Menstrual Pain Soother Using T.E.N.S Method

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***Abstract*- One method of stimulating the body's nerves is transcutaneous electrical nerve stimulation. However, this study is developing the system to address this issue by taking into account the TENS principle.**

The issue of stomach pain or, more specifically, menstrual pain experienced by the user while traveling or working. Menstruation causes discomfort for women. They find it awkward to alter preferences or settings straight from the device once they have attached it to their body. The goal of this study is to make it simple to use the device from a mobile application without having to touch it. Here, this issue is resolved using the TENS method. Bluetooth has made it simple to control the device from a phone. Three distinct TENS-based algorithms are applied here. The suggested MCU can generate multiple pins.

Keywords: Transcutaneous Electrical Nerve Stimulation, Menstrual Pain Relief, Bluetooth Control.

I. Introduction

Menstrual cramps, or dysmenorrhea, are experienced by many women and result in pain that interferes with daily activities and reduces overall quality of life. The syndrome is defined by cramping of the lower abdomen and is mild to severe in nature, often accompanied by other signs like nausea, fatigue, and mood changes. Though multiple forms of treatment are available—such as over-the-counter medications, hormone therapy, and lifestyle modifications—many turn to alternative methods because of side effects or the failure of traditional treatments. One rising alternative is Transcutaneous Electrical Nerve Stimulation (T.E.N.S.). This is an extremely painless and non-surgical method of using low-voltage electrical currents transmitted through electrodes on the surface of the skin. The aim is to decrease pain by stimulating sensory nerves, which can also prevent pain signals from reaching the brain.

In addition, T.E.N.S. can stimulate the release of endorphins—natural painkilling chemicals that the body produces—enhancing its effectiveness in relieving discomfort. T.E.N.S. for relieving menstrual cramps has gained interest both in medical environments and home applications, with studies indicating favorable results for most users. The devices are simple to use and provide a convenient solution, making them perfect for people looking for dependable pain relief without the need for medication.

Moreover, the non-invasive nature of T.E.N.S. dramatically lowers the likelihood of side effects typically associated with drugs, and it is therefore an attractive choice for most women. This document will explore the mechanism of T.E.N.S., explore the scientific basis for its efficacy against dysmenorrhea, and consider practicalities of its application. Through this investigation of a different pain management technique, the intention is to provide a comprehensive understanding of how T.E.N.S. can be a positive tool in managing menstrual pain, giving patients greater control over their symptoms and overall health.

In recent years, advancements in technology have significantly enhanced the functionality and ease of use of T.E.N.S. devices, particularly through the integration of mobile apps and Bluetooth connectivity. These innovations allow users to conveniently adjust intensity settings, switch between stimulation modes, and monitor session durations directly from their smartphones—eliminating the need for direct interaction with the device once it's in place. This hands-free feature is especially advantageous for individuals experiencing pain while at work or on the move, enabling discreet and continuous pain relief throughout the day. As a result, the incorporation of smart control features into T.E.N.S. therapy not only improves user experience but also represents a significant step forward in delivering personalized, accessible healthcare solutions focused on women's health and wellness.

II. Literature Survey

Dysmenorrhea is an extremely prevalent condition in menstruating women, and studies indicate that up to 90% of women suffer from menstrual cramps during their reproductive life. The traditional treatment modalities include the use of non-steroidal anti-inflammatory agents or oral contraceptives. These modalities might not be suitable for all, as they can be side-effect causing or contraindicated in some situations. Consequently, there is a growing interest in alternative, non-surgical forms of therapy such as Transcutaneous Electrical Nerve Stimulation (T.E.N.S.) for the alleviation of menstrual pain.

T.E.N.S. works on the gate control theory of pain, which suggests that painless input may interrupt and minimize the sensation of pain. Upon application of electrical impulses to the skin, T.E.N.S. stimulates large A-beta nerve fibers that aid in "closing the gate" to pain transmissions via the smaller C fibers. In addition to simply blocking pain pathways, T.E.N.S. is also believed to cause stimulation of endorphin release—natural body chemicals that help relieve pain—which further enhances its efficacy. The combined action of this has been evidenced in some studies, such as that of Rosenfeld et al. (2018), which revealed reduction in perception of pain caused both by nerve stimulation and heightened levels of endorphins.

Several clinical trials have examined the effectiveness of T.E.N.S. in treating dysmenorrhea. For instance, a randomized controlled trial by Kahn et al. (2020) reported that women who applied T.E.N.S. had a significant reduction in pain levels compared to the control group. Similarly, a meta-analysis by Vickers et al. (2018), which surveyed a number of studies, came to the conclusion that T.E.N.S. provides considerable and clinically significant pain relief for the sufferers of menstrual cramps. These findings point towards the imperative of comprehensive patient education regarding appropriate device use and compliance in achieving optimal results.

Patient acceptance is important for T.E.N.S. therapy to succeed. The vast majority of women preferred T.E.N.S. to the standard drug treatments, based on a study conducted by Zhang et al. (2021), because it was easy to employ, produced no systemic side effects, and let them take care of their own pain. In addition, consumers enjoy the independence and control that T.E.N.S. allows them, especially with regard to managing chronic menstrual pain, as per qualitative studies by Smith et al. (2022).

Existing studies of T.E.N.S. have certain limitations, despite their positive results. They include variability of patient compliance, stimulation settings, and electrode location, all which can influence dependability and reproducibility of treatment outcomes. In addition, although T.E.N.S. is known to be largely safe, there are certain exceptions, i.e., in some individuals or with dermatological disease.

III. METHODOLOGY

Transcutaneous electrical nerve stimulation (TENS) is an applied electrical signal to stimulate nerves through pain. An electric signal applied topically to stimulate nerves by causing discomfort is referred to as transcutaneous electrical nerve stimulation, or TENS. It is simple to generate pain-free pain signals by using the TENS method.

Therapy with PWM signals. TENS is primarily developed by square waves. Here we are developing a TENS signal by using the PWM method. By utilizing embedded code, the MCU regulates the PWM signal. An embedded algorithm identifies user input and reacts in an appropriate way. Parameters of the algorithm depend on the mode employed for the production of TENS. Characteristics of different TENS production methods are standardized by the International Association for the Study of Pain (IASP). Depending on the type of pain or treatment, TENS is identified by three methods.

A. Conventional TENS

This method is applied to make the user comfortable and pain-free. Low intensity, high frequency, and brief pulse width define conventional TENS. This method is often utilized to encourage relaxation and comfort. Here, we are employing this method by default for the user. The technology is low-intensity, with high frequency in the 90–130 Hz range and brief pulse width between 50 and 200 uS. The electrode is placed on the skin over the area of pain. The user receives a feeling of physical relaxation without motor contraction with these features.

B. AL TENS

It is also referred to as acupuncture-like TENS. It has a wide pulse width, high intensity/amplitude, and low rate. This has a long pulse width, high intensity/amplitude, and low frequency. This method has a low frequency ranging from 100–400 uS, high intensity, and long pulse width. It works at 1–5 Hz. The electrodes are placed on top of the sore muscle. It is only used for a brief period.

C. Intense TENS

The term "intense TENS method" describes high frequency, high amplitude, and short duration. It is in the range of 100 Hz frequency, with pulse duration of 200-us. It also includes a significantly large amplitude, making it powerful but acceptable to human health. The electrodes are only placed upon the body surface for a very short period (5 to 15 minutes).

III. SYSTEM ARCHITECTURE

While the TENS device is not able to detect pain, it is able to make the user feel relaxed and calm. In our program, the TENS system will be accessed by the user via an Android-based smartphone application. The device and the mobile app may communicate using Bluetooth. After installing the app in the phone, the user has to choose the TENS mode from the app. The combined system (TENS device) will receive the request directly from the user. An exclusive algorithm within the combined system creates the different modes depending on user requests. The recommended technologies—Traditional TENS, AL_TENS, and Brief Intense—are utilized to set the TENS device modes TENS, Modulated TENS, and Burst Mode TENS.

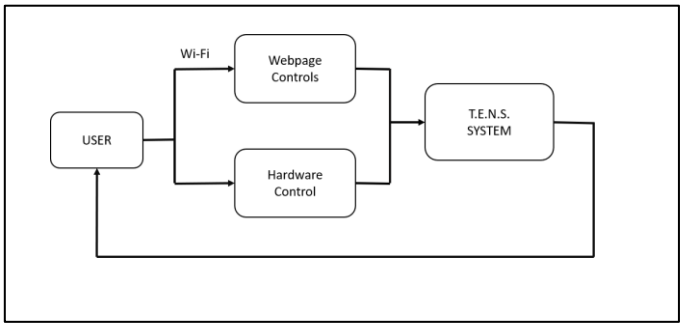

Fig 1: T.E.N.S. System Architecture

This architecture (Fig 1) is employed to ensure the user becomes comfortable during menstruation/period cramps. Whereas some users are not in a comfortable mood while changing modes or turning the device on/off at public spots. Particularly when the user is at work or has stepped out during menstruation.

There are a few modes present in the TENS approach. By default, we used traditional TENS for a very long time to relieve period cramps within our system. For selecting the mode and turning the device on/off while in operation, this architecture is managed by the mobile app. By taking out the device and operating it with the assistance of a mobile application, this design met the primary intention of not employing the device to operate the gadget. The user will conduct all procedures via the mobile application after binding the device and placing the electrodes properly.

IV. PROPOSED WORK

A micro-controller (MCU), which interfaces with the Bluetooth module to obtain the user's signal, assists in constructing the TENS-based system (Fig 2). The MCU will produce a PWM signal with variable frequency and pulse width functionality. The MCU also regulated the voltage amplitude to modify the intensity of the TENS signal.

For portability, we are employing Li-ion/Li-poly batteries. Also, the system provides the feature of battery charging and trouble-free operation. But this voltage is being boosted again by a 10V DC booster (DC-DC converter). Using a digital potentiometer, this signal now enters our voltage control system again to regulate the voltage amplitude. The MCU regulates our digital potentiometer algorithmically. The voltage is raised up to 8.3V through the voltage control scheme. Using a step-up transformer (1:10), the voltage is further raised up to a maximum of 83V. Current control is possible by utilizing the duty breadth of the signal.

A. Mobile Application

The recommended mobile app is available on the Android platform. Based on the number of users, it has a good market share worldwide. We have created an application that allows the device to be connected using Bluetooth's advertisement mode. We have a control panel that allows us to put the gadget in sleep mode or turn it off from standby. We can select the mode of operation using a control panel. Default Mode, AL-TENS Mode, and Intense Mode are all visible. The signal will be broadcast over Bluetooth and received as packets, per the user interface.

B. Voltage control mechanism

The MCU does this to control voltage .To automate the process without any intervention on the part of the user, we are trying to control the voltage from the controller .We are trying to calibrate and establish the correct voltage for operation with the digital potentiometer R2.The maximum voltage that the mechanism can deliver is 8.3V.We are trying to change the R2 from MCU with R1.

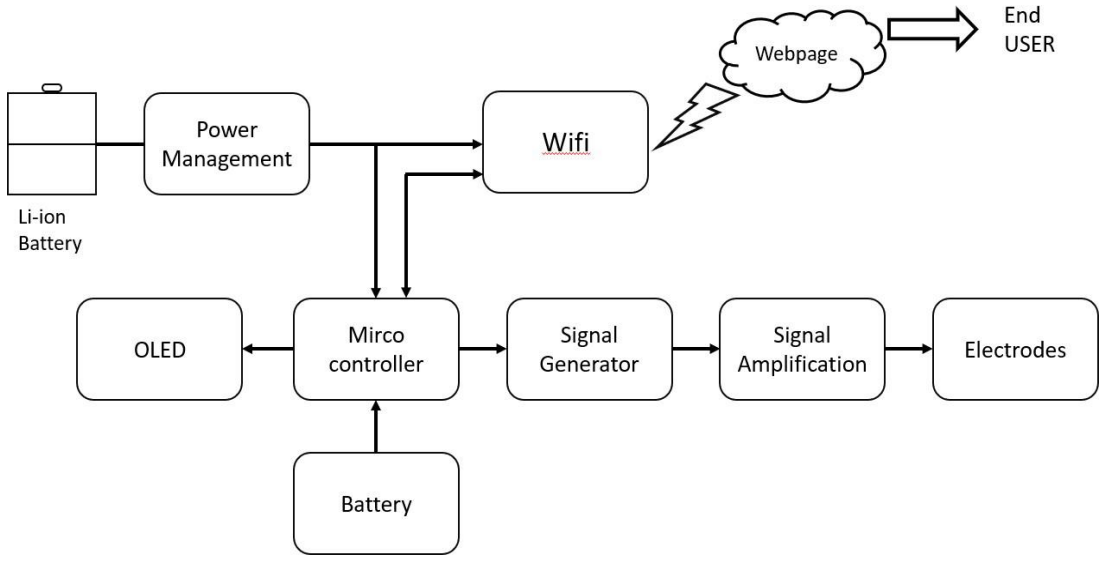

Fig 2: Circuit Flow diagram of TENS based system

C. Power Source

In this case, the device is mostly powered by the battery. The battery can store voltage up to 4.2V, with a nominal value of 3.7V. This kind of battery is used in portable gadgets that are not limited by weight or space because of its compact size. For operation, we are using a lithium battery, which is incredibly robust and long-lasting.

D. Microcontroller (MCU)

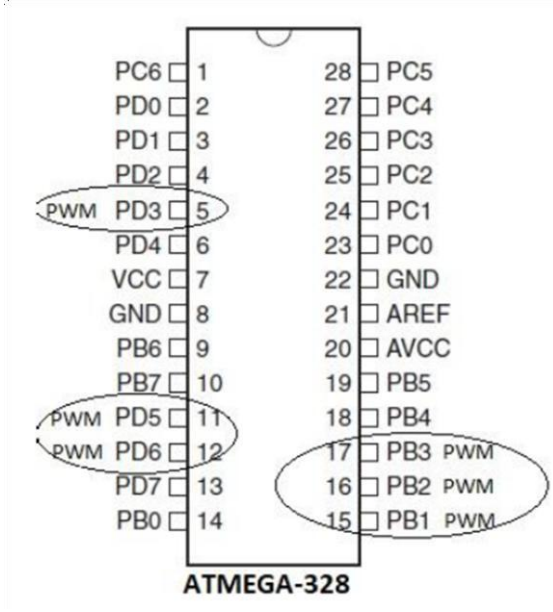

Fig 3: Pin out diagram of ATMega328

The TENS device is controlled by the ATmega 328 microcontroller. It contains multiple IO pins for control signals in addition to six pins for the PWM output. This MCU will be powered by 3.2V in accordance with our specifications. 32K flash memory, 2K internal SRAM, and 1K EEPROM are all supported. It has an adequate amount of pins to run every feature. It is simple to utilize this controller. Making a PWM signal is inexpensive and easy. This MCU has phase-correct pulse width modulation and no glitches. We have good control over the frequency and variable PWM signal generation.

V. RESULT AND DISCUSSION

The circuit is constructed and simulated using software based on Figure 4. There are multiple PWM pins on the ATMega328. By altering the PWM signal's duty cycle, we may regulate it.

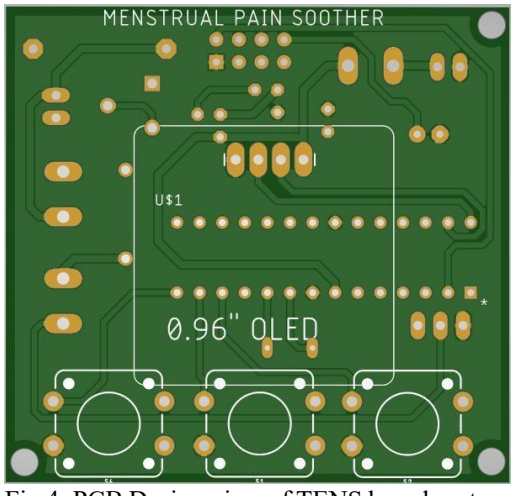

Fig 4: PCB Design view of TENS based system (Eagle software v21)

The specifications of the prototype are listed in the table 1.

Table 1: Parameter and Specification of TENS System

Sr.No.	Parameter	Specifications
1	Method Used	TENS
2	Pulse Output	Square(PWM)
3	Frequency Range	Min 80 Hz Max 150Hz
4	Power Supply	5V for charging

Software Applicationn

The Period Cramp Soother is a robust web application meant to help users manage menstrual pain and general menstrual well-being. It includes functionalities like a user-specific dashboard, period tracking, user authentication, AI-powered chatbot support, washroom location finder near you, health suggestions, and medicine management. Here is a detailed analysis of its features and back-end technologies.

A. Dashboard

Once logged in, users are welcomed by a custom dashboard that is the core point for all the functionalities. The dashboard shows the overview of the menstrual cycle of the user, the prediction of upcoming periods, symptom logs, and direct access to other features such as the AI chatbot, washroom finder, and health suggestions. The easy-to-use interface ensures users can move from one section to another effortlessly, which enhances the user experience.

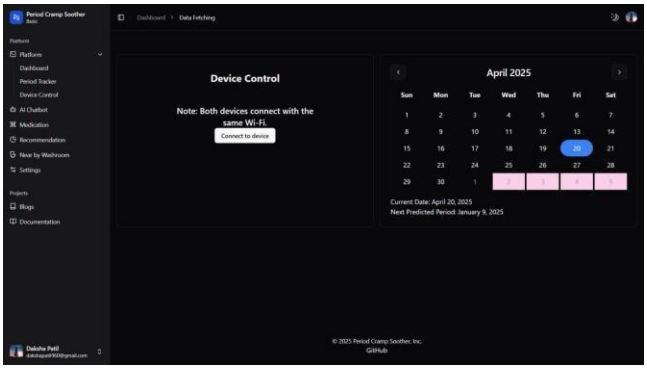

Fig.5 : Dashboard

B. Period Tracker

The period tracker is an integral part, enabling users to record menstrual cycles, monitor symptoms, and obtain forecasts for future periods and ovulation windows. By entering information including the beginning date of the last period, duration of bleeding, and cycle length, the program employs algorithms to predict future cycles.

C.User Authentication

For guaranteeing data privacy and individualized experiences, the application has an authentic and secure authentication system. The users are allowed to create accounts through email or social media integration, and the passwords are encrypted with secure session management. This authentication process protects sensitive health information and provides exclusive access to users for their data.

D. Health Recommendations

Drawing from the data collected from both the period tracker and user interactions, the app provides tailored health suggestions.
These include nutritional advice, workout routines, and lifestyle changes specific to the user's menstrual cycle and symptoms. With actionable insights, the app enables users to actively manage their menstrual health.

E. AI Chatbot Support

A chatbot powered by AI is embedded to offer instant support and information about menstrual health to users. Users can chat with the chatbot to ask questions, record symptoms, or get advice on how to handle discomfort. The chatbot uses natural language processing to interpret user queries and give relevant, empathetic answers to improve user interaction and support.

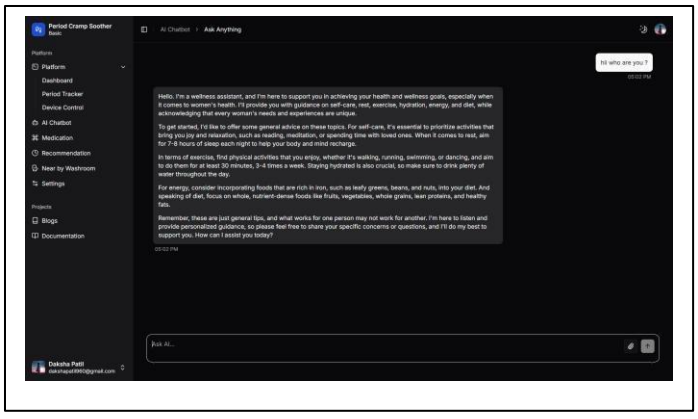

Fig.6 : AI Chatbot

VI. Conclusion

Every month, women who experience menstrual discomfort endure excruciating pain when they work, travel, etc. TENS is the most effective method of relaxation that doesn't include medicines or prescription. It is an easy-to-use, hassle-free, and reasonably priced approach. Additionally, in response to the control parameters, the device generates an electrical signal. The pulse width allows us to regulate the signal in compliance with the guidelines. By removing the device from the body, the suggested device's mode can be changed without using it in public places through a mobile application. There is an efficient therapeutic method for menstrual (or stomach) pain, despite the fact that its use can occasionally be impeded.

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