 90° pulses are used to obtain the spectrum from occipital gray matter.

When the concentration of NAA goes below the normal level and when the concentration of Mi goes beyond the normal level, the subject is diagnosed to be of Alzheimer's type. We have considered non-Alzheimer's type subjects. Above 65 years of age, the NAA and Mi levels of the normal subjects decrease.

a) Study of variance of NAA levels of Population X and Population Y

- **Null Hypothesis H0:**

$$\begin{aligned} & (\text{Variance of NAA levels of Population X})^2 \\ & = (\text{Variance of NAA levels of Population Y})^2 \end{aligned}$$

- **Alternate Hypothesis H1:**

$$\begin{aligned} & (\text{Variance of NAA levels of Population X})^2 / \\ & (\text{Variance of NAA levels of Population Y})^2 \neq 1 \\ & \text{Significance value } (\alpha): 0.05 (5\%) \end{aligned}$$

- b) *Study of variance of Mi levels of Population X and Population Y*
- **Null Hypothesis H0:**
(Variance of Mi levels of Population X)²
= (Variance of Mi levels of Population Y)²
 - **Alternate Hypothesis H1:**
(Variance of Mi levels of Population X)² /
(Variance of Mi levels of Population Y)² ≠ 1
Significance value (α): 0.05 (5%)
- c) *Study of Mean of NAA levels of Population X and Population Y*
- **Null Hypothesis H0:**
Mean of NAA levels of Population X = Mean of NAA levels of Population Y
 - **Alternate Hypothesis H1:**
Mean of NAA levels of Population X > Mean of NAA levels of Population Y
- d) *Study of Mean of Mi levels of Population X and Population Y*
- **Null Hypothesis H0:**
Mean of Mi levels of Population X = Mean of Mi levels of Population Y
 - **Alternate Hypothesis H1:**
Mean of Mi levels of Population X > Mean of Mi levels of Population Y

IV. ANALYSIS

- a) *Using the statistical software R, we find the following for of variance NAA:*
- Test Statistic: F = 0.4853
 Numerator dof (degree of freedom) = 10
 Denominator dof = 9
 p-value(probability value) = 0.2753.
 95% Confidence Interval (C.I.) = [0.1224257
 1.8338515]
 Ratio of Variance s= 0.4852791
- b) Using the statistical software R, we find the following for variance of Mi:
- Test Statistic: F = 0.6584
 Numerator dof = 10
 Denominator dof = 9
 p-value = 0.5234.
 95% Confidence Interval (C.I.) = [0.1660956
 2.487996]
 Ratio of Variances=0.6583807
- c) Using the statistical software R, we find the following for mean of NAA:
- Test Statistic: t=2.1693
 Dof: 19
 p-value = 0.02148
 95% Confidence Interval (C.I.) =
 [0.02134239 ∞]
 Mean of NAA levels of Sample X =1.408182
 Mean of NAA levels of Sample Y =1.3030

- d) Using the statistical software R, we find the following for mean of Mi:
- Test Statistic: t = 1.3325
 Dof: 19
 p-value = 0.09924
 95% Confidence Interval (C.I.) = [-0.0099 ∞]
 Mean of Mi levels of Sample X =0.6772727
 Mean of Mi levels of Sample Y =0.644

The statistical software R snapshots are as follows:

```
> # This is two sample hypothesis test
> # We considered Population X : < 65 years of age and
> # Population Y: >above 65 years of age
>
> X_NAA <- c(1.49,1.43,1.45,1.47,1.27,1.43,1.24,1.48,1.41,1.5,1.32)
> X_MI <- c(0.72,0.68,0.62,0.72,0.67,0.7,0.76,0.57,0.66,0.67,0.68)
> Y_NAA <- c(1.34,1.13,1.09,1.30,1.34,1.33,1.21,1.34,1.52,1.43)
> Y_MI <- c(0.62,0.56,0.63,0.62,0.79,0.67,0.62,0.62,0.61,0.7)
> alpha = 0.05
>
> # part a) Study of variance of NAA levels of Population X and Population Y
> # H0: (sigma of X_NAA)*(sigma of X_NAA) = (sigma of Y_NAA)*(sigma of Y_NAA)
> # H1: (sigma of X_NAA)*(sigma of X_NAA) != (sigma of Y_NAA)*(sigma of Y_NAA)
> var.test_NAA <- var.test(X_NAA,Y_NAA,ratio=1,alternative = "two.sided",conf.level = 0.95)
> print(var.test_NAA)

F test to compare two variances

data: X_NAA and Y_NAA
F = 0.4853, num df = 10, denom df = 9, p-value = 0.2753
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
 0.1224257 1.8338515
sample estimates:
ratio of variances
 0.4852791

> # part d) Study of Mean of Mi levels of Population X and Population Y
> # H0: X_MI-Y_MI=0
> # H1: X_MI-Y_MI>0
> meantest_MI <- t.test(X_MI,Y_MI,alternative = "greater", mu = 0, paired = FALSE, var.equal = '
> print(meantest_MI)

Two Sample t-test

data: X_MI and Y_MI
t = 1.3325, df = 19, p-value = 0.09924
alternative hypothesis: true difference in means is greater than 0
95 percent confidence interval:
 -0.009905457      Inf
sample estimates:
mean of x mean of y
0.6772727 0.6440000
```

V. CONCLUSION

1. Since, p-value > α, we fail to reject H0. The variance of NAA levels of population X could be equal to the variance of NAA levels of population Y.
2. Since, p-value > α, we fail to reject H0. The variance of Mi levels of population X could be equal to the variance of Mi levels of population Y.

3. Since, $p\text{-value} < \alpha$, we reject H_0 . The Mean of NAA levels of population X are greater than the mean of NAA levels of population Y. Therefore, we conclude that the concentration of NAA levels would decrease after the age of 65 years.
4. Since, $p\text{-value} > \alpha$, we fail to reject H_0 but as per the found $p\text{-value}$ at 0.1 significance level, we can reject H_0 . Still, it's a strong statement to state that the Mean of Mi levels of population X are greater than the mean of Mi levels of population Y. Therefore, we have strong evidence to conclude that the concentration of Mi levels would decrease after the age of 65 years.

Final Conclusion: Variance of NAA and Mi levels of Population X and Population Y could be equal (It's a weak statement). We have strong evidence that NAA and Mi levels would decrease after the age of 65 years.

VI. ACKNOWLEDGMENT

The author thanks Prof. Sharad Bharatiya, PROFESSOR, IITB for continuous guidance in statistics. The author would also like to thank Dr. Deepak Patkar and Dr. Sona Pungaonkar from nanavati hospital to perform the experiment on patients to achieve data. She would also like to thank Bharat Reddy, Phd student at iitb for guiding me in R software.

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OPTIMIZATION AND DESIGN OF RF MEMS SWITCH

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ABSTRACT

The increasing need for a high performance, low loss, high speed and batch Fabrication enabled components at microwave frequency motivated the development of RF MEMS Field. RF MEMS Components are the basic building blocks in telecom systems. These components are RF Switches, capacitors, resonators, inductors and filters. This paper focuses on the optimization of RF MEMS Switch by Orthogonal experiment method. Then by multiphysics software, different analysis are done to effectively design the switch. Al and Au are used for the switch design. The results obtained show that Al has a greater resonant frequency (258547Hz) than Au(111769) along with high down state capacitance (0.18pF) than Au(0.15pF).

Keywords : Optimization; switching speed; Orthogonal experiment.

I. INTRODUCTION

The advent of surface and bulk micromachining techniques triggered the development of RF MEMS components. The first MEMS Switch was demonstrated by Peterson [1]. RF MEMS Switch replaced its Traditional counterpart PIN/FET as it showed the desired performance in terms of near zero power consumption, low insertion loss, low intermodulation products and low cost [2]. Moreover, RF switches can be designed through batch fabrication that enables reduction in cost and ensures integration compatibility with associated electronic devices.

One of the parameter that influences the Dynamic performance of the switch at microwave frequency is switching speed. The speed of the switch depends on the Actuation voltage. This voltage in turn depends on the switch Geometry. Therefore, optimization of physical parameters of the device (Length, width and thickness) play a vital role. This paper determines the device parameters by orthogonal experiment method. The mechanical resonant frequency is then calculated to select the best combination of device parameters for both Al and Au beam. The switch is then designed using the selected parameters to obtain the desired results. The simple structure of the switch is designed in order to reduce the fabrication cost and design complexity. Switches designed in the past include different designs which include Serpentine, cantilever springs[4], non-contact beam with comb

drive actuator[5], spring folded suspensions[6], cantilever beam with variable lengths[7], structures with movable plates[8], low contact resistance[9]. After optimization, it is possible to design the switch that can be operated at high frequency with electrostatic actuation. For effective switch design, cantilever beam and the lower electrode are used for biasing and as the actuation voltage reaches pull in voltage the beam snaps down to lower electrode. A dielectric layer can be deposited on lower electrode to avoid DC contact. In on state, the beam is in steady position and as the pull in voltage is reached the capacitance increases causing signal to get grounded which is considered as the off state for the switch.

II. ORTHOGONAL EXPERIMENT METHOD

Orthogonal Experiment Method is a technique in which an orthogonal array is created. This array consists of combination of different device parameters at different number of levels. In this paper, total four parameters are selected and an array is created for 3 different levels. The 3 levels (Parameter values) selected for beam length, width and thickness are (80,100,200 μm), (60,70,100 μm) and (1, 2, 3 μm) respectively. Here, four parameters are Length, width, thickness and beam material (Al/Au). The resonant frequency for each of the experiment is determined by multi-physics software. Table below shows a L9 Orthogonal array.

No.	Length (μm)	Width (μm)	Thickness (μm)	First mechanical resonant frequency Hz	Beam Material
1	80	60	1	134498	Al
2	80	70	2	111769	Au
3	80	100	3	170537	Au
4	100	60	2	171661	Al
5	100	70	3	258547	Al
6	100	100	1	35564	Au
7	200	60	3	25714	Au
8	200	70	1	21179	Al
9	200	100	2	42668	Al

TABLE 1. L9 Orthogonal array

From the results obtained from Table 1. It can be observed that for Aluminium, number fifth combination is showing highest resonant frequency. It can also be observed that for Gold, the second combination can provide best resonant frequency when length is greater than the width. These two combinations can be selected for switch design since it provides best frequency and hence greater Dynamic stiffness for the beam.

III. DYNAMIC PERFORMANCE EVALUATION

In this section different simulation analysis are performed on the switch with the Dimension selection obtained in section II for both Al and Au. 'Stationary', 'Eigen frequency, prestressed' with 'parametric sweep' are the type of analysis that are performed to obtain the values of Pull in voltage, resonant frequencies and down state capacitances.

Surface: Total displacement (μm)

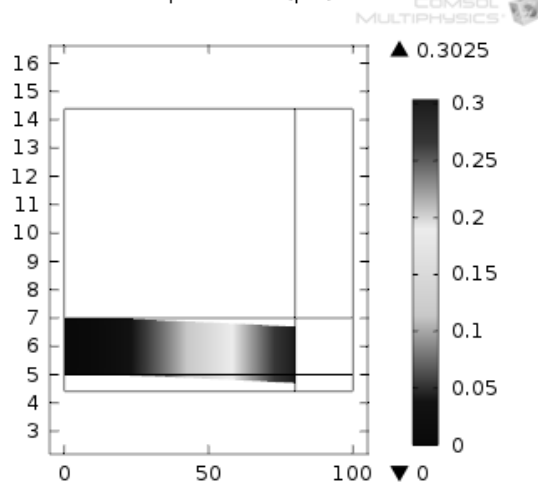


Fig. 1. Displacement of the Beam($0.3 \mu\text{m}$)

Surface: Electric potential (V)

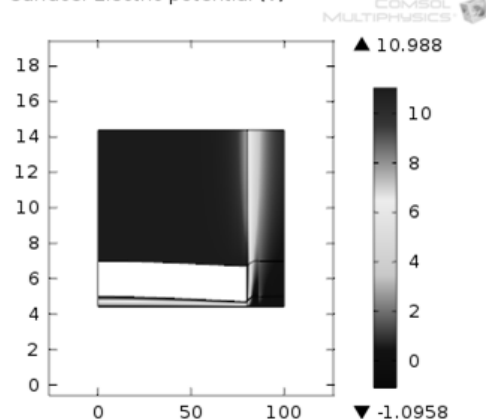


Fig.2. Out of plane Displacement for 10.98V

Point Graph: Total displacement emi.disp (μm)

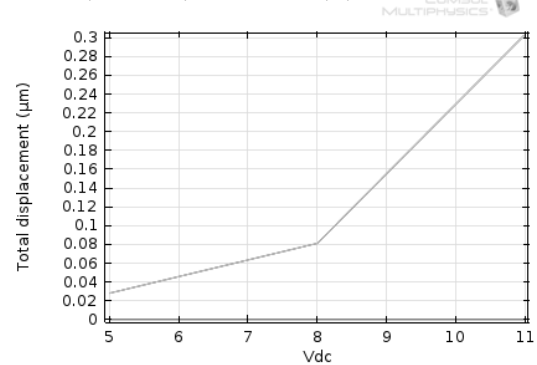


Fig. 3. Displacement Vs. Bias voltage Vdc

Global: Capacitance (pF)

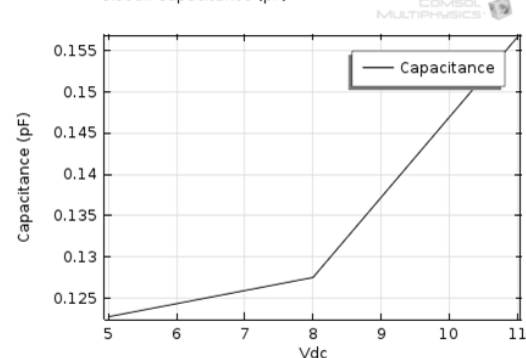


Fig. 4. Capacitance vs. Bias voltage

Global: Frequency (Hz)

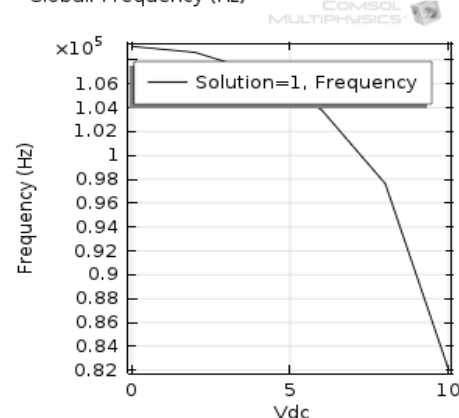


Fig. 5. Eigen frequency vs. Bias voltage

Figures 1-5 indicates the dynamic performance for Au in terms of Pull in voltage, displacement, capacitance and resonant frequency with bias. From the figures it can be studied that simplest switch can be designed with a gap(distance between Cantilever and lower electrode) of $0.3 \mu\text{m}$ for the bias voltage of 10.98V. The plots between Displacement and Vdc(Bias voltage) and also capacitance vs. Vdc indicate a non-linear relationship. The capacitance is increased from 0.12pF to 0.15pf as the bias voltage is increased from 5V to 11V.

Similarly Figures 6-10 indicate the dynamic response/Behavior of the switch. The values for pull-in voltage, displacement, and capacitance are 12.20V,

0.27 μm and 0.18 pF respectively. The Falling curve in Figures 5 and 9 indicate the reduction in Eigen frequencies with increased bias due to 'Spring Softening effect'.

Surface: Electric potential (V)

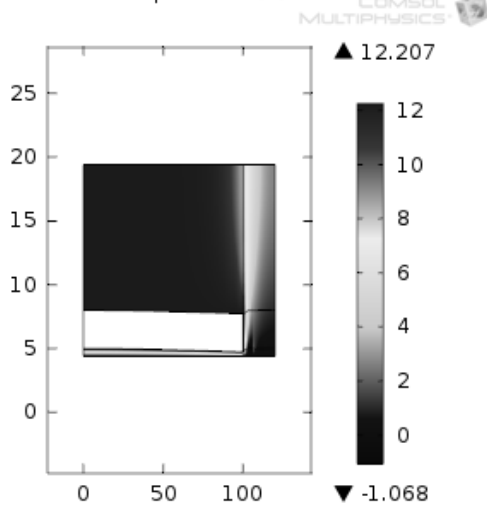


Fig. 6. Out of plane Displacement for 12.207 V

Surface: Total displacement (μm)

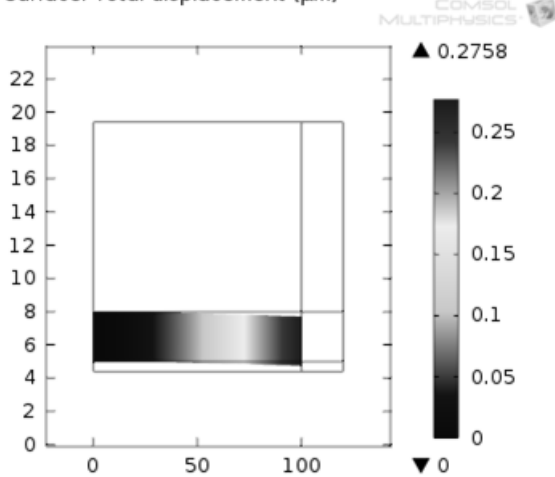


Fig. 7. Displacement of the Beam(0.275 μm)

Point Graph: Total displacement (μm)

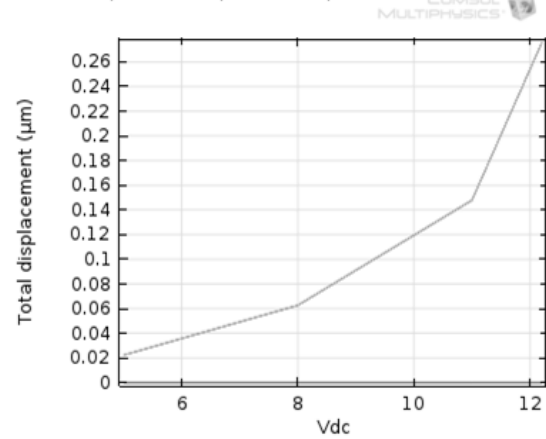


Fig. 8. Displacement Vs. Bias voltage V_{dc}

Global: Capacitance (pF)

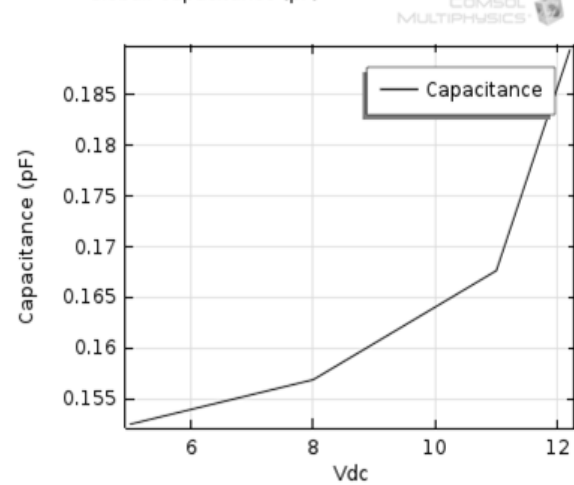


Fig. 9. Capacitance vs. Bias voltage

Global: Frequency (Hz)

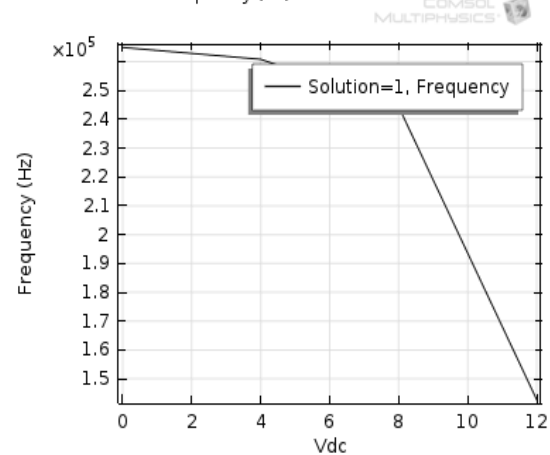


Fig. 10. Eigen frequency vs. Bias voltage

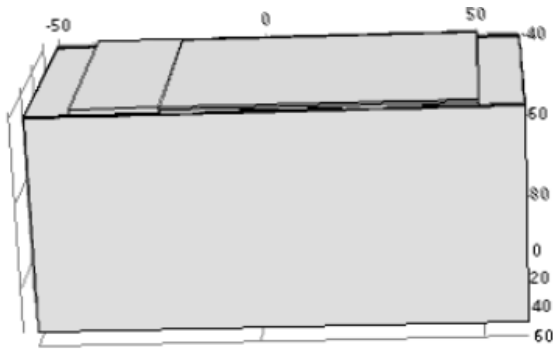


Fig.11. Designed Generic switch Model for Al

IV. CONCLUSION

The cantilever beam parameters were optimized by orthogonal experiment method to design the switch using Al and Au. The values of Length, width and thickness for Al were found to be 100 μ m, 70 μ m and 3 μ m respectively with first resonant frequency of 258547Hz. Similarly for Au length, width and thickness obtained were found to be 80 μ m, 70 μ m and 2 μ m with first resonant frequency of 111769Hz. These results show that Al has better resonant frequency and hence better Dynamic stiffness along with high down state capacitance (0.18pf) than Au (0.15pF). The Pull in voltage for Au (10.9V) was obtained less than Al (12.2V). The plots in Figures 3, 4, 5 and Figures 8,9,10 provide a set of values for further Simplest design of the switch.

V. ACKNOWLEDGMENT

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SMART MATERIAL AND THEIR APPLICATIONS

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ABSTRACT

Science and technology have made amazing developments in the design of electronics and machinery using standard materials, which do not have particularly special properties (i.e. steel, aluminum, gold). Smart materials have one or more properties that can be dramatically altered. Most everyday materials have physical properties, which cannot be significantly altered; for example if oil is heated it will become a little thinner, whereas a smart material with variable viscosity may turn from a fluid which flows easily to a solid. A variety of smart materials already exist, and are being researched extensively. These include piezoelectric materials, magnetostrictive materials, chromic materials, and shape memory alloys.

Keywords : Chromic, Magnetostrictive, Piezoelectric, shape memory alloys, stimulus, Viscosity.

INTRODUCTION

To define a Smart material we really need to understand what is meant by Smart behaviour and then, by means of some examples, to develop our definition. Smart behaviour occurs when a material can sense some stimulus from its environment and react to it in a useful, reliable, reproducible and usually reversible manner. A really Smart material will use its reaction to the external stimulus to initiate or actuate an active response, e.g. with an active control system.

Smart materials have one or more properties that can be dramatically altered. Most everyday materials have physical properties, which cannot be significantly altered; for example if oil is heated it will become a little thinner, whereas a smart material with variable viscosity may turn from a fluid which flows easily to a solid. A variety of smart materials already exist, and are being researched extensively. These include piezoelectric materials, magnetostrictive materials, chromic materials, and shape memory alloys. Some everyday items are already incorporating smart materials (coffee pots, cars, the International Space Station, eyeglasses) and the number of applications for them is growing steadily.

Each individual type of smart material has a different property which can be significantly altered, such as viscosity, volume, and conductivity. The property that can be altered influences what types of applications the smart material can be used for.

The road to Smartness

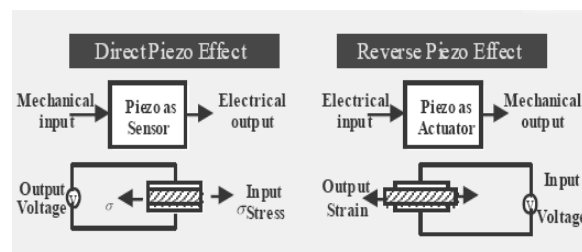
	Sensor	Actuator	Controller	Processor
Intelligent material & structure	✓	✓	✓	✓
Smart material & structure	✓	✓	✓	
Active material & structure	✓	✓		
Sensory material & structure	✓			
passive material & structure				

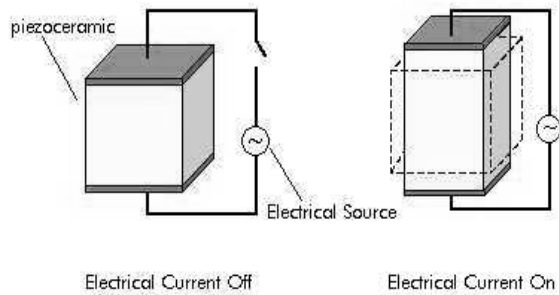
There are some materials that are designed to change their behavior of a material to some change in its environment, are as follows:

I. PIEZOELECTRIC

Piezoelectric materials have two distinct properties which are interconnected. When a piezoelectric material is deformed, it gives off a small but quantifiable electrical discharge. This effect also applies in the reverse manner, creating a voltage across the sample which produces stress within the sample. An applied mechanical stress will produce a voltage and an applied voltage will change the shape of the solid by up to a 4% change in volume. Structures made from Piezoelectric materials can be made to bend, expand or contract when a voltage is applied. Piezoelectric materials are most widely used as sensors in different environments. They are often used to measure fluid compositions, fluid density, fluid viscosity, or the force of an impact. An example of a piezoelectric material in everyday life is the airbag sensor in your car. The material senses the force of an impact on the car and sends an electric charge deploying the airbag [1].

Concept Diagram





There are two types of piezoelectric materials:

Actuator and Sensor

The actuator are usually made of ceramic material :

- Common material is PZT (Lead Zirconate titanate).

The sensors are made of polymers :

- Common material is PVDF (Polyvinylidene fluoride)
- PTF (Polymer thick film).[1].

Advantages

- Reversible (use as a sensor and actuator)
- Actuation mechanism is highly resistive to environmental effect (e.g. humidity ,temperature)
- Very easy to control small (sub-micron) displacements with applied voltage
- High stiffness
- Very fast response[2].

The main advantage of these materials is the almost instantaneous change in the shape of the material or the generation of an electrical field.

Disadvantages

- They are high impedance and can pick up is also prone to crack stray voltages in the connecting wires .
- The crystal is also prone to cracking if overstressed [2].

II. SHAPE MEMORY ALLOYS

Shape memory alloys (SMAs) are one of the most well known types of smart material and they have found extensive uses in the 70 years since their discovery.

A shape memory transformation was first observed in 1932 in an alloy of gold and cadmium, and then later in brass in 1938. The shape memory effect (SME) was seen in the gold-cadmium alloy in 1951, but this was of little use. Some ten years later in 1962 an equiatomic alloy of titanium and nickel was found to exhibit a significant SME and Nitinol (so named because it is made from *nickel* and *titanium* and its properties were discovered at the *Naval Ordnance Laboratories*) has become the most common SMA. Other SMAs include those based on copper (in particular CuZnAl), NiAl and FeMnSi, though it should be noted that the NiTi alloy has by far the most superior properties.[3]

Working

The SME describes the process of a material changing shape or remembering particular shape at a specific temperature (i.e. its transformation or memory temperature). Materials which can only exhibit the shape change or memory effect once are known as oneway SMAs. However some alloys can be trained to show a two-way effect in which they remember two shapes, one below

and one above the memory temperature. At the memory temperature the alloy undergoes a solid state phase transformation. That is, the crystal structure of the material changes resulting in a volume or shape change and this change in structure is called a “thermoelastic martensitic transformation.” This effect occurs as the material has a martensitic microstructure below the transformation temperature, which is characterised by a zig-zag arrangement of the atoms, known as twins. The martensitic structure is relatively soft and is easily deformed by removing the twinned structure. The material has an austenitic structure above the memory temperature, which is much stronger. To change from the martensitic or deformed structure to the austenitic shape the material is simply heated through the memory temperature. Cooling down again reverts the alloy to the martensitic state as shown in Figure 1. The shape change may exhibit itself as either an expansion or contraction. The transformation temperature can be tuned to within a couple of degrees by changing the alloy composition. Nitinol can be made with a transformation temperature anywhere between -100°C and $+100^{\circ}\text{C}$ which makes it very versatile.[3]

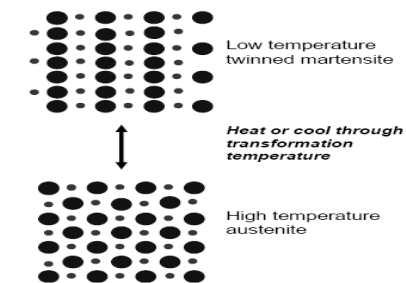


Figure 1 – Change in structure associated with the shape memory effect.

Applications

- Medical applications: Quite fortunately Nitinol is biocompatible, that is, it can be used in the body without an adverse reaction, so it has found a number of medical uses.
- Domestic applications :SMAs can be used as actuators which exert a force associated with the shape change, and this can be repeated over many thousands of cycles. Applications include springs which are incorporated in to greenhouse windows such that they open and close themselves at a given temperature.
- Aerospace applications :A more high tech application is the use of SMA wire to control the flaps on the trailing edge of aircraft wings. The flaps are currently controlled by extensive hydraulic systems but these could be replaced by wires which are resistance heated, by passing a current along them, to produce the desired shape change[4].

III.MAGNETOSTRICTIVE MATERIALS

Magnetostrictive materials are similar to piezoelectric except the change in shape is related to a magnetic field rather than an electrical field.

Magnetostrictive materials convert magnetic to mechanical energy or vice versa. The magnetostrictive effect was first observed in 1842 by James Joule who noticed that a sample of nickel exhibited a change in length when it was

magnetised. The other ferromagnetic elements (cobalt and iron) were also found to demonstrate the effect as were alloys of these materials. During the 1960s terbium and dysprosium were also found to be magnetostrictive but only at low temperatures which limited their use, despite the fact that the size change was many times greater than that of nickel. The most common magnetostrictive material today is called TERFENOL-D (terbium (TER), iron (FE), Naval Ordnance Laboratory (NOL) and dysprosium (D)). This alloy of terbium, iron and dysprosium shows a large magnetostrictive effect and is used in transducers and actuators. The original observation of the magnetostrictive effect became known as the Joule effect, but other effects have also been observed. The Villari effect is the opposite of the Joule effect, that is applying a stress to the material causes a change in its magnetization. Applying a torsional force to a magnetostrictive material generates a helical magnetic field and this is known as the Matteucci effect. Its inverse is the Wiedemann effect in which the material twists in the presence of a helical magnet field[5].

Working

Magnetic materials contain domains which can be likened to tiny magnets within the material. When an external magnetic field is applied the domains rotate to align with this field and this results in a shape change as shown in Figure 6. Conversely if the material is squashed or stretched by means of an external force the domains are forced to move and this causes a change in the magnetisation.[1]

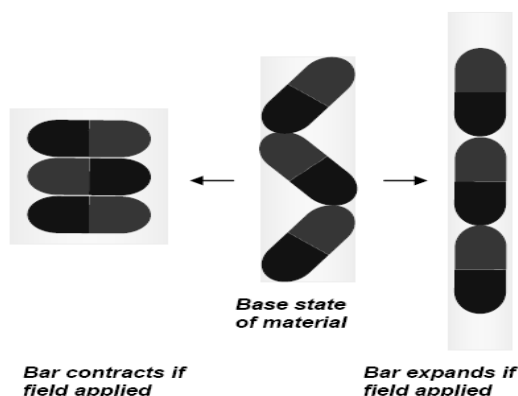


Figure 6 – Magnetostrictive materials are made up from domains (represented by red and blue bar magnets). If a magnetic field is applied the bar either decreases in length from its base state (centre to left) or increases in length (centre to right) depending on the polarisation of the applied field.

Applications

Magnetostrictive materials can be used as both actuators (where a magnetic field is applied to cause a shape change) and sensors (which convert a movement into a magnetic field).

In actuators the magnetic field is usually generated by passing an electrical current along a wire. Likewise the electrical current generated by the magnetic field arising from a shape change is usually measured in sensors.

Early applications of magnetostrictive materials included telephone receivers, hydrophones, oscillators and scanning sonar.

The development of alloys with better properties led to the use of these materials in a wide variety of applications.

Ultrasonic magnetostrictive transducers have been used in ultrasonic cleaners and surgical tools. Other applications include hearing aids, razorblade sharpeners, linear motors, damping systems, positioning equipment, and sonar.

III. CHROMIC MATERIALS

This group of materials refers to those which change their colour in response to a change in their environment, leading to the suffix chromic.

A variety of chromic materials exist and they are described in terms of the stimuli which initiate a change, thus:

- Thermochromic materials change with temperature;
- Photochromic materials change with the light level;
- Piezochromic materials change with applied pressure;
- In the case of electrochromic, solvatochromic and carsochromic materials the stimulus is either an electrical potential, a liquid or an electron beam respectively.

Thermochromic, photochromic and piezochromic materials are the most popular with the first two groups finding everyday applications.

Working

There are two types of thermochromic systems: those based on liquid crystals and those which rely on molecular rearrangement. In either case at a given temperature a change in the structure of the material occurs giving rise to an apparent change in colour. The change is reversible so as the material cools down it changes colour back to its original state. In liquid crystals the change from coloured to transparent takes place over a small temperature range (around 1°C) and arises as the crystals in the material change their orientation (Figure 9). However, liquid crystals are relatively expensive and so where there is no need for the colour change to take place in a very narrow temperature window molecular rearrangement materials are employed[6].

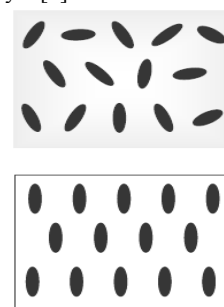


Figure 9 – A liquid crystal contains needle shaped particles which are arranged randomly below the transformation temperature (top). Above this temperature the particles are aligned, changing how the material reflects light, thus showing a change in colour (bottom)

Leucodyes change colour by molecular rearrangement and the colour and active temperature range of the dye can be controlled by changing the chemical groups on the corners and central site of the molecule. Leucodyes have a broader temperature range than liquid crystals and will usually become colourless over approximately 5°C. In both cases the thermochromic material is encapsulated inside microscopic spherical particles to protect it. These encapsulating molecules must themselves be transparent and able to withstand the thermal cycling which the thermochromic artefact will undergo.

The thermochromic material does not generally produce two or more colours itself. The encapsulated particles of the

material are printed on to or mixed in to another material in the second colour. At room temperature the sample is the colour of the thermochromic dye but when it is heated above its transition temperature the thermochromic material becomes transparent thus showing the base colour underneath. For example if a layer of red thermochromic pigment is applied to a blue substrate at room temperature it will appear red but as it warms up it becomes blue. As the temperature decreases again the red colour will reappear.

Application

Since thermochromic pigments can be used in a variety of ways they have found a varied range of applications.

The pigments can be incorporated in to dyes for fabric to produce clothing which changes colour with temperature. Thermochromic inks can also be used for printing on to clothing and food packaging. Thermochromic toothbrushes have been produced that change colour as they are warmed in the hand. It takes roughly two minutes to warm the brush enough to see a change in the colour and this is the length of time dentists recommend teeth should be brushed. Such a toothbrush is shown in Figure 10.

Thermochromic thermometers have been developed as they offer significant safety advantages over traditional glass / mercury thermometers. The plastic substrate consists of stripes of different colours representing the different temperatures. This is then coated with a layer of thermochromic dye of varying thickness (it is thinner at the cool end of the thermometer than it is at the higher temperature end). As the thermometer is warmed by placing it on the forehead the thin layer of dye warms up and becomes transparent first. The higher the temperature the thicker the layer of dye which can be warmed sufficiently to change colour. This principle is also employed in the tester strips which appear on the sides of some batteries, but this time the heat is generated by the resistance heating effect of a small electrical current flowing across the battery.

Thermochromic materials have also found safety applications in kettles and baby spoons. The body of the kettle is actually made from pink plastic, however this contains a small amount of a thermochromic dye which is blue at room temperature and becomes transparent when warm, thus showing the pink colour. A series of photographs showing the change in colour as the kettle is boiled are shown in Figure 12[6].

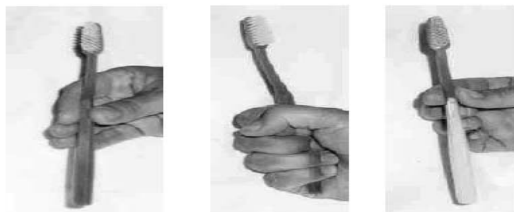


Figure 10 – A thermochromic toothbrush at room temperature, being warmed by holding in the hand and when warm.

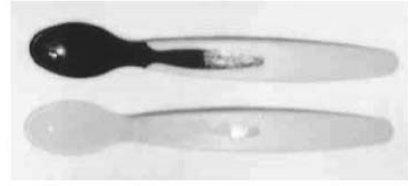


Figure 12 – Showing a thermochromic baby spoon at room temperature (top) and after immersion in boiling water (bottom)

Conclusion and Future Scope

In this paper we have given a brief review of smart materials, their working and applications.

We find that piezoelectric and magnetostrictive materials show similar principle of operation but piezoelectric gives better performance in certain applications because for piezoelectric materials mere mechanical parameter are sufficient to work, for e.g. pressure, force, acceleration and strain.

Whereas magnetostrictive materials need magnetic environment.

Further study can be done to find particular applications of each material. We are looking forward to developing the 'advance' electronic weighing machine.

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PERFORMANCE ANALYSIS OF ECG FEATURE EXTRACTION USING WAVELET TRANSFORM AND FEATURE COMPRESSION USING PCA

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ABSTRACT

ECGs are important biomedical signals, which are reflective of an electric activity of the heart. They form a subject of intensive research for over 100 years. ECG signals are one of the best-understood signals being at the same time an important source of diagnostic information. Because of this, in the recent years there has been a steady and intensive research with intent of developing efficient and effective methods of processing and analysis of ECG signals with emphasis on the discovery of essential and novel diagnostic information. An analysis of ECG signals requires their pre-processing and a suitable representation so that depending upon the nature of the ECG system, it helps reveal the required diagnostic information. In this study we propose a novel feature extraction scheme on electrocardiogram (ECG) signal using discrete wavelet transform (DWT) coefficients followed by Principal Component Analysis (PCA). This scheme provides more feature compression and hence less number of features will represent the given data.

Keywords : ECG, Signal Processing, Principal Component Analysis (PCA), Discrete Wavelet Transform (DWT).

I. INTRODUCTION

Today's fast-paced life and workplace pressures escalate stress levels, taking a toll on one's heart. Today, even youngsters are prone to heart ailments. Early diagnosis and medical treatment of heart diseases can prevent sudden death of the patient. ECG is the most common diagnostic tool used to monitor heart activity.

The human heart generates electrical impulses due to ionic activity in the cardiac muscles. In effect mechanical contraction and expansion of the heart takes place. Due to this at the surface of the body electrical signal is generated called as electrocardiogram (ECG). This signal maps the activity of the heart and has a normal pattern called normal sinus rhythm [1]. Due to some defects in the cardiac muscles the pattern and rhythm of mechanical activity departs from that of normal sinus rhythm. If such change in ECG pattern is rhythmic it is called arrhythmia. It is one of the important clinical abnormalities which is in need of therapeutic intervention and follow up. The holter monitoring of ECG enables 24 hour recording of data, and it is very much necessary for the identification of such beats.

In an attempt for the automation of the process of extracting important features from the given ECG signal Wavelet transforms can be used. The idea is that, only a certain set of data is used to represent the entire signal. Generally the obtained features will be large and may be redundant resulting in poor representation of the data. The

topic is further complicated, since most of the time the desired ECG signals are either corrupted or embedded in noises. The answer to all of these problems is wavelet analysis. Wavelet theory provides a unified framework for a number of techniques, which had been developed independently for various signal-processing applications.

In cases, like Holter ECG, a huge amount of data is generated which is used for analyzing the signal. Such large amount of data needs more storage and time for analysis. An attempt has been made to compress the signal so as to store a huge amount of necessary data in a smaller space. Data can be compressed by using a numerous ways, one of such method is use of Principal component analysis (PCA). PCA is a statistical technique whose purpose is to condense the information of a large set of correlated variables into a few variables ("principal components").

II. LITERATURE SURVEY

In recent years, several research and algorithms have been developed for the extraction, analyzing and classifying the ECG signal. The different methods which have been proposed during the last decade and under evaluation includes digital signal analysis, Fuzzy Logic methods, Artificial Neural Network, Hidden Markov Model, Genetic Algorithm, Support Vector Machines, Self-Organizing Map, Bayesian and other methods with each approach exhibiting its own advantages and disadvantages. The crucial step in the analysis of ECG is the detection of the QRS complex [2]. While there are many other algorithms available, there has been a recent proposal for a wavelet based approach which provides excellent performance have demonstrated the potential of wavelet-based feature extraction for discriminating between normal and abnormal cardiac patterns. Wavelets were also applied to characterize beat-to-beat fluctuations of the heart rate under varying physiological conditions.

A large number of techniques have been proposed over the years addressing the signal compression. Compression of ECG signals is desirable for three reasons- economic use of storage data, reduction of the data transmission rate and transmission bandwidth conversation. Although digital storage media is not expensive and computational power has exponentially increased in past few years, the possibility of electrocardiogram (ECG) compression still attracts the attention, due to the huge amount of data that has to be stored and transmitted; the amount that grows depending upon the time and amplitude, sampling rate and number of sensors. Wavelet compression techniques were found to be optimal in terms of compression. The result of ECG signal compression shows better compression performance for DCT and DWT with appropriate PRD. However, recently developed Principal component analysis

(PCA) can be used for this purpose. PCA is a mathematical procedure that uses an orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. The number of principal components is less than or equal to the number of original variables.

III. MATERIALS AND METHODS

The proposed methodology consists of registration, feature extraction and feature compression. In the registration step Pan-Tompkins algorithm (Pan and Tompkins 1985) is been employed for extraction of R peak position. For extracting the features wavelet transform sub bands are used. Finally feature compression is been done using principal component analysis.

1) R Point Detection

Detection of QRS complex is particularly most important in ECG signal processing. The information obtained from QRS detection, temporal information of each beat and QRS morphology information can be used for the improvement of performance for the other algorithms. Here we have studied a widely used and robust real-time QRS detection algorithm popularly known as Pan-Tompkins algorithm.

The Pan-Tompkins algorithm consists of several steps. In order to attenuate noise, the signal is first passed through a digital band-pass filter composed of cascaded high-pass and low-pass filters. The further steps includes differentiation, squaring followed by moving window integration. In derivative stage provides the slope information of QRS complex. Squaring operation intensifies the slope of the frequency response curve. The signal produced by the moving window integration operation provides the slope and width of the QRS complex. The window width can be determined empirically making sure that QRS complex and T waves do not merge together.

Finally, an adaptive threshold is to be applied to identify the location of QRS complexes. With the adaptive thresholds, decision processes make the final determination as to whether or not a detected event was a QRS complex.

2) Discrete wavelet transform (DWT) based feature extraction

Fourier transform provides frequency features having good frequency resolution but poor time resolution for any signal, particularly ECG in our case. In order to resolve temporal features one need to have adaptive resolution both in time and frequency. Wavelet transform is the one which provides multi resolution analysis, which uses a basic wavy shape of finite duration, called as mother wavelet, whose translations and dilations provide the varying resolution.

The main advantage of the WT is that it has a varying window size, being broad at low frequencies and narrow at high frequencies, thus leading to an optimal time-frequency resolution in all frequency ranges.

The WT of a signal is the decomposition of the signal over a set of functions obtained after dilation and translation of an analyzing wavelet. In order to decompose the ECG signal into time frequency components, two variables 'a' and 'b' named as scale and translation parameters

respectively are considered. The scale 'a' defines the amount of dilation (i.e. either stretching or contraction) and the translation 'b' defines the quantity of shift of the basis function for the time frequency transformation. Such a basis function at scale 'a' and translation 'b' is defined by the following wavelet equation.

$$\psi_{a,b}(t) = \frac{1}{\sqrt{a}} \psi\left(\frac{t-b}{a}\right)$$

The basis function at unit scale and zero translation is called as mother wavelet, whose shape must be similar to ECG signal morphology. The parameters a and b are sampled on a dyadic grid, and such a wavelet transform is called as dyadic grid wavelet transform. These discrete dyadic grid wavelets are generally orthonormal having unit magnitude and being perpendicular to each other. The DWT of a given ECG signal is obtained as the inner product between the basis wavelet and the signal itself [1].

Discrete Wavelet Transform is also referred to as decomposition by wavelet filter banks. This is because DWT uses two filters, a low pass filter (LPF) and a high pass filter (HPF) to decompose the signal into different scales. The output coefficients of the LPF are called approximations while the output coefficients of the HPF are called details. Amongst many wavelet families, the db4 wavelet has similar shape as the ECG signal morphology. The ECG signal is decomposed in time frequency using db-4 wavelet for a depth of 4 levels.

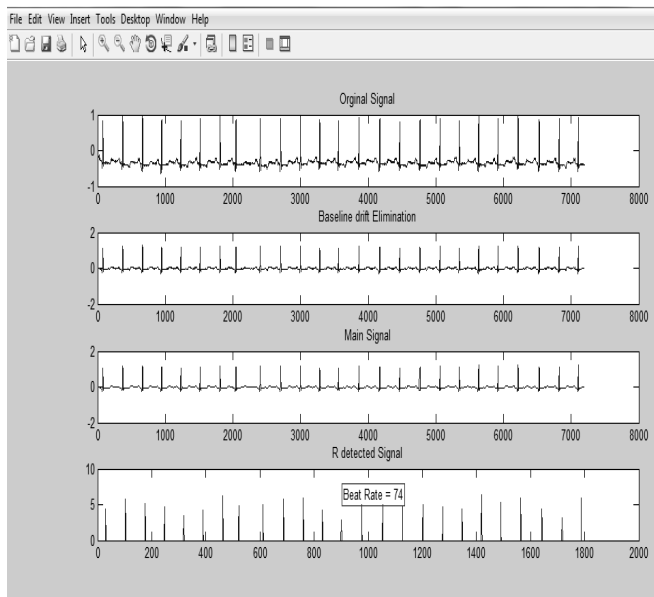
In order to further make data more compact, it is compressed using a new technique known as Principal component analysis (PCA). It is a mathematical procedure that uses orthogonal transformation to convert a set of observations of possibly correlated variables into a set of values of linearly uncorrelated variables called principal components. This transformation is defined in such a way that the first principal component has the largest possible variance, and each succeeding component in turn has the highest variance possible under the constraint that it be orthogonal to the preceding components. Principal components are guaranteed to be independent if the data set is jointly normally distributed. PCA is sensitive to the relative scaling of the original variables.

Steps of ECG data compression using PCA:

The following simplified steps are applied to the PCA based ECG compression analysis:

- Step 1. Get ECG data (take data MIT-BIH Arrhythmia data base).
- Step 2. Calculate the mean of ECG data.
- Step 3. Subtract the mean from ECG data.
- Step 4. Calculate the covariance matrix of subtract data.
- Step 5. Calculate eigenvectors and Eigen values of the covariance matrix.
- Step 6. Sort the Eigen values and Eigen vectors, on the basis of highest Eigen values.
- Step 7. Principal components choose and form ECG feature vectors = [eig1; eig2; eig3; eigL]
- Step 8. Deriving the new ECG data i.e. New data = [Row Feature Vector]^T * [Row data adjust]
- Step 9. Calculate of percentage root mean square difference (PRD).
- Step 10. Calculate the compression ratio (CR). [11]

I. RESULTS



The case study was performed on the of the certain set of data.

The principal components of the given data set was calculated mathematically and the results are given as follows:

Input Data X (e.g. Airflow)	Input Data Y (e.g. ECG)
3.5	3.4
1.5	1.3
2.1	1.2
1.3	0.8
0.7	0.1
0.91	1.6
1.31	1.9
1.56	1.2
2.34	0.78

$PCA_1 = [2.7232 \ -0.1753 \ 0.1495 \ -0.6815 \ -1.6033 \ -0.3441 \ 0.1461 \ -0.210 \ -0.0042]$ [11].

II. CONCLUSIONS

The conventional scheme is to compress the features in time domain by PCA, whereas the proposed scheme outperforms than the conventional scheme. The principal components of the sub bands of discrete wavelet transformed signal in the compact supported basis space represent the data better than in the time domain.

In this work we pointed out the advantage of using wavelet transform associated with the feature extraction of the data. Further, the possibility of detecting positions of QRS complexes in ECG signals is investigated and a simple detection algorithm is studied. Through Discrete wavelet transforms all relevant noise are removed of the signal, allowing the utilization of simple detection logic for the QRS detection. The QRS detection helped us to calculate the important features from the ECG signal. The main advantage of this kind of detection is less time consuming analysis is gained for long time ECG signal. The use of PCA helped us to compress the data to a large extent making it simpler for the analysis of the signal as well as

making it more storable. This kind of digitization of data and compression of data can be helpful in making huge ECG archives and thereby more cost effective in the coming future.

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PERFORMANCE ANALYSIS OF MEMS BASED CANTILEVER FOR DETECTION OF GREEN HOUSE GASES

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ABSTRACT

The world is facing drastic changes in the climatic conditions because of the heating effect caused by various greenhouse gases which is increasing at an uncontrolled rate. The people working underground are generally caught unawares of the hazardous gas emission around their workplace. Hence an effective sensing and communicating system is required to effectively monitor and alert the neighbourhood to save them. This paper aims in finding out a way to quantitatively measure the hazardous gas molecules. The gravimetric type sensor works by absorbing the chemical in an absorbers compound, which changes the overall mass of the sensing element i.e. a cantilever, and its displacement. Here a micro-cantilever beam is fabricated using selective coatings on the surface to selectively absorb the hazardous gases. This change in displacement gives the measure of amount of gas present in that environment. The advantage of this technique are easy portability, sensitivity, repeatability and overall fabrication cost of the sensor.

Keywords : MEMS, Cantilever, Green House Gas, Intellisuite.

I. INTRODUCTION

The greenhouse gases in the Earth's atmosphere are water vapor, carbon dioxide, methane, nitrous oxide, ozone and CFCs[1].

The recent efforts focus on several converging areas of science such as biotechnology and health sciences [2]. Yang-Choon Lim et.al have pointed out that the cantilever sensor are the device among MEMS that offers a very promising future for the development of physical, chemical and biological sensors [3]. Low power consumption is primary requirement for a sensor because of the limitation of a battery power for a hand held electronic instruments [4]. For the detection of various gases the same sensing material (viz. ZnO, TiO₂, SnO₂) may be used [5]. However there are some factors which are responsible for the detection of individual gas components from the mixture of gases. They are explained here as--(a) Temperature of the sensing material (b) Response time and (c) Recovery time of the sensor. Among these, the Temperature of sensing material is one among the important factors for the detection of a particular gas[6-7]. It is seen that the highest sensitivity for a gas is achieved for a particular temperature of the sensing material[8]. The microcantilever sensors must provide good sensitivity, smaller sizes, cheaper, more sensitive, rugged, and reliable analyses.

II. DESIGN PRINCIPLE

The working principle of metal oxide sensors is based on the change in conductance of the oxide upon reaction with a gas and this change is usually proportional to the concentration of the gases. There are two types of metal oxide sensors., i.e., N-type (Zinc oxide, Tin dioxide, Titanium dioxide or Iron (III) oxide) which respond to reducing gases and P-type(Nickel oxide, Cobalt oxide) which respond to oxidising gases.

The N-type sensor responds to a reducing gas like H₂, CH₄, CO, CO₂, C₂H₅ or H₂S while P type sensors respond to oxidising gases like O₂, O₃, NO₂, and Cl₂. Catalytic metals are sometimes applied on top of the oxides to improve sensitivity to certain gases. The sensitivity of the metal oxide sensor depends on the film thickness and the temperature at which the sensor is operated, with the thin films being more sensitive to gases.

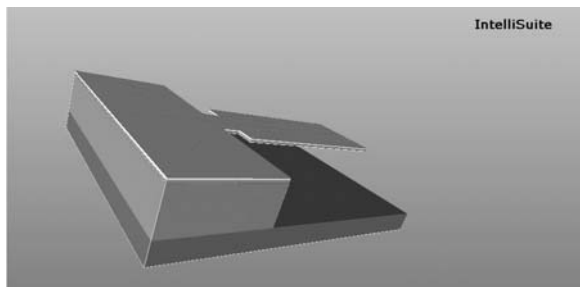
III. DESIGN AND SIMULATION

This paper explains a new methodology of measurement of the green house gases especially methane, carbon dioxide, nitrous oxide and ozone. These gases have different densities so for a reference volume they have different mass values.

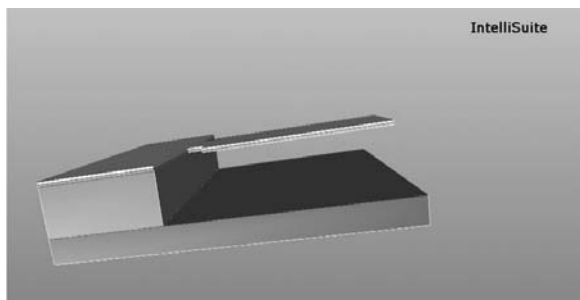
Here we have taken the mass equivalents of these gases which cause corresponding displacement on the cantilever. Present research integrates the SiO₂ cantilever with a selective coating Layer for the measurement of green house gases. The sensing layer is generally Zinc Oxide and Cobalt Oxide. The surface area had to be increased for better sensitivity.

IV. CANTILEVER DISPLACEMENT MEASUREMENT

The sensor consists of two components- sensing layer and transducer i.e. cantilever. The sensing layer is the critical component and it mechanically responds to mass change. Hence if there is more deposition of gases there will be more change in displacements. By comparing the variations, the effective mass of the cantilever before and after exposure is calculated.



(a) Gas sensor Top View



(b) Gas sensor Side View

Fig.1 Design of Gas Sensor using 3D Module

VI. RESULTS AND DISCUSSION

The output displacements for different gases are tabulated here.

Table-1

[A] Methane Gas

Mass Eqvt(gm)	Pressure Eqvt (MPa)	Displacement (μm)
0.0714	0.1747	1.42947
0.1785	0.4367	1.07373
0.3571	0.8732	2.14708
0.7140	1.7470	4.29573

Table-2

[B] Carbon Dioxide Gas

Mass Eqvt(gm)	Pressure Eqvt (MPa)	Displacement (μm)
0.196	0.48	1.18021
0.490	1.20	2.95067
0.980	2.40	5.90145
1.960	4.80	11.2702

Table-3

[C] Nitrous Oxide Gas

Mass Eqvt(gm)	Pressure Eqvt (MPa)	Displacement (μm)
0.198	0.4851	1.13897
0.495	1.2120	2.84569
0.990	2.4250	5.69377
1.980	4.8510	11.3899

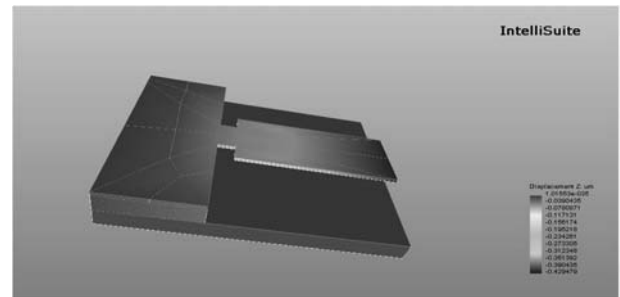
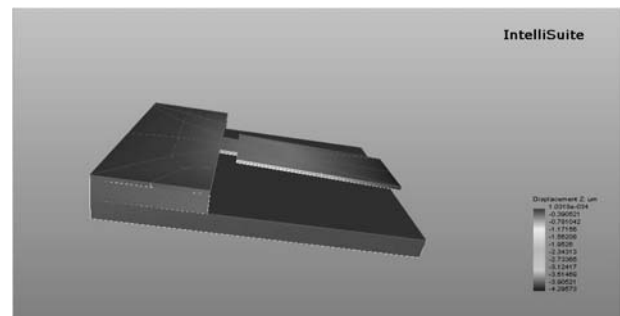
Table-4

[D] Ozone Gas

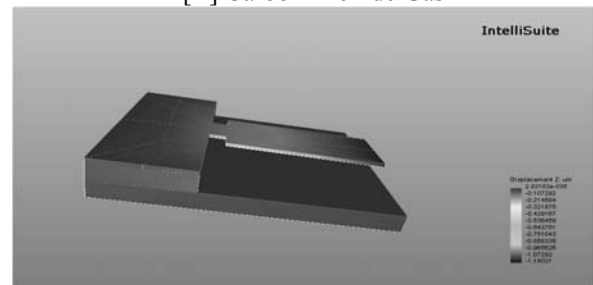
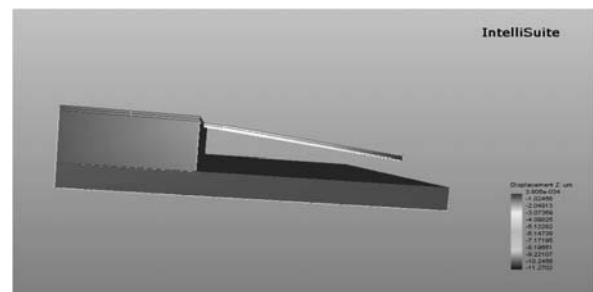
Mass Eqvt(gm)	Pressure Eqvt (MPa)	Displacement (μm)
0.214	0.5243	1.2310
0.535	1.3100	3.0757
1.070	2.6210	6.1539
2.140	5.2430	12.310

SIMULATION RESULTS

[A] Methane Gas

**Fig.2 Output Displacement for Mass Eqvt. of 0.0714gm****Fig.3 Output Displacement for Mass Eqvt. of 0.714gm**

[B] Carbon Dioxide Gas

**Fig.4 Output Displacement for Mass Eqvt. of 0.196gm****Fig.5 Output Displacement for Mass Eqvt. of 1.960 gm**

VII. CONCLUSIONS & FUTURE WORK

Driven by the continued demand for more advanced electronic control systems to increase efficiencies, users of gas sensors require ongoing advances in sensor accuracy, reliability, response time, miniaturization and telecommunications capability.

In this paper we focused on the principles of solid state gas sensors, discussing the current and future trends of the scientific research. In particular, metal oxide gas sensors are discussed due to their low cost and simplicity, advantages that works in their favour as new types of applications and technologies will emerge. We observe that when the change in mass is more; the change in displacement is also more.

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IMPLEMENTATION OF RASPBERRY PIE BASED ECG HEALTH MONITORING SYSTEM

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ABSTRACT

The concept behind this paper involves handheld ECG unit for remote areas for individual use which facilities to have premedical check-up at home with the help of latest processors raspberry pie. For this the design circuit is implemented which should be miniature model of ECG sensor. Rather than making circuitry complicated and bulky, direct high precision ICs are used which is interfaced with efficient controller like Raspberry Pi serving many facilities and provide easy interfacing with required modules. The soul part of this implementation is programming, which should be efficient during switching information. This ECG unit don't use leads as that of conventional ones. Thus, there is no purpose of using leads or electrodes using gels, multiple leads etc. Though multiple leads contribute to efficient waveform, this ECG unit is near to comparison with the conventional ECG machine. Moreover, this data can be send to doctors in urban areas for diagnosis as well as can be uploaded to local host with the help of webserver. And this can be implemented by AT commands of GSM unit which is in future scope because of extra circuitry. Also, there can be feedback facility from doctors in this overall unit which helps in premedical check-up at home.

Keywords : ECG signal, sensor, Raspberry pie, FIR filtering, visual studio, Linux, GLCD, webserver, GSM.

I. INTRODUCTION

The Electrocardiograph (ECG) signal is an electrical signal generated by the heart's activity, which can be used as a diagnostic tool for examining some of the functions of the heart. It has a principal measurement range of 0.5 to 4 mV and signal frequency range of 0.01 to 250 Hz. Each time the heart beats, it produces three distinct ECG waves: P wave, QRS complex and T wave. ECGs provide useful data and can help detect various problems related to heart function. Diagnosis of certain medical problems is also possible. For example, in patients with high blood pressure, the amplitude of the QRS complex is

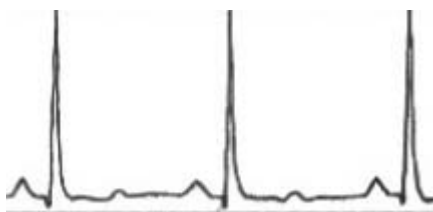


Fig.1

II. SCHEMATIC OF IMPLEMENTATION

GSM technology. Sensor unit uses two optocouplers to isolate the circuit from external voltages since any little noise from external source can be amplified as noise

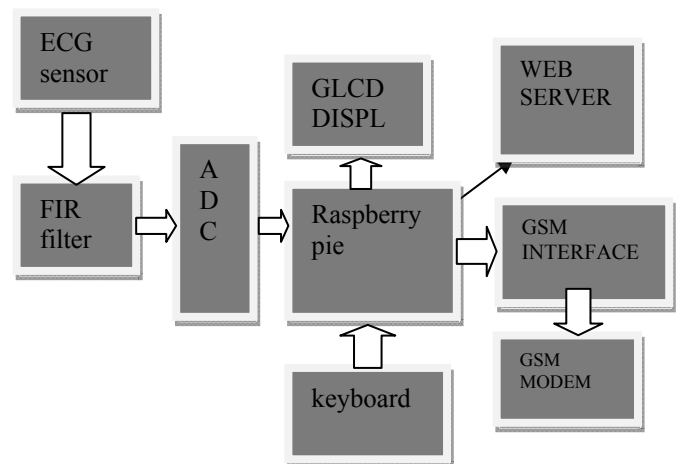


Fig.2. Block schematic

The Fig. 2. Involves instrumentation amplifier with high CMRR to remove the noise induced from body and amplify the difference between right and left body parts. Here thumb pads are used as transducer input interface. The analog amplified ECG voltage is then made to pass through digital FIR filters. High pass and low pass filters are implemented to get ECG signal of proper range. Various processors are available for implementing Digital FIR filtering. This converts these signals to analog output in serial format and pulse output. The serial data is 1 byte every 5 milli-second. Each byte can be from 0-255 indicating an analog value of the signal. The pulse output is outputted through optocoupler. The serial output is given to **Raspberry pie** which processes the value. This is interfaced with keyboard and GLCD which shows desired output. This then can be send to doctors at far places by cheap

III. ECG MAIN UNIT OVERVIEW

3.1 Instrumentation amplifier 0846:

IC technology uses Op Amps to design an ECG amplifier. This amplifier allows differential input, have enough gain to amplify a small ECG signal (<4mv) and reject DC, 50-Hz and high frequency noises.

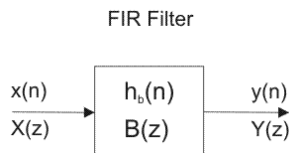
Requirements:

1. Differential input
2. Adjustable gain: 200 - 2,000
3. Band pass filter:
4. Minimize 50 Hz noise there are many factors that should be taken into consideration in the design of an ECG.

Amplifier, such as the frequency distortion, saturation distortion, interference from electric devices and other sources. The most important kind of noise in an ECG amplifier is the 50 Hz noises, since using a band-pass filter can easily reject both the DC and high frequency noise. A major source of noise when one is recording or monitoring the ECG is the electric power system. And this is possible in implemented instrumentation amplifier.

3.2 FIR Filtering

FIR filters are digital filters with finite impulse response. Fig.3.2 is also known as non-recursive digital filter. In practical



ECG measurements, the primary signal are often contaminated by relatively strong disturbances, which should be removed before signal further proceed. Even EMG signals cause disturbances. The varying ECG contact potentials and breathing artifacts (below 0.5 Hz) causes unwanted baseline drift. Especially in stress ECG recordings, this drift may sometimes make the recording impossible. Another problem is the mains frequency (50 Hz) noise which occurs within the clinically important frequency range. Up to now, the harmful baseline drift is usually removed from the measurements using analog high-pass filters. Because of their highly nonlinear phase response, the pass band cutoff frequency is usually selected to be only one-tenth of the heart rate. With these filters it is not possible to effectively remove low-frequency noise without distorting the ECG signal shape. In the case of linear-phase filters, like linear-phase finite impulse-response (FIR) filters, it is possible to increase the cutoff frequency up to the fundamental heart rate without causing any distortion to the ECG signal. The linear-phase performance of FIR filters enables us to make the stop band deeper and wider compared with nonlinear-phase filters. Thus, linear-phase FIR filters give us a potential tool of effectively eliminating low-frequency noise components (<0.5 Hz).

3.3 Opto- coupler PC817

PC817 is a 4 pin 1-channel type optocoupler having high isolation voltage. Optocoupler

transfers electrical signals between two isolated circuits by using light. Opto-isolators prevent high voltages from affecting the system receiving the signal. Commercially available opto-isolators withstand input-to-output voltages up to 10 kV and voltage transients with speeds up to 10 kV/us. The main function of an opto-coupler is to block such high voltages and voltage transients, so that a sudden surge in one part of the system will not disrupt or destroy the other parts.

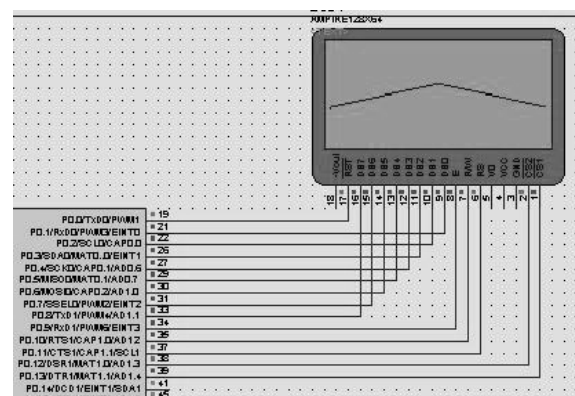
Raspberry pi : The Raspberry Pi is a credit-card-sized computer developed configurations. **Memory** 256Mb RAM

Connections 2 USB ports Ethernet port 3.5mm jack for audio out HDMI

Processor SoC is a Broadcom BCM2835

This contains an ARM1176JZFS (ARM11 using an ARMv6-architecture core) with floating point, running at 700Mhz, and a Videocore 4 GPU. Capable of BluRay quality playback, using H.264 at 40MBits/s. Has a fast 3D core accessed using the supplied OpenGL ES2.0 and OpenVG libraries. Provides Open GL ES 2.0, hardware-accelerated OpenVG, and 1080p30 H.264 high-profile decode.

Capable of 1Gpixel/s, 1.5Gtexel/s or 24 GFLOPs of general purpose compute and features a bunch of texture filtering and DMA infrastructure. Overall real world performance is something like a 300MHz Pentium2.

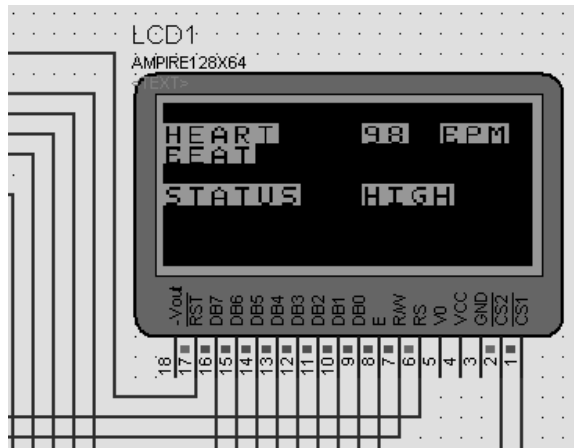
**IV. TESTING AND SIMULATION**

waveform, information showing BPM and status of patient.

Fig.4.3 GUI simulation on PC

4.0 HARDWARE IMPLEMENTATION AND RESULTS

This pulse outputted from optocoupler as Will Be Fed To Raspberry Pie The GLCD output from detected ECG signal is which is not so clear because of resolution of GLCD. High resolution GLCD



GUI implementation



Fig.4.3.It involves running idea about the components required for implementing the possible model.



Fig.5.2 Pulse frequency for a normal person heartbeat

Can be interfaced which gives accepted results. Also, some noise is involved due to deterioration of thumb pads after long use. The change of screen information

can be achieved by key pressed functions which can also be used for giving attention to GSM module. The above Fig.5.4 is SIM300 which is a Tri-band GSM/GPRS engine that works on frequencies EGSM 900 MHz, DCS 1800MHz and CS1900MHz. Best thing about SIM300 is that it have SIM card slot as that of mobile phone device for sending and receiving message and also provides GPRS multi-slot class 10 capability and support the GPRS coding schemes CS-1, CS-2, CS-3 and CS-4. ith a tiny configuration of 40mm x 33mm x 85 mm, SIM300 can fit almost all the space quirement in any application like smart phone, PDA and other mobile device. Moreover SIM300 is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode.

Webserver (WebIOPi): It is a fully integrated Internet of Things framework for the Raspberry Pi Control, debug, and use your Pi's GPIO locally or remotely, from a browser or any app. REST API over HTTP and CoAP (draft-14) with multicast support Supports GPIO, Serial, I2C, SPI, 1-Wire with zero dependency Supports more than 30 devices including DAC, ADC, sensors. Full Python library for the Server, GPIO, Serial, I2C, SPI and devices drivers Compatible with both Python and Extensible and highly customizable[13]. Programming part of the processor is based on python based on LINUX operating system.

V. FUTURE SCOPE

The major value of this system is in the detection of cardiac disorder of the patients who are located in the remote areas or in travel and are not in a position to report to the doctor for immediate treatment .An alert SMS can be transmitted using the GSM technology to the doctors and advises can be sought for saving the life of the patient which can contain medicines prescription or food proscription. As a future enhancement, system can be interfaced with GPS & GIS facility for effective rescue of patient from any location detected at doctor's place by ambulance in any case of cardiac emergency. Moreover, newer cellular access technologies, such as Third generation (3G/3.5G) or Fourth

VI. CONCLUSION

The implementation of ECG unit using Graphics User Interface on PC is successful. However, implementing sensitive run-time ECG signal on 128X64 GLCD using **Raspberry pie** and also joining pixels of large difference values requires different algorithm is in process. Input to ECG sensor must be stable in order to avoid unexpected high pulse in signal. Output on PC through GUI is in progress and also webserver is more explanatory as compared to output on GLC D. system.

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PERFORMANCE EVALUATION OF LOW LEAKAGE TRI-GATE MOSFET STRUCTURE WITH LaAlO_3 HIGH-K AND TiN METAL GATE AND ANALYSIS OF TEMPERATURE EFFECTS AT ULTRA SHORT GATE LENGTH 15NM

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ABSTRACT

Pragmatic design of triple-gate MOSFET device is presented in this paper with high-k gate oxide material LaAlO_3 and TiN metal gate at ultra short gate length 15nm. The subthreshold characteristics and device performance are analyzed and validated by 3D numerical simulations at room temperature 300k and liquid nitrogen temperature 77k. The proposed TG with high-k and metal gate structure is compared with conventional TG-MOSFET structure with SiO_2 and DG-FinFET structure with high-k and metal gate. Our results show that the proposed TG-MOSFET design with TiN metal gate has better V_{th} control and lesser short channel effects. With LaAlO_3 we are able to achieve low leakage and higher drive current and good temperature stability.

Keywords : TG-MOSFET, high-k gate dielectric, DIBL, Subthreshold Swing, On current, Leakage Current, liquid nitrogen temperature.

I. INTRODUCTION

The triple gate MOSFET has emerged as one of the promising candidates to extend CMOS technology beyond the scaling limit of conventional CMOS technology. The control of short-channel effects (SCEs) has become one of the major issues for device scaling beyond the 65-nm node [1]. Several emerging planar and nonplanar structures that aimed to alleviate the SCEs have been proposed [5]. In these devices (e.g., fully depleted SOI MOSFETs, doublegate (DG) FinFETs, and TG MOSFETs), thin silicon film is usually required, yet challenging, to suppress the SCEs. The DG FinFET (with ultrathin fin) exhibits superior SCE control and current drive. On the other hand, the TGFET relaxes the requirements on fin height and fin (silicon film) thickness, thus allowing more flexible body dimension and fin aspect ratio to ease manufacturability [2]. With decreasing oxide thickness below 1.5nm in short length MOSFET devices causes gate oxide leakage. The obvious remedy is to replace silicon dioxide with an insulator that has significantly higher dielectric constant than 3.9. This will allow the device to operate using the same capacitance, but with a higher physical thickness that suppresses direct current leakage, and hence, lower power consumption [3].

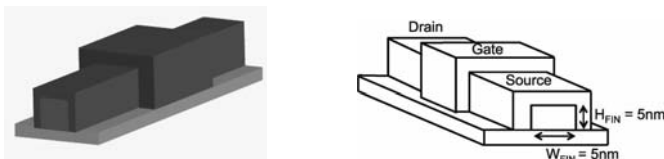


Fig.1.3D and 2D cross section of the TG-MOSFET Device Structure used for device simulations

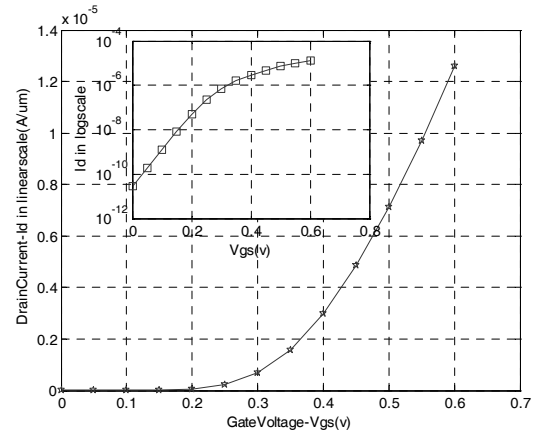


Fig.2. Plot showing the Id-Vg characteristics for Tri-gate MOSFET at 15nm gate length. Inset shows the plot of Id-Vg in logscale.

The new oxides must satisfy six conditions to be acceptable as gate dielectrics, a high enough K value, thermal stability, kinetic stability, band offsets, good interface quality with Si, and low bulk defect density. As Lanthanides are the future dielectrics for mosfet structures in ultra shorter gate lengths below 22nm, we have chosen LaAlO_3 ($k=30$) for this work [4]. Trigate Mosfet structure with high-k gate oxide LaAlO_3 and the metal gate ($\phi_m \sim 4.9\text{eV}$) is built using 3D simulation tool Omen_FET at 15nm gate length. The device performance is compared with the tri-gate MOSFET structure with SiO_2 and Double gate FINFET device with LaAlO_3 and TiN metal gate to control the threshold voltage shift. The temperature stability of the above mentioned device structures are examined via simulations at room temperature 300k and liquid nitrogen temperature 77k.

TABLE I

Dimensions Used for TG-MOSFET Simulations with specifications matching the ITRS requirements

Gate length- L_g (nm)	15
Channel width(nm)	5
Channel Height(nm)	5
Gate Oxide thickness- T_{ox} (nm)	1
Work function(ev)	4.9
V_{dd} (v)	0.6 and 0.05
Source Length(L_s)	10
Drain Length(L_d)	10
Silicon Orientation	<1 0 0>

II. DEVICE STRUCTURE

The 3-D perspective view and the two dimensional cross section view of TG-MOSFET structure are shown in fig.1. To meet the requirements of International Technology

Roadmap for Semiconductors (ITRS), simulations have been performed for the proposed technology node at 15nm gate length (see Table-I) with proportionate device dimensions. Source and drain extension lengths are fixed to 10nm. The doping levels used in the channel and heavily doped source/drain regions were $1e+16/cm^3$ and $1e+20/cm^3$ respectively. The device structures correspond to the profile of Id-Vg characteristics as shown in fig.2. The gate oxide thickness for SiO₂ is taken as 1nm and for LaAlO₃ same EOT is calculated using matlab. OMEN_FET simulates atomistic full-band quantum transport at the nanoscale, which is close to the atomistic dimension [7].

III. DETAILS OF SIMULATION SETUP

The simulations are performed using sp3d5s tight binding model by solving Poisson and Schrodinger equations. This model uses wave function approach for carrier transport. This involves atomistic full-band quantum simulations than the drift and diffusion approach. In this paper we have analyzed the TG-MOSFET structure at room temperature 300k and liquid nitrogen temperature 77k. It is the nitrogen in a liquid state at an external low temperature. Operation of silicon MOSFET devices will be much improved at cryogenic temperature. The temperature lowering allows a substantial increase of the carrier mobility and saturation velocity. It decreases the subthreshold slope and improves the device reliability. All of these advantages will make CMOS circuit better turn-on capabilities, faster switching speed, high gain, low power dissipation and higher integrated density. It is widely applied to infrared focal plane arrays and detectors in the national defense and outer space areas. BSIM3 model cannot solve freeze out effect at 77k. But with sp3d5s tight binding model we examined the device performance of TG-MOSFET structure at 77k.

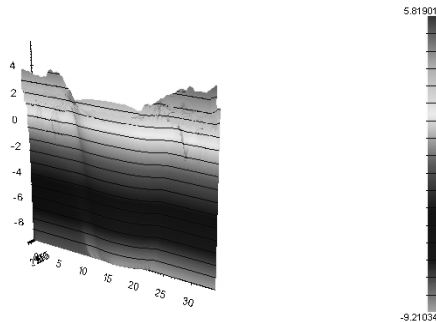


Fig3.3D simulation of Density of States (DOS) for TG-MOSFET structure

IV. EFFECT OF TEMPERATURE ON TG-MOSFET DEVICE PARAMETERS

Simulations are performed on TG-MOSFET device at 15nm gate length with high-k LaAlO₃ and metal gate TiN at 300k and 77k. The drain characteristics is observed for V_{ds}=0.6v and V_{ds}=0.05v and plotted in logscale for different temperature 300k and 77k. Fig.4.a & Fig.4.b shows the plot for TG-MOSFET with and without high-k LaAlO₃ at 300k. Fig.4.a depicts the fact that with LaAlO₃ low leakage current can be achieved in TG-MOSFETs. A significant increase in On-current is achieved in fig.4.d.

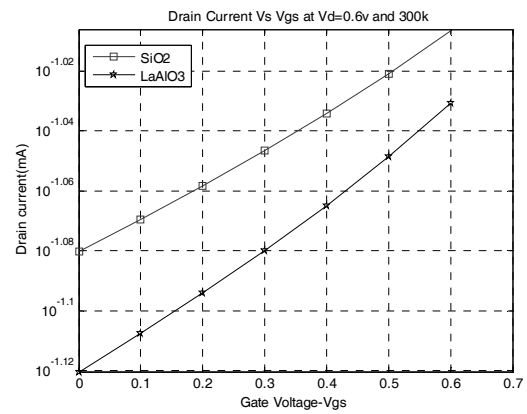


Fig.4.a. Characteristics of ID as a function of VGS at VDS = 0.6V at Temp = 300k

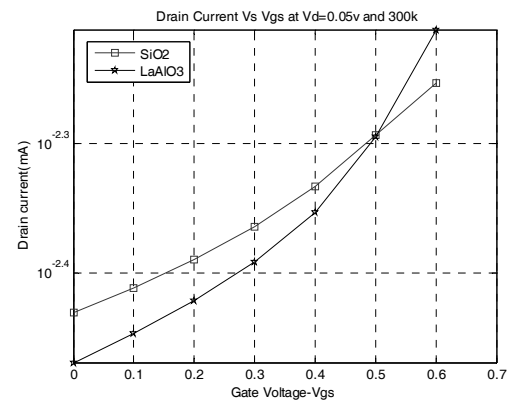


Fig.4.b. Characteristics of ID as a function of VGS at VDS = 0.05V at Temp = 300k

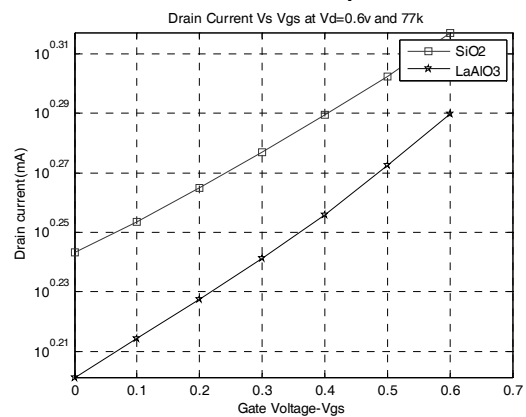


Fig.4.c. Characteristics of ID as a function of VGS at VDS = 0.05V at Temp = 77k

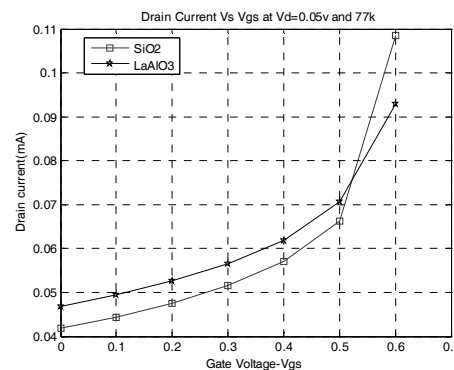


Fig.4.d. Characteristics of ID as a function of VGS at VDS = 0.05V at Temp = 77k

In our earlier work, Double-gate FinFET structure at 15nm gate length with LaAlO₃ and TiN metal gate was designed using PADRE and the results are taken from the published work for comparison. Fig.4.e & Fig.4.f shows the temperature effects on DG-FinFET device with LaAlO₃ and TiN metal gate at 300k and 77k.

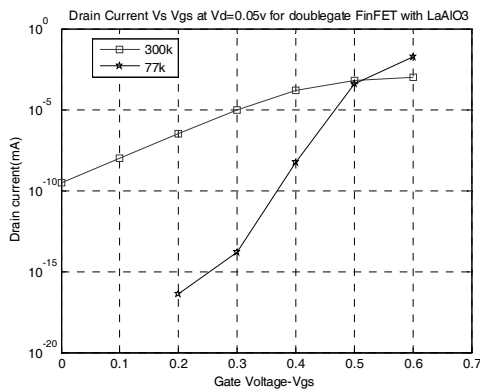


Fig.4.e.Characteristics of ID as a function of VGS at VDS=0.05V for DG-FinFET structure.

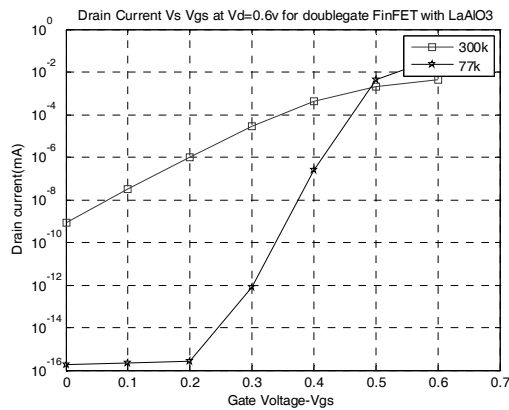


Fig.4.f.Characteristics of ID as a function of VGS at VDS=0.6V for DG-FinFET structure

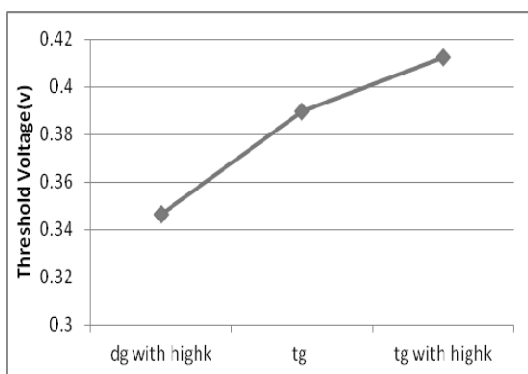


Fig.5. Plot showing effect on threshold voltage-Vth for various device structures at 15nm gate length.

Fig.4.d shows that at liquid nitrogen temperature drive current is improved compare to room temperature. TG-MOSFET with LaAlO₃ shows higher on-current and low leakage current in comparison with SiO₂ as an oxide material. Threshold voltage is also a very important parameter for higher on state current which improves the circuit speed. By increasing the top gate work-function at a

fixed side gate work-function of bulk FinFET, threshold voltage increases and off-state leakage current reduces significantly without increasing doping concentration of fin body [6]. It is because of the fact that as the increase in metal gate work-function increases the corresponding threshold voltage, which in turn reduces the off-state leakage current and results in the improvement in the device performance. Fig.5 shows the improvement in V_{th} for TG-MOSFET with high-k and TiN metal gate. Fig.6 and fig.7 depicts the major short channel effects Drain Induced Barrier Lowering and Subthreshold Slope for all the 3 device structures. It depicts that the Tri-Gate FET structure with high-k degrades the short channel effects at 15nm.

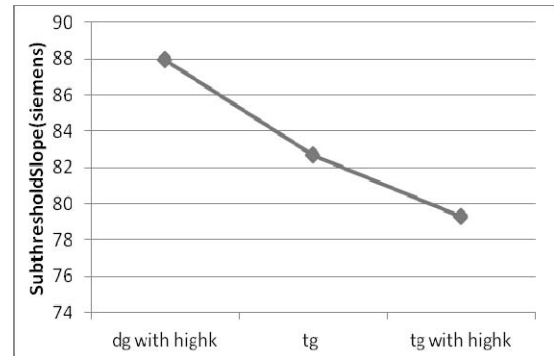


Fig.6. Plot showing effect on Subthreshold Slope-SS for various device structures at 15nm gate length.

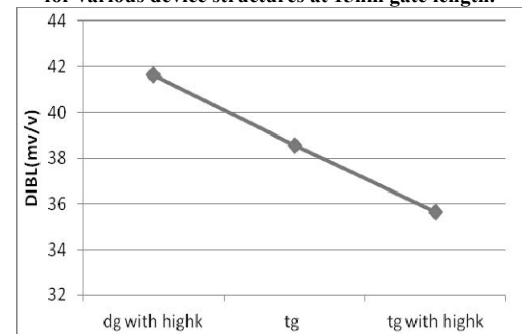


Fig.7. Plot showing effect on DIBL for various device structures at 15nm gate length

The greater capacitive coupling between gate and the channel in DG-FinFETs yields higher on-current and LaAlO₃ ($k=30$) as a gate material can yield an increase in on-current with suitable threshold and less leakage. The stand-by power of a chip is determined by the combined I_{off} of all the transistors, and as such it must be minimized to integrate millions of transistors together. From the fig.8 and fig.9 it is clear that TG-MOSFET with high-k and metal gate provides high on-current and low leakage current at 15nm gate lengths. It provides good temperature stability at 300k and 77k in comparison with conventional Tri-Gate and Double-Gate MOSFET structures with SiO₂ as an oxide material.

IV. CONCLUSION

This paper proves that TG-MOSFET structure with high-k LaAlO₃ and metal gate TiN has a better V_{th} control and it degrades short channel effects. This proposed device yields

low leakage and good temperature stability at room temperature 300k. It shows increased On-current at liquid nitrogen temperature 77k. This device can be used in infrared applications at 77k. TG-MOSFET structure provides higher drive strength and low leakage with high-k LaAlO_3 and temperature stability at 300k and 77k.

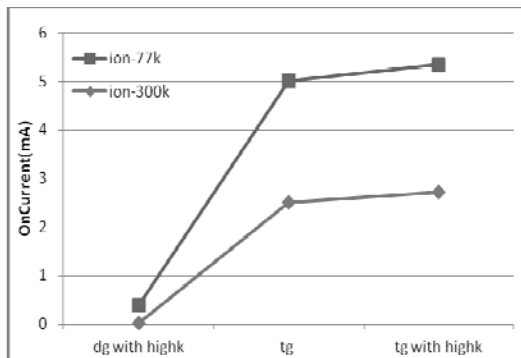


Fig.8. Plot showing effect on On-current for various device structures at 15nm gate length

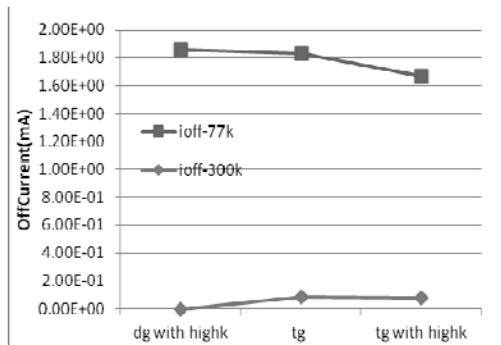


Fig.9. Plot showing effect on Off-Current for various device structures at 15nm gate length

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A STUDY OF ECOSYSTEM MODEL FOR SURVIVAL OF AQUATIC SPECIES AND INTRODUCTION OF EUTROPHICATION

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ABSTRACT

Oxygen is essential for all plants and animals to survive, whether they live on the land or in the water. Aquatic species rely on oxygen that is dissolved in the water (DO). If water is polluted because of discharge of pollutants or the water body acquires a high level of concentration of nutrients resulting excessive growth of algae (the process is called Eutrophication), due to which the level of dissolved oxygen decreases to support their lives. To analyze this ecological problem a conceptual and mathematical model is proposed. This model consists of set of non-linear differential equations with boundary conditions. After obtaining the solution of these equations it is important to study about the stability of the solution by using stability theory.

Keywords : Mathematical model, Water pollution, Dissolved oxygen (DO), algal bloom, Eutrophication.

INTRODUCTION

The water bodies near to residential areas or factories are most polluted because of constant discharge of wastes. The organic matters present in wastes are taken by small biological species (e.g., bacterias) present in water and they convert them into inorganic matters using dissolved oxygen (DO) (hence level of DO decreases). A reason for decreased DO may be fertilizer runoff from farm fields and lawns. The same fertilizer which was meant to make land plants grow better now makes the aquatic plants do the same. If the weather becomes cloudy for several days, respiring plants will use much of the DO while failing to photosynthesize. When the increased numbers of aquatic plants eventually die, they support increasing amounts of bacteria which use large amounts of DO.

There is a food chain present in water body-

Bacteria(microorganism)----->Protozoa----->other biological species-----> Fishes

This ecological problem has been studied since long. The first model of effect of organic pollutants on dissolved oxygen in a water body produced by Streeter Phelps (1925). Since then this model has been generalized by many researchers including Dobbins (1964), O Conner (1967), Beck and Young(1973) and the research is still going on.

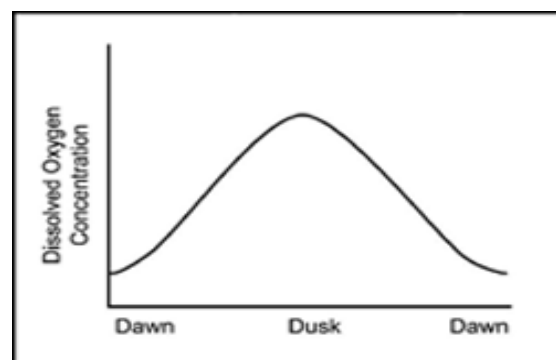
It is important to mention here that these models have only linear differential equations. They have not considered the non-linear process that exists into water body.

There are several other aspects such as natural depletion rate of pollutants, crowding of population (they kill each other to survive) growth of oxygen from green plants like algae, macrophytes etc during photosynthesis have also not been taken into account in these studies but should be considered. It may also be noted here that the level of dissolved oxygen can be increased by pumping air into the water body such as in lakes and big ponds which are used for production of fish.

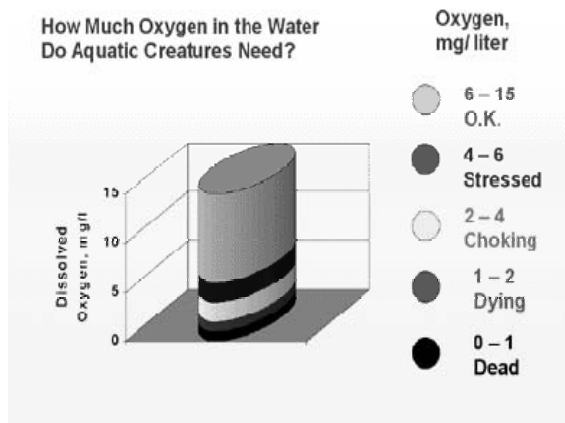
Therefore, these aspect needs to be considered in the modeling process.

STATISTICS OF DO IN WATER BODY :

DO levels rise from morning through the afternoon as a result of photosynthesis, reaching a peak in late afternoon. Photosynthesis stops at night, but plants and animals continue to respire and consume oxygen. As a result, DO levels fall to a low point just before dawn. Dissolved oxygen levels may dip below 4 mg/l in such waters - the minimum amount needed to sustain warm water fish like bluegill, bass, and pike.

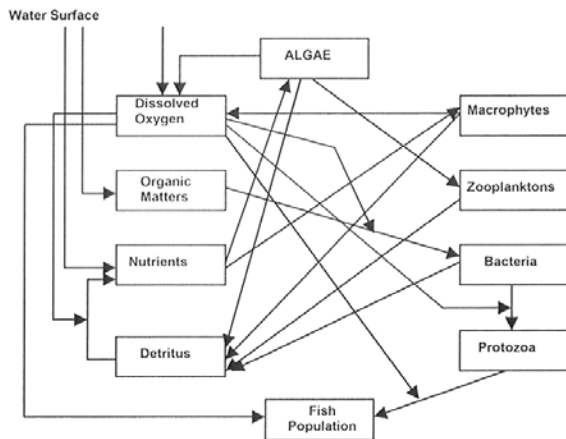


The oxygen content of natural waters varies with temperature, salinity, turbulence, photosynthetic activity of algae and plants, and atmospheric pressure. Primary sources of oxygen in water bodies include diffusion of atmospheric oxygen across the air-water interface and photosynthesis of aquatic plants



Thus, variations can occur seasonally as well as over 24-hour periods in response to temperature and biological activity. Dissolved Oxygen in a stream may vary from 0 mg/l to 18 mg/l. Readings above 18 mg/l are physically impossible. Concentrations below 5 mg/l may adversely affect function and survival of biological communities, and below 2 mg/l can lead to death of most fishes. The amount of DO an aquatic organism needs depends upon its species, the temperature of the water, pollutants present, and the state of the organism itself (adult or young, active or dormant).

CONCEPTUAL MODEL :



MATHEMATICAL MODEL :

Let us consider a water body where organic matters are discharged in the form of wastes.

It is assumed that these pollutants are part of a food chain consisting of bacteria, protozoa and other aquatic species using the dissolved oxygen into water body for various biochemical and biodegradation process.

Let us consider following notations

T – The cumulative concentration of organic matters (degradable pollutants).

B – The density of bacteria.

P – The density of protozoa.

N – The density of an aquatic population such as fish which depends wholly on protozoa.

C – The concentration of dissolved oxygen.

Q – The constant rate of cumulative discharge of organic pollutants in water body.

q – The growth rate of dissolved oxygen by various sources including atmospheric diffusion and pumping of air into water body.

System of nonlinear differential equations :

$$\frac{dT}{dt} = Q - \alpha_0 T - \frac{K_1 TB}{K_{12} + K_{11} T} \quad (1.1)$$

$$\frac{dB}{dt} = \frac{\lambda_1 K_1 TB}{K_{12} + K_{11} T} - \alpha_1 B - \lambda_{10} B^2 - \frac{K_2 BP}{K_{21} + K_{22} B}$$

$$\frac{dP}{dt} = \frac{\lambda_2 K_2 BP}{K_{21} + K_{22} B} - \alpha_2 P - \lambda_{20} P^2 - K_3 PN$$

$$\frac{dN}{dt} = \lambda_3 K_3 PN - \alpha_3 N - \lambda_{30} N^2$$

$$\frac{dC}{dt} = q - \alpha_4 C - \lambda_{12} \frac{K_1 TB}{K_{12} + K_{11} T} - \lambda_{23} \frac{K_2 BP}{K_{21} + K_{22} B} - \lambda_{34} K_3 PN - \lambda_{11} \alpha_1 B - \lambda_{22} \alpha_2 P - \lambda_{33} \alpha_3 N$$

Where $T(0) > 0$, $B(0) > 0$, $P(0) > 0$, $N(0) > 0$, $C(0) > 0$

In this model all the coefficients are assumed positive. The constants λ_{10} , λ_{20} , λ_{30} are crowding coefficients of bacteria, protozoa and aquatic population respectively.

In the following lines, we analyzed this model by using the qualitative theory of differential equations. It may be pointed out here that for feasibility of the above mathematical model, the growth rate of bacteria and protozoa should be positive.

Now we find the region of attraction Ω for model (1.1), the proof of which is outlined here in the following lemma

SOLUTION (FEASIBILITY) OF MODEL (1.1) :

The region of attraction in the positive octant, is given by

$$\Omega : \left\{ 0 \leq T \leq \frac{Q}{\alpha_0}, 0 \leq B \leq R_B, 0 \leq P \leq R_P, 0 \leq N \leq R_N, 0 \leq C \leq \frac{q}{\alpha_4} \right\}$$

Where,

$$R_B = \frac{\lambda_1 K_1 Q}{\lambda_{10} (K_{11} Q + K_{12} \alpha_0)}, R_P = \frac{\lambda_1 \lambda_2 K_1 K_2 Q}{\lambda_{20} [K_{22} \lambda_1 K_1 Q + \lambda_{10} K_{21} (K_{11} Q + K_{12} \alpha_0)]}$$

$$R_N = \frac{\lambda_1 \lambda_2 \lambda_3 K_1 K_2 Q}{\lambda_{20} \lambda_{30} [K_{22} \lambda_1 K_1 Q + \lambda_{10} K_{21} (K_{11} Q + K_{12} \alpha_0)]}$$

Proof:

From the first equation of the model (1.1), we get

$$\frac{dT}{dt} \leq Q - \alpha_0 T$$

$$\Rightarrow \frac{dT}{Q - \alpha_0 T} \leq dt$$

Integrating both sides with respect to t,

$$\int \frac{dT}{Q - \alpha_0 T} \leq \int dt$$

$$\Rightarrow -\frac{1}{\alpha_0} \log(Q - \alpha_0 T) \leq \int dt + \log c_1$$

$$\Rightarrow \log(Q - \alpha_0 T) \geq -\alpha_0 t - \alpha_0 \log c_1$$

{multiplying by $-\alpha_0$ both sides }

$$\Rightarrow \log(Q - \alpha_0 T) + \alpha_0 \log c_1 \geq -\alpha_0 t$$

Let $\log c_1^{\alpha_0} = k_1$

$$\Rightarrow \log(Q - \alpha_0 T) k_1 \geq -\alpha_0 t$$

$$\Rightarrow (Q - \alpha_0 T) k_1 \geq e^{-\alpha_0 t}$$

$$\Rightarrow (Q - \alpha_0 T) \geq \frac{e^{-\alpha_0 t}}{k_1}$$

$$\Rightarrow -\alpha_0 T \geq \frac{e^{-\alpha_0 t}}{k_1} - Q$$

On dividing the above equation by $-\alpha_0$ we get,

$$T \leq \frac{e^{-\alpha_0 t}}{-k_1 \alpha_0} + \frac{Q}{\alpha_0}$$

$$\Rightarrow T \leq -\frac{e^{-\alpha_0 t}}{k_1 \alpha_0} + \frac{Q}{\alpha_0}$$

Since $k_1 > 0, \alpha_0 > 0$ and $e^{-\alpha_0 t} > 0$

$$\frac{e^{-\alpha_0 t}}{k_1 \alpha_0} > 0$$

Therefore,

$$T \leq \frac{Q}{\alpha_0}$$

Hence

Since T be the cumulative concentration of organic matters which is positive

Hence $T \geq 0$

$$\Rightarrow 0 \leq T \leq \frac{Q}{\alpha_0}$$

This is the region of attraction for T

Now let's consider the second equation of the model (1.1), we get,

$$\Rightarrow \frac{dB}{dt} \leq -\frac{\lambda_1 k_1 T B}{k_{12} + k_{11} T} - \lambda_{10} B^2$$

$$\frac{\lambda_1 k_1 B}{\frac{k_{12}}{T} + k_{11}} - \lambda_{10} B^2$$

$$= \frac{\lambda_1 k_1 B}{\frac{k_{12} \alpha_0}{Q} + k_{11}} - \lambda_{10} B^2$$

$$\Rightarrow \frac{dB}{dt} \leq \frac{\lambda_1 k_1 B}{\frac{k_{12} \alpha_0}{Q} + k_{11}} - \lambda_{10} B^2$$

$$\Rightarrow T \leq \frac{Q}{\alpha_0}$$

Since

$$\Rightarrow \frac{dB}{dt} \leq \frac{\lambda_1 k_1 B Q}{k_{12} \alpha_0 + k_{11} Q} - \lambda_{10} B^2$$

$$\frac{\lambda_1 k_1 Q}{k_{12} \alpha_0 + k_{11} Q} = m_1$$

Let $\lambda_{10} = m_2$, a constant and

Hence the equation becomes,

$$\frac{dB}{dt} \leq m_1 B - m_2 B^2$$

This is an linear diferential equation, we can solve it by variable separable method,

$$\Rightarrow \frac{dB}{m_1 B - m_2 B^2} \leq dt$$

$$\Rightarrow \frac{dB}{B(m_1 - m_2 B)} \leq dt$$

By using partial fraction, it can be written as,

$$\frac{dB}{m_1 B} + \frac{m_2}{m_1} \frac{dB}{(m_1 - m_2 B)} \leq dt$$

Now integrating both sides,

$$\int \frac{dB}{m_1 B} + \frac{m_2}{m_1} \int \frac{dB}{(m_1 - m_2 B)} \leq \int dt$$

$$\frac{1}{m_1} \log B + \frac{m_2}{m_1} \frac{\log(m_1 - m_2 B)}{-m_2} \leq t + \log c_1$$

$$\frac{1}{m_1} \log B - \frac{1}{m_1} \log(m_1 - m_2 B) \leq t + \log c_1$$

$$\frac{1}{m_1} \log \frac{B}{(m_1 - m_2 B)} \leq t + \log c_1$$

$$\Rightarrow \log \frac{B}{(m_1 - m_2 B)} \leq m_1 t + m_1 \log c_1$$

$$\Rightarrow \log \frac{B}{(m_1 - m_2 B)} - m_1 \log c_1 \leq m_1 t$$

let $c_1^{k_1} = c_2$

$$\Rightarrow \log \frac{B}{(m_1 - m_2 B)} \frac{1}{c_2} \leq m_1 t$$

$$\Rightarrow \frac{B}{(m_1 - m_2 B)} \frac{1}{c_2} \leq e^{m_1 t}$$

$$\Rightarrow B \leq (m_1 - m_2 B) c_2 e^{m_1 t} \dots\dots\dots(i)$$

as we know B is the density of protozoa hence

$$B \geq 0$$

Consider the right hand side of above inequality,

$$m_2 > 0$$

$$c_2 > 0$$

(since $c_2 = c_1^{m_1}$ and c_1 is positive constant) ,
 $e^{m_1 t} > 0$

$$\Rightarrow m_2 c_2 e^{m_1 t} > 0$$

hence the bracket part of equation (i) has to be positive

$$\text{therefore, } m_1 - m_2 B \geq 0$$

$$\Rightarrow B \leq \frac{m_1}{m_2}$$

Now after substituting the value of m_1 and m_2 , we get

$$\Rightarrow B \leq \frac{\lambda_1 k_1 Q}{\lambda_{10} (k_{11} Q + k_{12} \alpha_0)}$$

$$\Rightarrow 0 \leq B \leq R_B$$

Hence the second result

Similarly from the third and fourth equation of the model (1.1), we get,

$$\Rightarrow 0 \leq P \leq R_P \quad \text{where}$$

$$R_P = \frac{\lambda_1 \lambda_2 K_1 K_2 Q}{\lambda_{20} [K_{22} \lambda_1 K_1 Q + \lambda_{10} K_{21} (K_{11} Q + K_{12} \alpha_0)]}$$

$$\text{and } 0 \leq N \leq R_N \quad \text{where}$$

$$R_N = \frac{\lambda_1 \lambda_2 \lambda_3 K_1 K_2 Q}{\lambda_{20} \lambda_{30} [K_{22} \lambda_1 K_1 Q + \lambda_{10} K_{21} (K_{11} Q + K_{12} \alpha_0)]}$$

Now consider the last equation of the model,

$$\frac{dC}{dt} \leq q - \alpha_4 C$$

$$\frac{dC}{q - \alpha_4 C} \leq dt$$

after integrating both sides with respect to t, we get,

$$-\frac{1}{\alpha_4} \log(q - \alpha_4 C) \leq t + \log n_1$$

(n_1 is a constant) multiplying above inequality by $-\alpha_4$, we get,

$$\log(q - \alpha_4 C) \geq -\alpha_4 t - \alpha_4 \log n_1$$

$$\Rightarrow \log(q - \alpha_4 C) n_2 \geq -\alpha_4 t \quad (\text{let } n_1^{\alpha_4} = n_2)$$

$$\Rightarrow (q - \alpha_4 C) \geq \frac{e^{-\alpha_4 t}}{n_2}$$

$$\Rightarrow C \leq \frac{q}{\alpha_4} - \frac{e^{-\alpha_4 t}}{n_2 \alpha_4}$$

$$\frac{e^{-\alpha_4 t}}{n_2 \alpha_4} > 0$$

$$\text{Here, } \frac{e^{-\alpha_4 t}}{n_2 \alpha_4} \quad (\text{since } n_2 > 0, \alpha_4 > 0) \quad \text{and} \quad e^{-\alpha_4 t} > 0$$

$$\Rightarrow C \leq \frac{q}{\alpha_4}$$

Since C is the concentration of dissolved oxygen hence it is positive

$$\Rightarrow 0 \leq C \leq \frac{q}{\alpha_4}$$

Hence the lemma is proved.

CONCLUSION:

From the above analysis we get the region of attraction of each variable. Now this model can be analysed by considering two possibilities:-

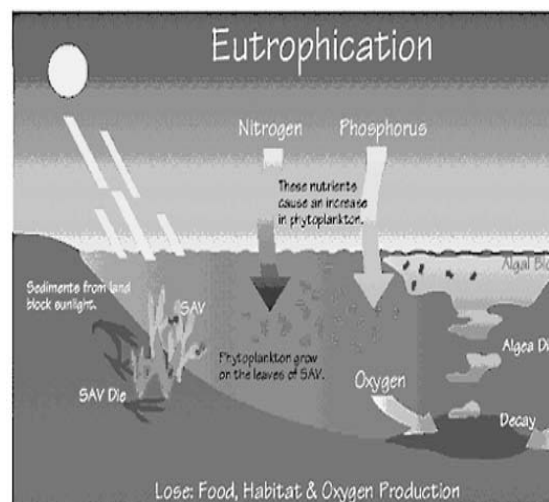
- (1) When $Q = 0$ i.e. when organic matters (pollutants) are discharged instantaneously into a water body at $t = 0$ with the cumulative concentration $T_0 > 0$
- (2) When $Q \neq 0$ i.e. the discharge rate Q is a constant.

By considering these cases we can analyze the stability of equilibrium points.

INTRODUCTION OF EUTROPHICATION :

Definition : Eutrophication is a process by which a water body becomes rich in nutrients (primarily phosphorus, nitrogen and carbon). It leads the excessive growth of algae. As the algae die and decompose, high levels of organic matter and the decomposing organisms deplete the level of dissolved oxygen, causing the death of other organisms, such as fish and other aquatic species. This is a natural slow-aging process.

IMAGE OF EUTROPHICATION :



IMPACT OF EUTROPHICATION :

Fertilizers are often used in farming, sometimes these fertilizers run-off into nearby water causing an increase in nutrient levels. This causes phytoplankton to grow and reproduce more rapidly, resulting in algal blooms. This bloom of algae disrupts normal ecosystem functioning and causes many problems. The algae may use up all the oxygen in the water, leaving none for other marine life. This results in the death of many aquatic organisms such as fish, which need the oxygen in the water to live. The bloom of algae may also block sunlight from photosynthetic marine plants under the water surface. Some algae even produce toxins that are harmful to higher forms of life. This can cause problems along the food chain and affect any animal that feeds on them.

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FACULTY PERFORMANCE IMPROVEMENT: SURVEY OF FACTORS AND REMEDIES AT AIKTC

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ABSTRACT

Improvements in quality teaching-learning help in effective concept learning by the students. This has become a mandatory requirement for the institutes providing professional courses like Engineering, Architecture and Pharmacy. This is because in such courses the focus is on learning concept so as to apply it in professional career of the students. In most of the cases different subjects of the professional courses are taught by different faculties. Their way of lecture delivery differs from person to person. The performance of the students is affected by some external factors as well as by the performance of their teachers. A survey of the factors affecting the students' performance was done from the teaching faculties and the most significant factor was considered for improvement. The current paper aims at getting the responses of teachers having highest students' feedback score through a questionnaire. The responses are for the factors affecting the performance of faculty. Based on the outcome of the survey the strategy to improve the teaching-learning process was decided.

Keywords : Quality, Faculty performance; Engineering Education, Professional Courses;

I. INTRODUCTION

There is always a requirement for improvements in the quality of education. It becomes more important when it comes to professional education as the students have to implement the skills learnt in the institutes. In order to increase the quality of education, the faculty performance is required to be improved. One of the very important parameter for the performance of the faculty is the performance of the students to whom the faculties are teaching. Many researchers [1, 2] have tried to investigate the factors that affect the performance of faculty so that proper action can be taken for improvements. Many researchers have proposed different methods for improving the performance of students [3, 5]. Some have tried to find out solutions for enhanced learning by the use of different tools to evaluate the courses taught in the institutes [4, 6, 7]. In a few papers the researchers aimed at the use of technology for improvements in the teaching learning process [5, 10]. It is equally important to inculcate moral and ethical values in students so that they will use the skills learnt

Islam's Kalsekar Technical Campus (AIKTC) consisting of School of Engineering, School of Pharmacy and School of Architecture, we have our slogan as "INNOVATIVE TEACHING & EXUBERANT LEARNING." In order to facilitate the teaching learning process, student feedback is taken as per the form provided (Table 1). The students have to rate the faculty for different points as mentioned in the form. The results of the feedback are then analyzed and every faculty gets an average score. In the current paper, top scorers from the six departments were identified and a survey questionnaire was given to them. Along with this an online and offline survey was conducted for investigating the factors affecting students performance. As the study was limited to AIKTC the respondents were the faculty members from all the three schools and a polytechnic in the same campus. Based on the results of the survey, the critical factors were considered for improvement.

Table 1 Students Feedback format

Sr. No.	Feed Back Question
1	Teacher Command on his/her subject (Depth of subject Knowledge)
2	Teacher's timely conduction of lectures, practical and Tutorials
3	Clear and Comprehensive explanations of the subject
4	Thought provoking interactions during theory and practical sessions
5	Efforts in making students understand subject (use of charts/Videos/models/ppts)
6	Availability and cooperation of teacher whenever help was sought
7	Timely assessment of experiments, Assignments, Test papers
8	Overall how would you rate the quality of teaching imparted by the teacher
9	Overall rating (filled by Dean/HOD)

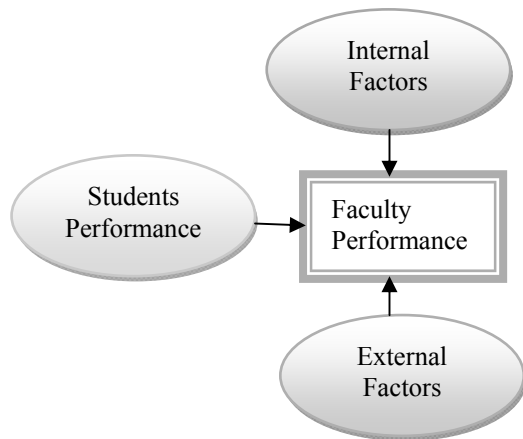


Fig.1 Factors affecting faculty performance

II. METHODOLOGY

It was found that the faculty performance gets affected by Internal Factors, External factors and the performance of the students [1] (Fig.2). In order to find the most critical factors that affect the performance of student's two different questionnaires (one for internal factors and the other for external factors) were given to the identified faculty members. The faculty members were asked to rate the different factors on a scale of 5 with 5 for the severely affecting factor and 1 for the least affecting factor. In addition to this responses from different faculty members of the campus were taken randomly for investigating the factors affecting the performance of students. The same scale was used for these responses. For this survey online responses from 27 respondents and questionnaire based responses (offline) from 25 respondents was taken. Two most severe factors from each category were selected and remedies for the identified processes were proposed.

III. THE INTERNAL FACTORS

The Internal factors are those factors which are related to the faculty himself such as the personality of the faculty, the confidence while he is teaching the students, the social background of the faculty etc.

Table 2 Internal Factors

Sr. No.	Internal Factors
1	Does class control affect your performance?
2	If the interest of students affect your teaching...
3	Does confidence affect your teaching?
4	Does revision of the topic for updating your subject knowledge affect your teaching?
5	If prior assessment of knowledge understanding level of students affects your teaching...
6	Does planning your lessons before the commencement of every semester help in

7	better teaching the subject? If the fear of syllabus completion has some impact on your performance...
8	Does being very rigid with the students affect your teaching?
9	Do friendly relationships with the students affect your teaching?
10	Does a lax attitude with the students affect your teaching?
11	Rate your concern for every student in a class of 60? (Scale of 5)
12	How many times do you reprimand your students if they don't pay attention? (Scale of 5)
13	Does an interactive session affect your teaching?

Severely Affecting – 5, Less Severely Affecting– 4, Affecting-3, Somewhat affecting-2, Least affecting - 1

The Internal factors were rated on a scale of five.

IV. THE EXTERNAL FACTORS

The Factors that are not in control of the faculty are referred to as the external factors. A few external factors were considered and their impact on the performance of a faculty was found through the questionnaire. The external factors are as listed below.

Table 3 External factors

Sr. No.	External Factors
1	Not getting your favorite subject affects your teaching...
2	Given lecture slot in all the classes you teach...
3	back to back lectures...
4	Motivating environment across the campus...
5	students' irregular attendance during your lecture affect your performance...
6	extra curricular activities along with teaching affects teaching
7	Lack of Technological resources like projector, Internet..
8	Interpersonal relationship with your supervisor
9	Interpersonal relationship with your junior
10	Salary...
11	Transport Facility
12	Your family responsibilities affect your performance
13	Charging some extra amount to the students for workshops and industrial visits...
14	support from the students' parents

Severely Affecting – 5, Less Severely Affecting –4, Affecting-3, Somewhat affecting -2, Least affecting- 1

V. FACTORS AFFECTING STUDENT PERFORMANCE

Performance of the faculty also depends on the performance of the students. Because of this reason factors that affect the performance of the students were considered and input was taken from the faculties belonging to different professional courses like Engineering, Pharmacy and Architecture. The survey was carried out through an online questionnaire and also by an offline mode.

Table 4 Factors Affecting Students Performance

Sr. No.	Factors
1	Commutation
2	Medium of answer during schooling
3	Maturity of student
4	Attendance in Theory & practical
5	Coaching classes in weekends
6	Mobile Addiction
7	Internet Addiction
8	Sports Addiction
9	Bad Friend Circle
10	Influence of Opposite Gender

VI. RESULTS AND DISCUSSIONS

A. Internal Factors :

The results of the survey of internal factors affecting the performance of the faculty are as shown in Fig. Referring to the quantitative values of each factor it is found that factor 1,3 and 13 have a score of above 4. These are related to class control, Confidence of the faculty and student interactions. Thus in order to improve the performance of the faculty these skills that is the confidence and controlling ability during the lectures is to be inculcated amongst the faculties. The faculties should also be trained for making their lectures interactive which is also an indicator for the performance improvement.

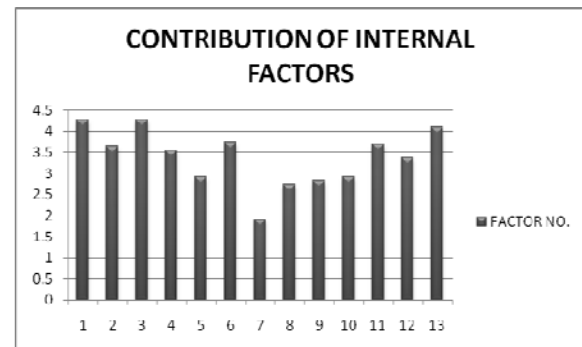


Fig.2 Contribution of Internal Factors

B. The external factors:

The results of the survey of external factors affecting the performance of the faculty are as shown below. From the diagram it is clear that factor no. 4,8 and 1 are amongst the significant contributors for the improvement of the faculty performance. These are motivating campus environment, Interpersonal relationship with the supervisor and not getting the favorite subject. Thus by providing a conducive working environment across the campus and considering the choice and interest of the faculties for their subject will improve the performance of the faculties.

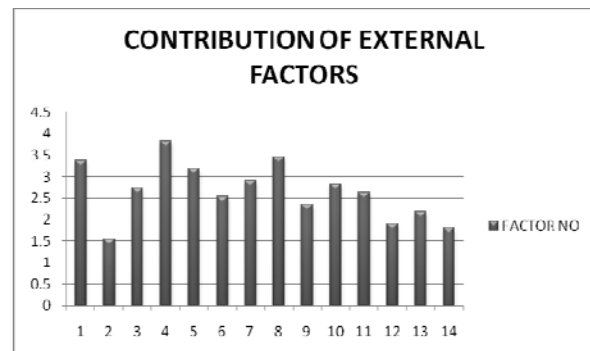


Fig.3 Contribution of External Factors

C. Factors affecting students performance:

The results of the survey of factors affecting the performance of the students are as shown in Fig. Here the survey was carried out in two ways first by an online mode and secondly by an offline mode. The results are shown on the same chart. It can be found that factors 9,4,6 and 7 are the most significant according to the online respondents while 1,6 and 7 are most severe according to the offline respondents so factors 6 and 7 are amongst both the groups so can be considered as critical. These are Mobile Addiction and Internet addiction. So by providing an environment where the students will be made aware about the effect of these factors on their performance, the effect of these factors can be reduced. Amongst the other factors that affect the student performance are poor attendance of students, Bad friend circle and to and fro commutation of students from their homes to college.

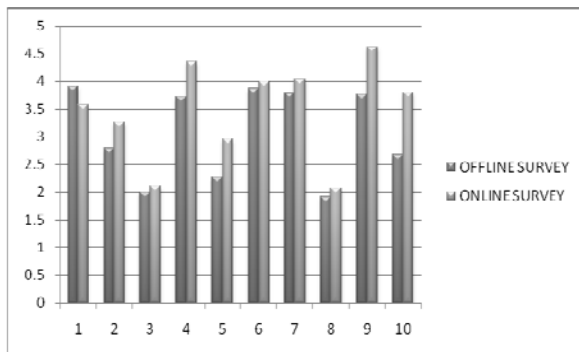


Fig.4 Contribution of Factors Affecting Students Performance

VII. REMEDIES

The following remedies can be adopted to improve the faculty performance

1. Training the faculties for adopting the skills on controlling the class during the lectures.
2. Thorough preparation of the subject, planning the topics as well as sub topics before conducting the lecture in order to gain some confidence.
3. Providing an interactive environment in the class so that the students participate during the lectures.
4. Developing conducive, motivational and friendly environment amongst the faculty members.
5. As far as possible taking the consent of faculty members while allotting the subjects at the start of the term.
6. Conducting awareness campaign in the campus for the misuse and addiction of mobile as well as social networking sites.
7. Creating the awareness amongst the students about the effect of a bad friend circle on their career.

Adopting some means for improving the attendance of students in theory as well as practical.

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COHESIVE APPROACH TO AMALGAMATE GOALS OF INFORMATION SECURITY MANAGEMENT FUNCTION WITH CORPORATE GOALS OF ENTERPRISE

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ABSTRACT

The activities of information security management function are most of the times based on imprudent knee-jerk reactions such as remediation of operational vulnerabilities rather than enhancing the corporate strategy. This disengagement between information security operations and strategic corporate objectives results in pressure to control security spending while risks, incidents and losses continue escalating to unsustainable levels. Hence it is necessary to have cohesive approach in the corporate objectives of an enterprise and the activities of information security management function. This can provide an intentional and powerful tool and source for competitive edge, creating support for additional expenditures for this function. This develops a business oriented approach while managing information security in the context of framework such as Control Objectives for Information and related Technology (COBIT). It utilizes integrated systems thinking to clarify complex relationships within the enterprise, and thus to more effectively manage the information security function.

INTRODUCTION

Organizations are spending and hiring information security practitioners on record numbers and legislation and regulations are ever increasing. Despite this effort, nearly every statistical measure of performance, from the number of incidents and vulnerabilities to the cost and impact of a breach, demonstrates that the problems are getting worse. It has been an interesting observation that more investments in terms of money and technology has not been able to reverse this trend. Further, the extent of enterprise adoption of information security management function and related practices vary widely across countries and industries. There are several factors that may be attributed for this, such as availability of skilled and experienced practitioners, uncertain outcomes of efforts in other organizations and, perhaps the most telling, actual value realized from information security management function.

Although the information security management function is more than 20 years old, generally it has not been given the due recognition it deserves for being able to bridge business and IT strategies effectively. There is wide acceptance of the need for strategic IT planning and information security management architecture (COBIT processes PO1 and PO2 respectively). The information security profession suffers from several problems that lead to

security program. One of the major reasons is the focus on technology. Many practitioners in the information security field are information technology (IT) engineers and technicians who just “happen to be in the field of Information security” Their training and background is technical, so they overlook the elements that technology depends on organization, people, processes and systems. Efficient and effective information security requires a balance among these elements. This lopsided technical focus can isolate the information security function from the other stakeholders in an organization and can create a gap between information security and the business units. Another reason is that the organizational leaders are concerned with other risks, such as physical security, legal financial and safety, in addition to information and technology. It is observed that both the sides continue to think in silos and fail to understand how all of these risks are interrelated. Under this situation, the investments in such unbalanced security programs cannot deliver the “value”, while the organizations continue to demand a greater return on their information security investments.

THE INTEGRATED SYSTEMS APPROACH

From the above discussion it is clear that the security functions are short of holistic approach and are ad hoc, reactive and tactically focused. Presented below is a holistic system approach, towards information security management, focused on business, not only technology. This approach blends technology with the strategic direction and needs of the organization. In coming together, they form a holistic and dynamic approach to information security that is both predictive and proactive as it adapts to changes, considers the organizational work culture and delivers value to the business.

This approach requires that the organization is sensitized towards adopting information security in its culture. This sensitization process has following important components :

- **Risk Analysis** -- Information security practitioners must understand the business, its objective, operating and regulative environment, potential threats, risk impacts, operational flexibility. Only then can appropriate control be selected to mitigate risk effectively. Information security controls often are implemented with little or no assessment of the actual risks and

threats to an organization, which results in failure to protect valuable assets or wasteful overprotection.

- **Concurrency of Corporate objective and information security** -- The Information Security program should align with the organization from the boardroom to end users, and information security controls should be practical and provide real measurable risk reduction.
- **Equilibrium between organization, people, systems, process and technology** -- effective risk management requires organizational support competent people, effective systems, standardized processes and the selection of appropriate technology. Each element impacts and supports the other elements, in complex ways, so it is crucial to achieve the balance among these elements.
- **Convergence of security strategies** -- To maximize return on investment, all security functions (Data or Information security, environmental security etc.) should be properly integrated. Nonaligned security functions are wasteful and hinder the identification and mitigation of cross- functional risk.

As can be seen the approach is independent of any particular technology or technical changes overtime and is therefore applicable across wide range of industries, geographies and regulatory and legal systems. Also it should be seen as a long-term exercise that will ultimately aid the enterprise in achieving business goals. In fact, it may help to think of it as a key to organizational maturity. The maturity of the information security program is often related to the maturity of the enterprise, which is linked to the degree to which systemic thinking is used in the organization.

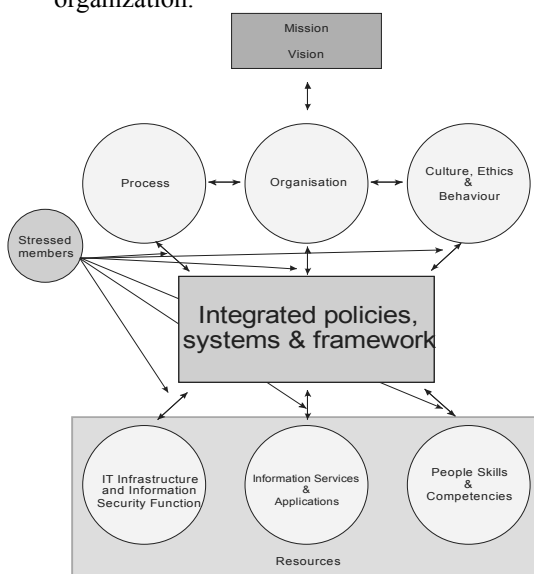


Fig 1. Framework depicting integration of IT Security & corporate objectives

The figure (1) depicts this integrated system approach. It includes the traditional elements of a people, systems/process and technology and adds organization- design and strategy.

From an information security practitioner's perspective the interplay and dependency among these entities, the stress-members, create the opportunity to integrate the information security program with the business by focusing on the issues that too often are overlooked. The stress-members are logical linkages between organization, culture, processes, IT-infrastructure & security function management, information services, people skill and communication; connected to integrated policies, systems and framework.

These stress-members interact with each other and the entities in complex dynamic and sometimes competing ways. The role of information security function is not to eliminate the tensions among these stress members but to recognize and understand their interactions to create a more comprehensive information security program by addressing the whole organization. Some of the benefits gained by this approach are;

- Recognizing new and unidentified risks and evaluating them cross- functionally.
- Linking different information security value chains within the context of the extended enterprise
- Facilitating the analysis of risks and control implementation on the whole organization.

Fig 2 shows the 5-stages process flow indicating how the above mentioned integrated framework can put into practice. As can be seen, the integrated framework development stage encompasses Business vision and IT & Info security function. A critical component of this new approach is that the technology element is not restricted to a particular vendor, architecture, protocol or standard and more important, focus is not on the technology, but rather the interaction of the technology with the rest of the organization. This framework, for Information Security enables security professionals to examine security from integrated systems point of view, creating an environment where actual risks can be effectively addressed.

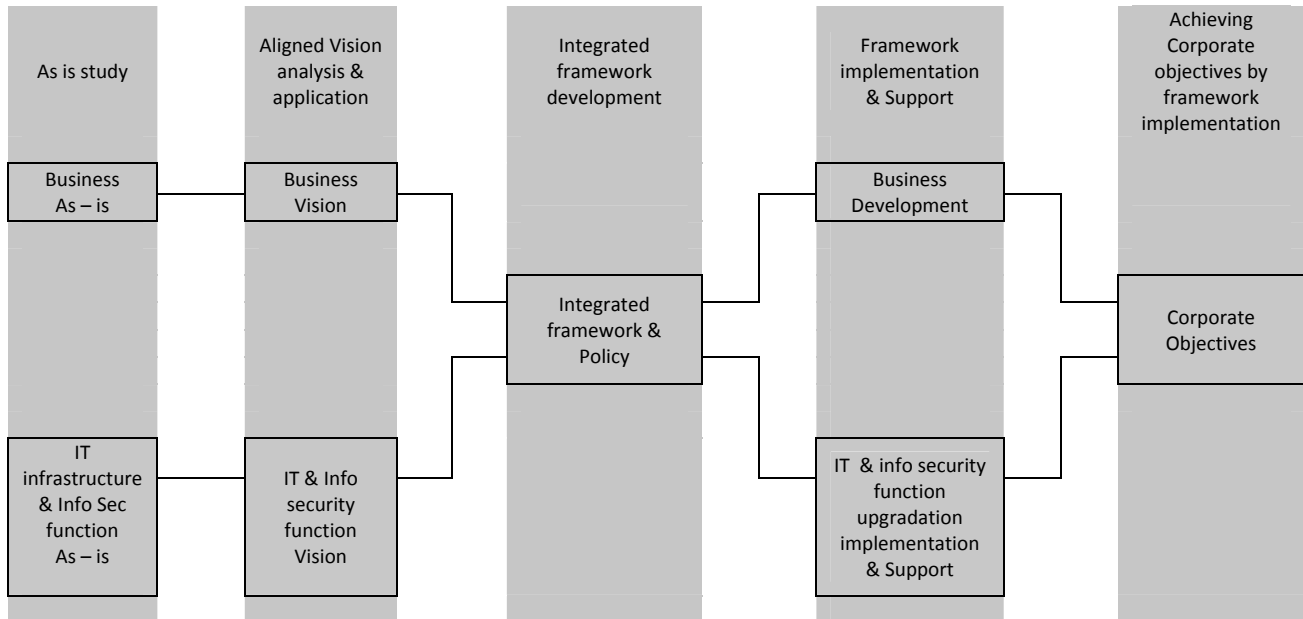


Fig 2. Process flow for integrating IT, Info security and Corporate Objectives

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FACILITY MANAGEMENT : A NEW REFORM FOR ENGINEERING INSTITUTION

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ABSTRACT

Facility Management (FM) is well known concept in corporate culture. FM plays very crucial role in education sector. It takes care of sanitation, health & hygiene of students as well as staff. Creating a healthy & soothing ambience enhances efficiency & productivity. Modern sophisticated high tech equipment / Instruments are now available for the purpose of cleaning. Therefore, this paper describes Facility Management Department as a new reform for elevating standards of an Engineering Institute.

INTRODUCTION

Facility Management refers to an interdisciplinary field that involves operation, maintenance & security of commercial as well as institutional building's especially outsourced. It is felt that to raise the standards indirectly in educational system FM is important. Maintaining cleaning standards is necessary, as it is the responsibility of the organization to create the right work environment for its employees. Cleanliness improves the productivity & work efficiency. Cleaning is the most important function & ingredient of the Engineering institutions.

FM is the second largest contributor to the operational cost. FM encompasses almost everything that comes in & out of the premises/campus. FM is a profession which integrates people, place, process & technology.

With global exposure, customers expect better quality & standards. The present turnover of FM industry around USD \$6bn. (2) In the competitive edge & drastic awareness, health consciousness the FM has become paramount. In FM it is very important to have right blend of latest equipment's & manpower. FM has taken a paradigm shift. Lot of new management concepts such as 5 S, Six sigma, Quality Circle EMS 140001, OSHASIS 18000 have been utilized in FM industry.

FM at Vidyalankar Institute of Technology:

In Vidyalankar Institute of Technology we have a full fledged FM department. Authors have a strong belief

that none of the education institute in Maharashtra has such FM department. FM takes care of their Sanitation & hygiene. FM department is equipped with latest cleaning machines such as Surface cleaning machine, Vacuum cleaning machine. Etc. Skilled & trained manpower is being deployed for sanitation, cleaning work. Purifiers are provided for bacteria free drinking water facility. HVAC system takes care of cool air. Underground & Overhead water tanks are cleaned to avoid any water contamination. High volume STP (Sewage Treatment Plant) is there to recycle sewage water. For safety purpose all labs are equipped with smoke detectors. Fire extinguishers & Fire alarms are placed in the campus. Full campus is under CCTV surveillance 24 x7. Well-equipped gymkhana is located at basement of the college to full fill the sports activities. Overhead projectors are placed in each class room & labs for teaching & presentation. Well-equipped Auditorium & Seminar halls are available for workshops, seminars, National & International conferences.

ORGANOGRAM OF FM IS AS FOLLOWS :

It consist of Director, Chief Operating officer, Sports officer, Event coordinator, Administrative staff, Support staff & Contract staff. Structure of FM department is depicted in Fig.

Director is the highest & top most position of management who does corporate & strategic planning. All Corporate & strategic policies are framed by the management.

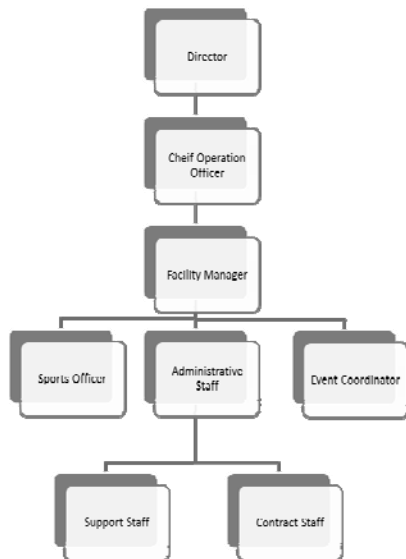
Chief operating officer monitors smooth & effective implementation of policies. Role of FM is to implement the Corporate Policies & also to get the work done. Facility Manager implements the corporate policies decided by the management with the help of FM Team.

Sports officer is overall responsible for all the sports activities which takes place in college. He is actively involve in purchasing sports equipment's, maintaining the playgrounds in good condition, to prepare sports schedule, to conduct the sports. To take teams in other colleges for inter college sports competitions.

Event coordinator prepares schedules of all forthcoming events & prepares action plans for events. All seminar hall reservations are look after by him. He is actively involved in annual day celebrations & Industrial Visits.

Administrative staff Supervises & gets the work done from support staff & contract staff.

Support staff & Contract staff are hands on Staff. They do Campus cleaning, toilet & class room cleaning etc.



Role & Responsibility of FM Department :[3]

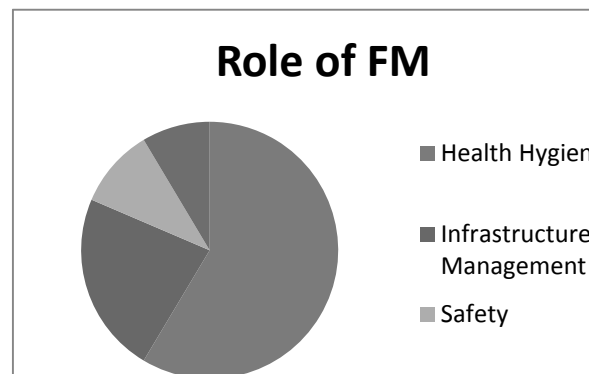
FM manager is responsible for daily operations. Some of the important duties & responsibilities of FM managers are as follows:

- preparing documents to put out tenders for contractors;
- project management and supervising and coordinating work of contractors;
- investigating availability and suitability of options for new premises;
- calculating and comparing costs for required goods or services to achieve maximum value for money;
- planning for future development in line with strategic business objectives;
- managing and leading change to ensure minimum disruption to core activities;
- liaising with tenants of commercial properties;
- directing and planning essential central services such as reception, security, maintenance, mail, archiving, cleaning, catering, waste disposal and recycling;
- ensuring the building meets health and safety requirements;
- planning best allocation and utilization of space and resources for new buildings, or re-organizing current premises;

- checking that agreed work by staff or contractors has been completed satisfactorily and following up on any deficiencies;
- coordinating and leading one or more teams to cover various areas of responsibility;
- using performance management techniques to monitor and demonstrate achievement of agreed service levels and to lead on improvement;
- Responding appropriately to emergencies or urgent issues as they arise.

FM – ONE OF THE REFORMS IN VIT : [4]

FM plays very crucial role in education sector. It takes care of sanitation, health & hygiene of students as well as staff. Healthy & soothing ambience enhances efficiency & productivity. SOP (Standard Operating Procedures) are prepared for every process. Daily check list is utilized to monitor the process. PDCA (Plan Do Check Action) cycle is followed in order to keep system in its place & to improve further. Periodic audit takes place for effective control. Walky Talky is provided for quick response & easy way of communication. Regular training is imparted to all categories of staff for improving efficiency.



Source – Hand Book of Facility Management [1]

VARIOUS EQUIPMENT'S:

Scrubber Drier



Machine is ideally suited indoor cleaning from light to medium task. It provides excellent surface cleaning. It is value for money and economical to use.

Single disk machine

High Performance Machine available with various speed capacity. Machines can be used for floor scrubbing, polishing, buffing, burnishing or spray cleaning.

Wet & Dry Vacuum Cleaner

It's a multi-purpose accessory for daily wet and dry cleaning depending upon the type of application.

Mechanical Sweeper

It is 10 times faster than manual sweeping. Sweeps more thoroughly than a broom saving time and labor. Picks up dust, granules, papers, leaves even small screws, nails and bolts, just about anything keeping surrounding neat and litter free with minimal cost and effort. It can be used as indoor on floors, outdoors on paths, roads, parking lots, petrol stations etc.

RESULTS :

FM is basically service rendering department. It is also known as support service. It has certain tangible & non tangible gains.

Tangible Gains:

1. Effective preventive maintenance helped to reduced breakdown of AC.
Maintenance cost for the year 2012 – Rs. 1,20,000.
Maintenance cost for the year 2013 – Rs. 74,000.
2. Inventory Planning & regular stock taking assist to bring down overall inventory cost.
HK Material consumption cost for the year 2012 – Rs.4,20,000
HK Material consumption cost for the year 2013 – Rs.3,60,000
3. Man Power Cost :
Due to outsourcing of staff average cost per staff is reduced by 28%.
4. Automated & mechanized cleaning machine helped to save 30% of man power which was utilized on Daily cleaning.

INTANGIBLE GAINS:

1. Clean & right work environment.
2. Cleaning standards are maintained.
3. Work place productivity & efficiency is increased.
4. Appropriate Sanitation & hygiene is being maintained.

CONCLUSION:

In the global scenario FM has got vital importance. We strongly enforce that all the Engineering Institutions should have FM department which will act as secondary support to enhance the overall conducive ambience which will subsequently help for increasing efficiency of stakeholders.

Acknowledgement:

I would like to give my sincere thanks to Management for giving me an opportunity to write & present this paper on Facility Management. I would also like to thank Dr.Sangeeta Joshi, Professor & Technical Advisor of Vidyalkar Institute of Technology for her guidance and motivation for writing this paper,

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EXPLORING RUBRIC BASED ASSESSMENT FOR STUDENTS' PROJECT

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ABSTRACT

For the continuous improvement of students, it is imperative to assess the quality of student's project and the efforts put therein. Currently engineering students' project assessment is done based on the Mumbai University's guidelines where the marks are distributed based on demonstration and seminar on the project. However, there is no guideline specified about the criteria upon which the students' project can be evaluated. In general, colleges assess students' project based on criteria which they seem fit for their own college. The usual criteria used for evaluation are project report (or synopsis), presentation, demonstration, viva-voce, attendance etc.

The effectiveness of rubrics for evaluation of students' project is not explored. This paper evaluates the effectiveness of rubric based assessment over traditional assessment of students' project. On an experiment basis, few students were subjected to both, rubric based and traditional assessment for their project. No significant change in grades or marks under both the approaches was observed. However, by using the proposed rubric based assessment, the grades or marks obtained by the students can be clearly justified leading to fewer complaints and questions regarding grades obtained by them. The discussion also points out how the rubric based assessment of students' project can help in fulfilling academic accreditation mandates.

Index terms : rubric based evaluation, project assessment, perception gap.

I. INTRODUCTION

During our time as students and now as academic practitioners, we felt that there is a perception gap between students' expectations of grades and what he/she actually gets. Unfortunately, this gap remains unexplained due to the traditional assessment approach. Were this gap to be closed, it is a reasonable assumption that student performance will improve with respect to learning outcomes, as they know what is expected of them [1]. In this currently used assessment technique, the examiner assesses the students' project on a given scale, granting random marks whichever he/she feels suitable at the given point of time under various heads like synopsis/report, presentation and viva-voce. In order to fill this gap, the traditional assessment approach needs to be replaced by Rubrics based assessment. A rubric can serve as a multi-purpose scoring tool for assessment of students' project and performances. This tool is especially useful for students who belong to non-traditional and first generation of population gaining education. Moreover, rubrics can improve teaching, assessment and act as a source of information to improve a program [5].

II. BACKGROUND & RELATED WORK

Rubrics are kind of fuzzy in nature. They are similar to checklists, but rather than a simple "yes" or "no" answer to questions, numeric scores are used to differentiate between weak, competent, strong and superior students. Rubrics can be used in classroom evaluation, research projects and accreditation evaluation [2]. As per Wolf and Stevens [5], when there are no explicit performance criteria to inform students in creating their projects or to guide the professor in assessing them, a rubric can come to their rescue. When students are unaware of how the assessment is going to be done, they are in a risky situation than students who have learned to "play the game" to excel in evaluation.

Boettger [2] presented a case study of designing six rubrics, including their creation, a description of the raters, and the training process used to achieve a statistically acceptable level of inter-rater agreement.

Andrade [7] reported an experience of using rubrics. Rubrics make it easier for the teacher to explain what is expected, and students feel that rubrics are useful. Rubrics also help in clearly explaining expectations, which are no longer hidden. Often teachers assume that the students should know what is "good" and what is "poor," however this is often not the case.

The criteria in rubrics also support students in identifying their strengths and weaknesses. Overall, based on conversations with students, the teacher found that students learned more content with the introduction of rubrics.

For computer science, a Web application development project used rubrics [8]. The results were that rubrics: 1) help in defining one's own achievement goals (i.e., the desired outcome); 2) are good at assessing oneself against self-defined standards; and 3) lead to higher satisfaction with grades. Furthermore, rubrics have been used in grading essays on ethics in computer science [9]. To test the rubrics, two teachers graded one assignment independently and compared the results. There were only slight differences in grading. In software engineering, rubrics have been suggested as a tool in higher education (cf. [10] and [11]), but no detailed evaluations and empirical results have been reported. Blair and McGinty [4] conducted a study using action research at two universities focusing on political science/history students. A majority of students at the two universities studied were convinced that verbal feedback helped them improve their learning. In fact,

students wanted feedback after exams and prior to the submission of assignments. However, according to Blair and McGinty [4], there exists a gap between the desire of students to get oral feedback and the willingness of staff to provide it. In this situation, the authors encourage the use of verbal peer feedback, such as through the discussion of examples.

Gibbs *et al.* [11] surveyed two universities (A and B) focusing on programs in physics, chemistry, and biochemistry. Teachers at university A mainly provided written feedback, while university B focused on oral feedback. Their findings were that, from an effort perspective, oral feedback is better for the teacher as it requires less time in comparison to writing detailed feedback.

However, a problem observed with oral feedback was that it is not long-lasting, as students cannot easily refer back to the information provided. Also, there is a difference in perception as to what feedback is or should be. The teachers felt that they provided feedback all the time (in lectures, laboratories, workshops, and informally). However, the students did not count that information as feedback. This might also be a reason why students do not undertake the proper effort in documenting and storing the feedback provided.

McMartin, McKenna and Youssefi [6] developed an analytic rubric associated with a scenario tool to assess students' knowledge with respect to the learning outcomes. Students were given a scenario describing a "day in the life" problem faced by engineers and were asked to describe a process they would use to solve the problem. After careful testing of the rubric and training of the scorers it was revealed that the scores reliably differentiated among student abilities. Two sample student responses to a battery scenario were presented and discussed. Their Initial findings suggest that use of the scenarios can help faculty to quickly identify students' strengths and weaknesses and adapt their course to address the areas where students need attention.

Feldt, Host and Luders[3], conducted a survey where 23 students from three different Swedish Universities were asked about which generic skills are needed and developed in a Master thesis project in software engineering. The survey analysis showed that there is a definite lack of understanding of what generic skills are needed and how to assess them in software engineering thesis projects.

III. RESEARCH DESIGN

A. Rubric Design

To check the perception gap we conducted an experiment by assessing 10 students of St. Francis Institute of Technology, Borivali, Mumbai. The evaluators assessed their projects in both the ways viz. traditional assessment and rubrics based assessment. For rubrics based assessment, we have proposed separate rubrics

for synopsis/report, presentation and viva-voce; the design for the same is as shown in the table I through table III as follows.

B. Data collection and analysis

Data collection:

Same set of students were subjected to evaluation using both the traditional assessment and rubrics based assessment. They were evaluated for synopsis/report, presentation and viva-voce. Two separate sheets for assessment were used which were collected at the end of the evaluation. The evaluators were given sufficient understanding about the new rubric based assessment before the assessment commenced. However the students were unaware of this dual assessment. The duration of evaluation was twenty five minutes comprising of fifteen minutes of presentation, five minutes for viva-voce and five minutes for synopsis/report evaluation.

Grade calculation:

The weightage of marks for synopsis/report, presentation and viva-voce are five each. The calculation of score under traditional assessment was simply addition of marks under the three categories viz. synopsis/report, presentation and viva-voce.

Whereas, the rubric normalized score (i.e. basically a percentage grade) is calculated as

$$G_s = \frac{\sum_{i=1}^N (g_i - \min_i)}{\sum_{i=1}^N (\max_i - \min_i)} \quad \dots (1)$$

Where $g_i \in \mathbb{N}$, is the number of points given to the i^{th} criterion, $\min_i \in \mathbb{N}$ is the minimal possible number of points for the i^{th} criterion, $\max_i \in \mathbb{N}$ is the maximal possible number of points for the i^{th} criterion and $N \in \mathbb{N}$ is the number of criteria in the rubric.

Example: Consider the synopsis assessment form with five criteria, each having five levels. The evaluator chooses level with 5 points for first criteria; and 4, 5, 3 and 2 for the remaining criteria respectively. Then the normalized score as per the formula (1) is:

$$G_s = \frac{(5 - 1) + (4 - 1) + (5 - 1) + (3 - 1) + (2 - 1)}{(5 - 1) + (5 - 1) + (5 - 1) + (5 - 1) + (5 - 1)}$$

$$G_s = 70\%$$

This score is a percentage of the maximum marks or points awarded for synopsis. Hence the marks or points obtained by a student as per the above example is 70% of 5 marks, which equals 3.5 marks, which can then be rounded up to 4 marks. This can be seen in the graph shown in fig. 1

	Excellent(5)	Good(4)	Average(3)	Fair(2)	Poor(1)
Language Spelling, Wording, Grammar, Sentence Structure, Paragraph Structure	There are no errors that impair the flow of communication. (Perfect with <2 errors)	There are few errors that impair the flow of communication. (There are <5 errors)	Occasional errors that have only minor impact on the flow of communication. (A few minor errors)	Frequent errors that impede the flow of communication. (A few more serious errors)	Errors are serious and numerous. Reader must stop and reread to decipher the authors meaning. (Multiple, serious errors)
Format Layout & Length	All required formal information is present and correct	All required formal information is present but something is unclear	A few minor deviances from the proposed structure, format, layout and style.	Some formal information is missing. Several deviances from the proposed structure, format, layout and style.	Several pieces of the formal information is missing. Major and multiple deviances from the proposed structure, format, layout and style.
Coverage Coverage of all the points to be included as per the guidelines of mentor/department	Every point in the format given by the mentor/department is covered	Most of the points in the format given by the mentor/department are covered.	Most of the points in the format given by the mentor/department are covered. Some of the points covered by requirements are identified as assumptions	There are some gaps in the information covered by the points in the format given by the mentor/department	There are obvious gaps in the information covered by the points in the format given by the mentor/department
Requirement Specification How well-formed the synopsis/report is	All requirements are complete, unambiguous, consistent, testable and clearly conveys what the system is supposed to do	All requirements are mostly complete, unambiguous, consistent, testable and clearly conveys what the system is supposed to do	All requirements are mostly complete, unambiguous, consistent, testable and convey what the system is supposed to do, but there are some deviations.	Many requirements are incomplete, ambiguous, inconsistent, untestable or does not convey what the system is supposed to do	There is no structure to the requirements at all, and many requirements fail on more than one of the quality criteria (complete, unambiguous, consistent, testable and conveys what the system is supposed to do)
Overall score Overall impression of the synopsis/report	The requirements are logically ordered, and all sections of the document are filled with relevant and complete information.	The requirements are mostly logically ordered, and most sections of the document are filled with relevant and complete information.	The requirements are mostly logically ordered, and most sections of the document are filled with relevant and complete information, but there are some deviations.	The requirements are mostly logically ordered. Some sections of the document are not filled with relevant or complete information.	The requirements are not logically ordered, which makes it difficult to understand what the system is supposed to do

TABLE II. RUBRICS FOR VIVA-VOCE

	Excellent(5)	Good(4)	Average(3)	Fair(2)	Poor(1)
Clarity	Communicates all ideas clearly and fluently	Communicates some ideas clearly and fluently	Communicates some ideas clearly with less fluency	Communicates few ideas clearly	Unable to communicate ideas
Understanding of concept	Explains fully the concepts involved	Explains the concepts involved with few gaps.	Adequately explains the concepts involved	Partially explains the concepts involved	Unable to explain the concepts involved
Application of concept	Able to apply the concept correctly and provide evidence for proof/disproof	Able to apply the concept correctly; but unable to provide sufficient evidence for proof/disproof	Able to apply the concept; but unable to provide evidence for proof/disproof	Partially able to apply the concept	Unable to apply the concept
Overall score	Clarity, understanding of concept & application of concept are completely fulfilled by the student.	Clarity, understanding of concept & application of concept are fulfilled by the student with few deviations.	Some of the quality criteria (Clarity, understanding of concept & application of concept) are not fulfilled by the student.	Many of the quality criteria (Clarity, understanding of concept & application of concept) are not fulfilled by the student.	Almost all quality criteria (Clarity, understanding of concept & application of concept) are not fulfilled by the student.

TABLE III. RUBRICS FOR PRESENTATION

	Excellent(5)	Good(4)	Average(3)	Fair(2)	Poor(1)
Non-Verbal					
Eye contact	Holds attention of the entire audience with the use of direct eye contact, seldom looking at notes/slides.	Holds attention of the entire audience with the use of direct eye contact, sometimes looking at notes/slides.	Consistent use of direct eye contact with audience, but still returns to notes/slides.	Displayed minimal eye contact with audience while reading mostly from the notes/slides.	No eye contact with audience while reading entirely from the notes/slides.
Body language	Student seems to be relaxed, self-confident and makes no mistakes.	Makes minor mistakes, but quickly recovers from them; displays little or no tension	Makes minor mistakes, but takes time to recover from them; displays little tension.	Displays mild tension; has trouble recovering from them	Tension and nervousness is obvious; has trouble recovering from mistakes
Verbal					
Enthusiasm	Demonstrates a strong positive feeling about topic during entire presentation	Demonstrates a strong positive feeling about topic during entire presentation; but sometimes shows some negativity towards the topic	Occasionally shows positive feelings about the topic	Shows some negativity towards presenting the topic	Shows absolutely no interest in presenting the topic
speech delivery	Students uses a clear voice and correct, precise pronunciation of terms so that all audience members can hear presentation	Student's voice is clear. Student pronounces most words correctly. Some audience members have difficulty hearing presentation	Student's voice is clear. Student pronounces most words correctly. Audience members have difficulty hearing presentation	Student's voice is low. Student pronounces many words incorrectly. Many audience members have difficulty hearing presentation	Student mumbles, incorrectly pronounces terms and speaks too quietly for a majority of audience to hear
Presentation content					
Language Spelling, Wording, Grammar, Sentence Structure, appropriate use of graphics/animation	There are no errors that impair the flow of communication. (Perfect with <2 errors)	There are few errors that impair the flow of communication. (There are <5 errors)	Occasional errors that have only minor impact on the flow of communication. (A few minor errors)	Frequent errors that impede the flow of communication. (A few more serious errors)	Errors are serious and numerous. Reader must stop and reread To decipher the authors meaning. (Multiple, serious errors)
coverage	Student presents information in logical, interesting sequence which audience can follow	Student presents information in logical sequence which audience can follow	Student presents information in logical sequence; but audience has some difficulty in following	Audience has difficulty following presentation because student jumps around	Audience cannot understand presentation because there is no sequence of information
Overall score Overall impression of the presentation	The verbal, non-verbal skills & presentation content are completely fulfilled by the student.	The verbal, non-verbal skills & presentation content are fulfilled by the student with few deviations.	Some of the quality criteria (verbal, non-verbal skills & presentation content) are not fulfilled by the student.	Many of the quality criteria (verbal, non-verbal skills & presentation content) are not fulfilled by the student.	Almost all quality criteria (verbal, non-verbal skills & presentation content) are not fulfilled by the student.

IV. RESULTS

The result for this experiment is limited to the 10 students who gave their project exam which comprised of submitting synopsis/report, giving presentation and viva-voce. The results of these students for synopsis, viva-voce and presentation; by both the approaches of assessment are shown in fig. 1, fig. 2 and fig. 3 respectively. From these figures, it is evident that the marks obtained by students via both approaches are very close.

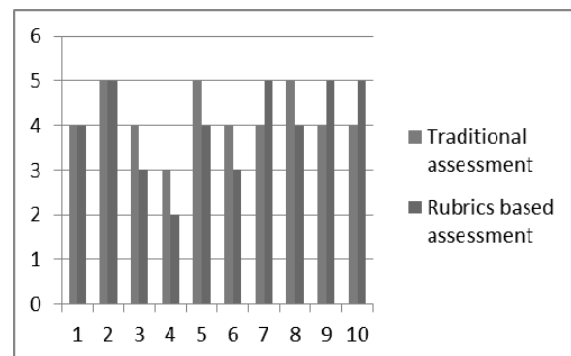


Fig. 1 Comparative results of ten students for synopsis

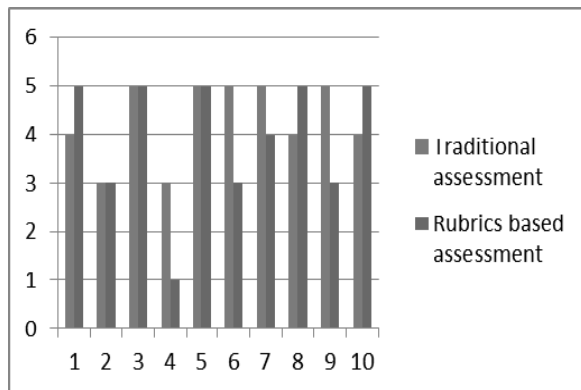


Fig. 2 Comparative results of ten students for Viva-Voce

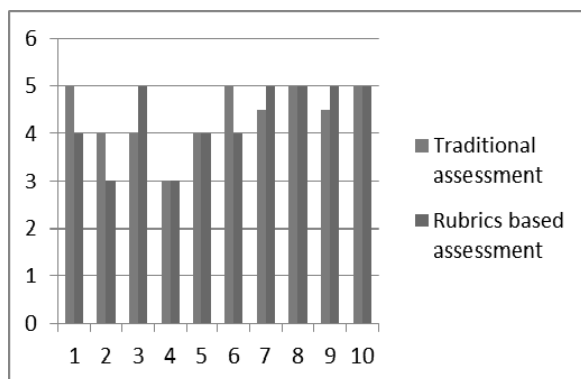


Fig. 3 Comparative results of ten students for Presentation.

V. CONCLUSION

This paper compares the results obtained by both the approaches viz. traditional assessment and rubrics based assessment for students' project evaluation. Both the techniques are shown to produce close results for the project evaluation. But, the rubric based assessment will surely reduce the perception gap of students once they are made aware of this type of assessment. Moreover, the rubric based assessment can help improve the scores obtained by students in their project, in turn improving the quality of projects.

The rubrics based assessment can be useful in creating evaluation standards for accreditation process. It can help in conducting transparent, systematic assessment of students' performance. This approach has not been explored fully in many of the technical institutes and we are hopeful that it's just a matter of time before this technique is fully accepted and implemented.

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INVOLVEMENT OF HCI IN SOCIETAL ISSUES: CONCERNS AND RESPONSES

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ABSTRACT

The assumption that the needs and concerns of human users are an intrinsically important part of computer system design is central to HCI work. As this assumption leads researchers and practitioners to move beyond specific interface design questions towards the consideration of larger contextual issues, societal and political questions necessarily intrude. A slight broadening of the view taken of a problem can move the researcher or practitioner from a purely technical role to a one that might require balancing of technical, societal, political, and personal concerns. The intention of this paper is to provide an overview on interrelation between HCI work and societal issues.

INTRODUCTION

As the population of computer users and the range of applications expanded, Human Computer Interface (HCI) professionals had to work on a variety of societal challenges posed by these new users. Accessibility research aimed at making computers usable by people with disabilities; interfaces for specific subpopulations such as children and the elderly; and explorations of the role of computers in various contexts were (and are) all active areas of HCI work. Innovations often led to analysis, as researchers investigated the social implications of tools for remote collaboration and communication. HCI expertise has also been involved in larger societal and political causes e.g the role of technologies for issues such as voting and privacy. The expansion of the scope of problems in human-computer interaction was accompanied by a similar evolution in the participants and the activities involved. From the early work of cognitive and computer scientists in academic, corporate and research labs, human-computer interaction has grown to include designers, sociologists, anthropologists, artists, and others working in areas such as interaction design, experience design, and usability. In this discussion, we use the term human-computer interaction to include all of these efforts and related fields.

Engagement with broader concerns has proven to be enormously constructive, playing a hand in the opening of new fields of research (participatory design, universal usability) the development of technological solutions for addressing human challenges (accessibility, education), and countless

computer and communication systems easier for millions of people to use on a daily basis. The impact of these efforts is significant: bad interfaces can and have lead to discomfort, injury, death, or catastrophe, with user interface problems contributing to disasters such as the crash of American Airlines Flight 965 in December 1995. Good interfaces can lead to improved communication among friends and family, improved access to health care information, and increased productivity, safety, creativity, and satisfaction [1].

The HCI community can certainly play a constructive role in responding to concerns and questions raised by policy-makers, citizens, and other stakeholders. However, proactive efforts aimed at addressing concerns before technologies are widely developed and implemented will arguably have greater impact. A framework for understanding the interaction between HCI and societal/political issues can provide some context that can inform efforts to proactively contribute to our collective understanding of appropriate design and uses of computer technology.

The range of factors that might stimulate the involvement of HCI researchers provides a starting point for categorizing efforts. HCI efforts that arise out of opportunities created by other computing research can be quite different from those that are motivated by the need to respond to societal problems that are largely non-technical. These motivating factors will be referred to as the *influences* that motivate HCI involvement in societal issues.

I. INFLUENCES MOTIVATING HCI INVOLVEMENT IN SOCIETAL ISSUES

We can identify two main classes of forces that have motivated HCI involvement in societal issues.

1.1 Personal and Community Needs that have served as influences for the societal involvement of HCI researchers. Examples Table 2. Few of the personal and community needs are:

Accessibility : The design and evaluation of accessible user interfaces has been a constant theme in HCI research ever since, including efforts for

people with visual, cognitive and muscular disabilities. The computing community's involvement with the use of technology to meet the needs of people with disabilities predates the emergence of HCI as a field of study.

Children & Education : One of the few early efforts at computing for children was the Logo language in the early 1980s created by Seymour Papert to help teach programming skills[7]. Druin's pioneering work has focused on getting children involved with the design process using techniques such as participatory design, contextual inquiry, and paper (and furry) prototypes. Others have focused on the design of screen interfaces and input devices. Children helped create new HCI based applications for storytelling and collaborative drawing. Many educational computing tools are aimed at enhancing learning.

Elderly: Communication is the main reason for many older users to get online (Fox, 2004). E-mail is the most popular application for older users. There is evidence that older users have more trouble finding information on web sites and dealing with multiple browser windows and that they find pointing devices challenging to use. Errors can be especially problematic, given that these users may make errors more frequently and have stronger negative reactions to errors. Usability guidelines (National Institute on Aging, 2001) and automated site analysis tools [8] provide assistance in designing web interfaces for older users.

Universal Usability: These interests in younger users, older users, and users with disabilities converged in the late 1990s to form the new field of Universal Usability, which marks a shift in thinking from interfaces aimed at specific populations to interfaces that are easy for all to use. Universal usability includes populations that have been well-studied, as well as populations that have not received much attention yet (users with cognitive or learning disabilities, low education or illiterate users, low motivation users, etc.). Universal usability includes technology diversity as well, ranging from modern laptops, cell phones, or PDAs with fast network connections to older machines with dial-up modems.

Social Computing : The second half of the 1990s saw an explosion of social forms of computing. Online communities, involving tools for group communication (e.g. newsgroups, bulletin boards, chat rooms) and shared resources, seemed to sprout up everywhere, from communities for those going through health crises, to those who share a passion for sports and those who are interested in similar books on Amazon.com

1.2 Business and Organizational Needs Business and management concerns about the ergonomics and human factors of computers predate the establishment of HCI as a research field. When most computing was done in corporate or academic contexts, improved interfaces and functionality implicitly served the needs of business users. Explicit consideration of the organizational issues involved in promoting usability[9], cost-benefit analyses of usability[10], and the implications of system design for employee autonomy and control [4] illustrate some of the tensions HCI efforts might create in organizations.

1.3 Government Needs Online provision of government information and services – collectively known as e-government requires careful design of interfaces for finding appropriate information [2] [3].

Proposals for advanced identification cards raise questions relating to privacy, access to information, informed consent [5][6]. Recent concerns about terrorism and natural disasters have led to increased focus on the analysis of large heterogeneous data sets and the dissemination of findings, in support of decision-makers and responders who work to prevent attacks and recover from disaster. A research agenda for visual analytics draws heavily on human-computer interaction, citing the need for advanced interfaces, support for collaboration, and provision for dissemination of results [11]. Examples of this work include interfaces for situational awareness, which combine domain configuration details such as network layouts or geographical maps with event timelines, allowing for visualizations that might indicate the progression of an epidemic throughout the country[12]. The recognition of the need for individual and community involvement in emergency response has also led to proposals for “Community Response Grids”, which would support requests for assistance, coordination, and information dissemination in the face of challenging emergencies [1].

1.4 Technological Innovations Research and commercial innovation, both from HCI professionals and from the larger computing community, repeatedly raises HCI questions of societal and political concern. Wearable computing, mobile computing and ubiquitous and context-aware computing are just a few areas of active computing research where HCI

professionals have addressed societal concerns. Advances in interface capabilities and functionality also generated activity. The advent of more life-like interfaces spurred analysis into the impacts of interfaces that made computers seem more human. Examination of persuasive interfaces [13], and trust[14] raise similar questions about the ways in which people interact with information and services presented through the mediation of a computer interface. The constructive use of technological approaches to addressing societal concerns can often generate new problems requiring further consideration. Logging technologies such as videotape are both useful and potentially troublesome, due to potential for abuse (Mackay, 1995). These concerns have led to innovative technological approaches and analyses[15] aimed at preserving the value of data capture tools while respecting privacy and related concerns. Additional examples are given in Table 3.

II. HCI RESPONSES TO SOCIETAL CONCERNS

Our review of the HCI literature showed that HCI engagement with societal and political issues involves combinations of system design, evaluations, and models and theories.

2.1 Design and Development

Much of the HCI community's involvement with societal issues has taken the form of systems and designs aimed at solving specific problems. The engineering and computer science elements in the HCI community (Grudin, 2005) have designed countless systems to address needs in many domains. Rural midwives, young children, emergency medical responders, and people with cognitive and physical disabilities have been the focus of these efforts. Additional examples are given in Table 4.

2.2 Evaluation and Analysis

Evaluations of voting systems, assistive technologies, health information practices, online communities, and privacy and security have provided valuable insight into how systems should be built to achieve specific goals and avoid problems. Other example evaluations involved digital libraries, elderly users, and children [1][5][8].

2.3 Models, theories, and methods

Interest in societal and political concerns has played a significant role in extending HCI theories and models. Participatory design techniques originally developed in Scandinavia as a response to concerns about the impact of computerization on workers have been adopted and adapted by HCI researchers [9].

2.4 Testimony and reports

HCI engagement with societal issues has also taken the form of direct work with policymakers. Congressional testimony regarding national ID cards [1] and empirical and analytical reports regarding the interface implications of electronic voting are recent examples.

2.5 Calls to Action

Constructive visions, proposed research programs, and declarations of beliefs and values have defined opportunities and galvanized efforts. Shneiderman's "Declaration of Responsibility" challenged the HCI community to directly tackle issues not normally associated with computing professionals, including world peace, freedom of expression, education, and health care [1][5].

III. MAIN ISSUES FOR HCI COMMUNITY : ACCESSIBILITY, PRIVACY

Accessibility and privacy have all generated significant interest and concern in the HCI community in recent years. A closer examination of these domains illustrates the opportunities and challenges facing HCI researchers who are interested in having a constructive impact.

The HCI community's long history of accessibility work has occurred in the context of early and continuing engagement with broader public policy questions. Government policies and the accessibility guidelines can sometimes be confusing and subject to revision. National computing and information systems curriculum models in the United States do not yet, cover accessibility.

As the explosion of web commerce led to increased privacy concerns, policy-makers and activists in the US and Europe became involved. Leading to discussions with groups like the Federal Trade Commission (Federal Trade Commission, 1998). As the model of "notice" and "choice" grew out of these discussions, the World-Wide-Web Consortium developed the platform for privacy preferences, known as P3P[16], a language for describing the privacy practices of web sites. P3P illustrates many of the HCI challenges presented by privacy concerns. Recent privacy work has explored issues such as phishing , spyware and secure e-mail. As new technologies such as RFID tags, RFID technology and advanced identification cards are more widely used and deployed, both controversy and the opportunity for constructive engagement will likely continue.

4. TOWARDS A GENERATIVE THEORY FOR HCI INVOLVEMENT IN SOCIETAL AND POLICY ISSUES

Previous sections discussed some of the involvement of the field of HCI in societal issues and warned of the pitfalls of delayed engagement. A two-part generative model of HCI and societal issues can help both in identifying areas that may need more attention either now or in the near future. The combination of proactive engagement and a willingness to tackle potentially controversial issues can aid in the identification and framing of opportunities for constructive participation. Once an issue has been identified, engagement matrices (based on the responses from Section 2) can be used to explore the possible contributions that HCI can make to these discussions. The application of these matrices to several domains illustrates possible uses of these matrices.

4.1 Proactive Engagement

Effective proactive engagement in societal issues will require a broader, critical view of emerging computer technologies and proposed applications. Visionary discussions of ambitious long-term goals for computing systems[5] must be balanced by focused analysis and understanding of short and medium-term trends, moving beyond HCI research, into other areas of computing and general societal concern. Identification of issues can help to generate appropriate responses and stimulate innovative research and development. HCI researchers and practitioners may never escape the tension between the desire to proactively anticipate concerns and the necessarily reactive nature of responding to issues as they arise. Although the ability to respond quickly may always be constrained by available human and financial resources, active and broad consideration of current and potential concerns may lay the groundwork for effective responses. Timing may also constrain the types of responses available in specific situations. Proactive efforts may have time for implementations of designs and development of models, theories, and frameworks due to the time available. Reactive responses may be limited to evaluations, reports, and calls to action.

4.2 Controversy

Active participation in issues that involve consideration of values and goals may lead HCI researchers into areas that are controversial. Some issues may lead HCI researchers to take potentially controversial stands on public policy debates, such as the need for national ID cards[1]. Disagreements between HCI professionals and other computing professionals

may lead to apparent inconsistencies that may confuse citizens and policymakers. The likely persistence of both individual controversies and the general question of how they should be handled should not prevent the HCI community from contributing. Attempts at understanding differences and working towards consensus will help identify areas where coordinated effort may be constructive.

4.3 Influences and Responses as Generators of Engagement

An examination of issues from each of the four influences (Table 1) provides some examples of current and potential proactive efforts that might be undertaken to address issues of societal and political concerns. The possibilities in each area are summarized in engagement matrices, which suggest current and future work in each of the response areas described in Section 2.

4.3.1 Personal and Community Needs: Energy Efficiency and Sustainability

The need for sustainable energy sources has led to a renewed interest in energy efficiency. The HCI community can contribute to these efforts by developing tools and models that help individuals and communities understand how they use energy, and how they might use it more efficiently.

Evaluations and analyses of these tools might start with traditional investigations into the efficacy of various interface designs, moving into more general questions regarding the larger goal. Researchers might ask whether these tools actually led to discernible changes in energy usage, and whether such changes were significant enough to offset the energy requirements of the devices needed for implementation. Study of the risks and unintended consequences will be particularly important for these tools that could involve monitoring of potentially sensitive data. Dissemination of these efforts might involve working with regulators and representatives of multiple industries to turn research prototypes into widely-used tools. Reports might detail best practices in designs of interfaces, tools, and overall systems, and broad visions would describe a constructive role of computer technology in the service of sustainable energy use.

4.3.2 Business and Organizational Needs: Electronic Health Records

Electronic health records may bring about health benefits, but the costs of the underlying infrastructure are not well understood. Given the variety of populations (health practitioners, patients, research) that must be served by such records, the designs of data representation standards and interfaces for accessing that data [8][1][17] play an important role in determining how such systems will affect people's lives. Personal health records – intended primarily for use by individuals to manage their own health information – present additional challenges distinct

from those associated with records intended for use by health professionals. Ideally, these tools will support customized arrangement of data and sharing of information for vastly different users facing different challenges. HCI professionals can explore interface designs that might meet these potentially conflicting needs, working towards general models for appropriate interfaces for information sharing. Criteria for evaluating the success of such interfaces – and their roles in larger systems – might help industrial and organizational partners improve their products. The presentation of a vision for providing electronic health records while still respecting the concerns of individuals might provide a model that would help achieve efficiency while minimizing negative outcomes. Table 6 provides an engagement matrix.

4.3.3 Government needs: National ID Cards

Principles of informed consent can be used to suggest appropriate designs. In addition to proposing best practices for the use and design of such IDs, contributions from the HCI community might include system designs of both cards and readers of information stored on those cards that would demonstrate the possibility of combining the use of information for legitimate purposes with safeguards that would protect privacy and personal autonomy. An engagement matrix is given in table 7.

4.3.4 Technological innovation: RFID Tags

Radio-frequency ID tags provide an example of a technology that was extensively analyzed before having a critical impact. Widely criticized as having security and privacy concerns – particularly when used in products –, RFIDs have also been used to aid blind people with navigation, and to augment museum exhibits. RFIDs have been proposed for use in identification and authentication contexts [17]. Opportunities for constructive engagement efforts with RFID include the development of personal, portable RFID readers, which would help individuals determine which items were tagged and how. Similar approaches have been used to build portable bar code readers as shopping aids for blind people[18]. National IDs, health records, and RFIDS are not disjoint topics. Discussions of National ID cards and electronic health records might converge into proposals for a single “smart” card containing identification and health information. Proponents might even suggest that embedded sensors could unobtrusively scan such a card upon entrance to a physician’s office or hospital, retrieving necessary information. Table 8 gives the engagement matrix.

4.4 Limitations

HCI concerns rarely exist in a vacuum. Practitioners frequently address tradeoffs between usability and other factors, including security, reliability, and cost. If cost is the primary criterion used, many systems that address societal needs would never be justifiable.

Insight from HCI research and practice can also inform discussions of the appropriate balance between technology and laws, regulations, or other forms of achieving societal or political goals. Technological solutions have been proposed as preferred mechanisms for addressing such questions such as freedom of speech and privacy, but usability questions may have limited the impact of these technologies[15]. The HCI community’s detailed understanding of how technologies work in context can be a vital resource for these discussions.

In some cases, the best computer interface may be to decide not to use the computer: the HCI community should also be willing to take a broad view that includes questions of whether or not certain computing systems should be built at all. Although a 1970s era call for a moratorium on community information networks (Press, 1974) may seem somewhat quaint in 2007, potential negative impacts can argue against the impact of certain technologies. Growing concerns over the environmental issues has led to an interest on the potential impact of pervasive technologies and visions for sustainable computing. In the spirit of working HCI professionals should be prepared to consider whether environmental concerns outweigh the possible benefits of widespread deployment of these technologies. Tackling such questions may not be easy. Stepping outside of well-defined bounds of professional expertise, exploring controversial topics, and perhaps building consensus may prove challenging and frustrating. Arguments that carefully draw on the HCI community’s unique expertise and accumulated scientific insight will likely be the most compelling.

5. SUMMARY

More than many other fields of computing research and innovation, Human-Computer Interaction includes all aspects of how people engage with computer systems, and how those systems change our world. Health care, education, electronic government, privacy, and voting are just some of the concerns with strong computing involvement that would benefit from the expertise of the HCI community, but contributions need not end there. Creative approaches to broader problems including global warming, poverty, and world peace can arise from our community as well. By tackling the challenges of these broader issues, the HCI community can expand our understanding of the field as a whole, while helping technicians and policy-makers build and use computer systems that appropriately meet human needs, goals, and aspirations. Motivated professionals in all lines of work can contribute to these efforts. Researchers can build research programs aimed at understanding the details of specific questions and the implications of design alternatives.

Well-designed studies can be particularly helpful in informing disputes between competing claims about system performance and impact. Engineers, product

designers, and others in industry can argue for the consideration of impact concerns in product design, ideally leading to improved products that will be better for business. Appropriately constructed arguments can lead corporations and industry leaders to consider HCI concerns. Policy makers with HCI expertise can raise concerns regarding the implications of government computer systems and regulations, helping legislators and regulators understand complex technical issues. Educators can include these topics in HCI courses and one potential approach is through service learning courses.

Community support can play a strong role as well: by encouraging our peers to contribute to many complex and challenging issues, we hope to foster new and creative efforts that will make positive contributions both within our field and beyond.

Tables:

Influences	Responses
Personal and Community Needs	Design & Development
Business and Organizational Needs	Evaluation
Government needs	Models and Theories
Technological Innovation	Reports, Testimony, and Related Public Policy Activities Calls to Action

Table 1: Factors influencing HCI involvement with societal concerns, and possible responses.

Category	Relevant Efforts
Communication	Girls, technology and privacy, children and wireless technology, context-enhanced mobile messaging, deception
Civil society	IT & Community, Social Networks
Home & Family	Social communication, Shared calendars, Device design, Mobility and technology use
Health Care/Medical Devices	Personal health information management, Emergency medicine, Encouraging exercise, Diabetes, Evidence-based care, Software engineering for clinical systems, Advanced surgical interfaces
Gender Issues	Gender & end-user debugging, Values and game design

Table 2. : Category-wise efforts in HCI fields

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OVERVIEW AND BENEFIT OF ENERGY STORAGE FOR SOLAR THERMAL POWER PLANT

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ABSTRACT

The use of energy storage is increased operational flexibility of solar thermal power plant in the limited solar hour. The paper explores the energy storage option for the integration with large-scale solar thermal power generation system. An analysis is done for five large-scale thermal energy storage technologies that are two-tank, thermocline, concrete, castable ceramic and phase change material (PCM). Cost-benefit analysis shows that the savings operation cost from energy storage increase with the size of the storage. Taking into account the large investment costs, energy storage units are however unlikely to have a profitable exploitation. A study is done by fixing thermal storage output capacity for operating 50MW power plant for six hours. The use of energy storage decrease the system's overall CO₂ emission levels, it is act as a replacement of natural gas boiler backup system for solar thermal power plant.

Keywords : Thermal Storage, Levelized electric cost

I. INTRODUCTION

Renewable energy is a constant growing part of the worldwide energy supply. In India solar is one of most important source of renewable energy. In comparison to conventional power plants the solar thermal have the main disadvantage of limitation in solar hour, power plant typically operates for 6–8 hour a day on solar energy. Typical daily solar energy distribution, along with a typical load curve is shown in fig. 1

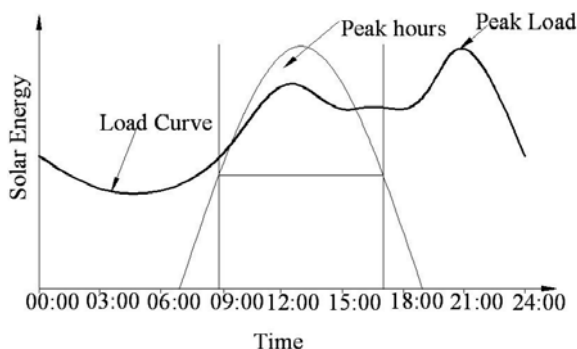


Fig. 1. Solar Radiation with respected to time.

In spite of this disadvantage, the solar energy is extra supported because it is a sustainable and environment friendly energy form and an important alternative for future supply. In India government also promote renewable energy power generation system but currently average production cost of solar thermal power generation is higher than the conventional power plants. Thermal energy storage is an option that can collect energy in order to shift its delivery to a later time, or to smooth out the plant output during cloudy weather conditions. Hence, the operation of a solar thermal power plant can be extended beyond periods of no solar radiation without the need to burn fossil fuel. Mismatch time between energy supply by the sun and energy demand can be reduced by storage system.

II. SIMULATION MODEL

The basic system consists of a 50 MW parabolic trough power plant with storage, solar field configuration and location is considered as Andasol 1, solar field aperture area is 510,120 m². Inlet and outlet temperature of solar field is 293° C and 393° C. Solar day of 20th August 2007 is chosen for the analysis [1]. Shown in the fig. 2. The thermal power plant configuration of 66 bar pressure and 384°C steam is consider for the analysis, thermal storage is considered for 6 h backup.

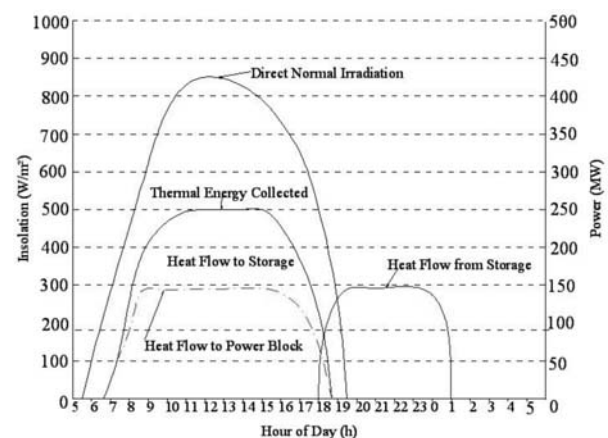


Fig. 2. Power plant operation on Aug 20th 2007 Andalusia.

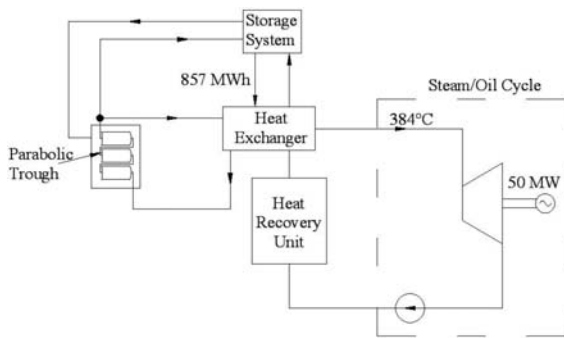


Fig. 3. Schematic Layout.

The gross power efficiency is considered to be 35%. Total thermal energy required for the operation is 857 MWh. Schematic of the system is shown in the fig. 3.

III. OVERVIEW OF THERMAL STORAGE SYSTEM

A. Sensible heat storage

Thermal energy can be stored by changing the temperatures of substances that experience a change in internal energy. Sensible heat storage may be solid media or liquid media. In solid media storage heat is stored by exchanging heat from heat transfer fluid, whereas in case liquid media storage heat is stored by exchanging heat from heat transfer fluid or directly by storage liquid media.

1. Concrete and castable ceramics thermal storage

Solid sensible storage is a simple in technological sense. Storage is design for parabolic trough power plants using synthetic oil as the heat transfer medium, and the application of solid media sensible heat storage is an attractive option regarding investment and maintenance costs. Storage system utilizes an inexpensive storage material. Solid storage system are been developed by German Aerospace Center (DLR) funded by the German Government. Concrete and castable ceramics have good characteristics to be used as a solid heat storage materials both tested are tested at the Plataforma Solar de Almeria [2].

2. Two-tank and thermocline thermal storage

Molten salts are used as prominent liquid storage medium for solar power plant systems, they are liquid at atmospheric pressure, provide an efficient, low cost medium in which to store thermal energy, their operating temperatures are compatible with High-pressure and high-temperature steam. The three principal candidate salts include the following: Hitec, Hitec XL1, Binary salt mixture of NaNO_3 and KNO_3 [5].

Two-tank thermal storage is well developed and commercially used in solar thermal power plant. Pacheco [3] simulated the thermal behavior of the tank and describe the heat transfer in the system. Herrmann [4] developed a program for two tank storage system to determine the electricity production from solar power plant with and without storage. Sandia National Laboratories identified inexpensive filler material which is widely available, high heat capacity, void fraction, compatible with nitrate salts, and non-hazardous filler material. Brosseau [5] had done comparison found that thermocline storage cost 35% cheaper than the two tank storage.

B. Latent heat storage

Thermal energy can be stored isothermally in the substances as latent heat of phase change, commonly solid-liquid transaction is used. Phase change materials allow large amounts of energy to be stored in relatively small volumes, resulting in the lowest primary storage material than the any other storage system. Zalba [6] review the materials, heat transfer and applications for phase change material.

The modeled parameters for each storage option are based on the case studies [7] are shown in Table 1.

TABLE I [7] EXISTING STORAGE SYSTEM

Technical parameters	Storage Technology				
	Ceramic	Concrete	Two-tank	Thermocline	PCM
Nominal Capacity, MW	900	950	875	875	900
Storage Capacity, MW	857	857	857	857	857
Power Plant Size, MW	50	50	50	50	50

IV. COST BENEFIT ANALYSIS

The cost of energy storage and solar thermal power plant have been quantified, a comparison can be made between the different options by taking into account their associated investment costs.

A. Marginal generation cost

Thermal storage provides a number of opportunities for the operation of power systems. Because of the need for a continuous power balance between generation and load, generation must be able to follow the load at all times. Thermal energy storage provides additional

flexibility for the system: at moments of low load, energy storage may be used to increase the overall system load by storing energy, whereas the stored energy can be delivered to the system at moments of high load. From a market perspective, this means that energy will be stored at moment of low prices (usually low load) and generated at high prices (usually peak load). The load curve of Delhi on 8th May 2011 is considered for the analysis. Load data is taken from India Electron Exchange [9]. The marginal cost is calculated from India Energy Exchange rate [10]. Fig4. shows marginal energy generation cost and load curve for Delhi.

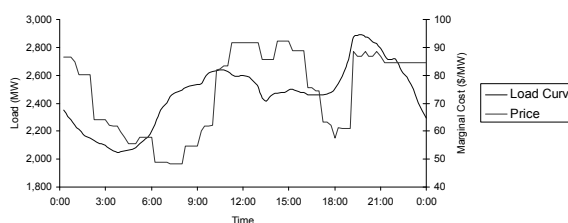


Fig. 4. Load and Marginal cost for Delhi on May 8th 2011.

Thermal energy storage thereby has an impact on the short-run marginal generation cost in the system. Fig. 5 shows the amount of energy in storage and energy collected by the solar field in each hour on Aug 20th for the given concentrating solar power (CSP) plant configurations. It is important to note that due to weather patterns on this particular day, the solar field only collects solar energy during 7:00-18:00 hours, the output of the field is zero in the remaining hours. Where as storage extend the generation of power plant to 17 hours.

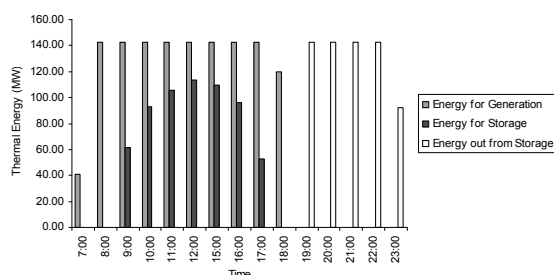


Fig. 4. Energy from solar field and energy in storage for a CSP plant at the Andalusia location on August 20th 2007.

B. Levelized electric Cost

Total cost of storage is divided into two part investment and operation & maintains (O&M) cost. The investment cost further divided into material and labour cost. There is separate

investment and O&M cost for power plant and storages. The investment and O&M cost considered same a 50 MW Barstow power plant [4]. O&M cost of thermal storage is assumed to be same as two-tank storage is 0.667 M\$ [4]. Annual interest rate is assumed to be 10%, only storage cost and power generate due to storage is consider for Levelized electric cost (LEC) calculation. Investment cost (IC), Capital recovery factor (CRF)

$$\text{Annualised cost} = (\text{IC of CSP}) (\text{CRF}) + (\text{IC of storage})(\text{CRF}) \quad (1)$$

$$\text{LEC} (\$/\text{MWh}) = \frac{(\text{Annualised cost}) + \text{O \& M cost}}{\text{Net electric output}} \quad (2)$$

Thermal energy storage not only increases the flexibility of the CSP plant but also reduces the Levelized cost of electricity; with thermocline system as the storage option provide lowest cost of electricity. The trend of Levelized electric cost with storage size is shown in fig. 5. Comparison shown in table II.

C. Advantage over gas fired boiler

The revenues from energy storage are heavily dependent on the generating cost. At present a gas price of 2.14 \$/GJ, investment cost for gas fired boiler is high, for 6 hour 50 MW power plant backup cost estimated as 8.2M\$ based on report sited by Solarpaces[8]. The operational cost of thermal storage is lower the gas fired boiler system. Since the electric generation cost gas fired boiler is higher than the thermal storage.

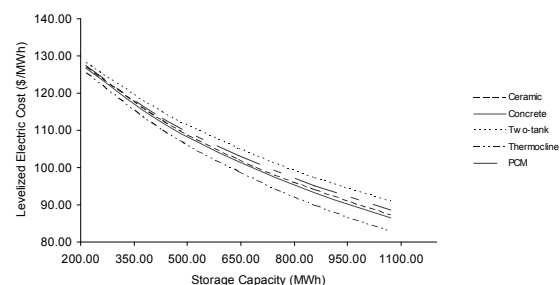


Fig. 5. Variation of electric cost with storage capacity.

	50 MW Solar Thermal Power Plant						
	No Storage	Ceramic	Concrete	Two-tank	Thermocline	PCM	Heat Boiler
Site	Andasol 1	Andasol 1	Andasol 1	Andasol 1	Andasol 1	Andasol 1	Andasol 1
Storage Capacity (hr)	0	6	6	6	6	6	0
Solar Field Size (m ²)	510120	510120	510120	510120	510120	510120	510120
Efficiency	35%	35%	35%	35%	35%	35%	35%
Power Plant Size (MW)	50	50	50	50	50	50	50
Net Electric (GWh)	111.8	194	194	194	194	194	194
Power Plant Cost (M\$)	118.8	118.8	118.8	118.8	118.8	118.8	118.8
Plant O&M Cost (M\$)	3.514	3.514	3.514	3.514	3.514	3.514	3.514
Storage Cost (M\$)	0	27.77	26.57	35.05	19.65	30.60	8.2
Storage O&M Cost (M\$)	0	0.667	0.667	0.667	0.667	0.667	0.23
Annual Fuel Cost(M\$)	0	0	0	0	0	0	3.47
Interest %	10	10	10	10	10	10	10
Life (Yr)	30	30	30	30	30	30	30
LEC (\$/MWh)	\$148.32	\$104.37	\$103.70	\$108.18	\$99.79	\$105.73	\$109.19

D. CO₂-emission levels

The system CO₂ emission levels are reduced with the integration of thermal storage solar thermal power plant. Larger solar fields and the integration of thermal energy storage allow the reduction of the CO₂ emissions up to 68% compared to the fossil fired combined cycle. It is clear that the specific reduction in CO₂ emissions is directly depending on the solar share. Annual reduction in emission of CO₂ emission for 50 MW with 6 hour storage is 176.6 MT CO₂.

V. CONCLUSION

This paper has explored the opportunities of thermal energy storage for the integration of solar thermal power system. Two-tank, thermocline, concrete, castable ceramic and PCM storage system has a number of benefits on integration, all system has wide exploration of possible synergies between solar power and energy storage integrated into existing power supplies. Thermal energy collects energy from solar peak hour and delivered it on peak load, thermal energy storage is used for substituting during peak-load gas boiler generation system. Energy storage also has advantage in terms of annual CO₂ emission reduction. The investment cost of thermal storage is significantly high it is necessary in future to further reduce the investment cost of the thermal storage.

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