Acuity Test in Virtual Reality

AET 001

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Abstract- Visual acuity testing is needed to identify and track visual issues, ensuring that patients are treated approximately in timely manner. Traditional testing methods, like the Snellen chart, have shortcomings that result in variable test outcomes because they are static and environmentally dependent. Moreover, less interaction may discourage the patients to actively engage. Utilizing virtual reality (VR), this project will look towards eradicating the drawbacks of traditional methods and provide and edge in terms in terms of text experiences. By removing external influences such as lighting and distraction, this method provides final effective experience.The Unity game Engine will be employed in making this application in an easy to use software which can be effortlessly utilized by the medical professionals. For the purpose of measuring better accuracy, the researcher will compare the VR-based testing strategy with the traditional methods as well. This way, the research will assist in improving the quality if vision care in the future.

I. INTRODUCTION

Visual acuity, or the capacity to see minute details, is an important measure of visual function that is used to diagnose and monitor a variety of eye diseases. Traditional visual acuity exams use physical charts and ask patients to identify optotypes at various distances. However, improvements in virtual reality (VR) technology open up new opportunities for improving the visual acuity testing process. By developing realistic virtual settings and mimicking visual stimuli, VR can provide patients with a more immersive and participatory experience while ensuring accuracy and standardisation. The Indian subcontinent has over 20% of the world's blind people. According to the majority of surveys in India, myopia and cataracts are the most common causes of blindness. [1] Initiatives to prevent blindness are primarily orientated towards the traditional

Visual acuity exams are the foundation of visual function examinations, and they are the most significant component for evaluating visual function. visual tests let us determine the levels of visual deterioration. Existing Vision Acuity is pricey, and we must see an optometrist. Visual acuity has a direct impact on people's capacity to work and quality of life, and an acuity test is one of the required check items in practically all health assessments. VR has been with us for decades and is the new kingpin for all future cutting-edge technical platforms and devices. People can verify their Vision Acuity Test results at the reception, eliminating the need to contact a doctor if their vision is correct. Candidates interested in joining the Armed Forces can also determine whether they have Colour Blindness [3] or whether their Stereopsis vision [4] is correct.

II. OBJECTIVES

Unity Hub is a standalone tool that makes it easier to search, download, and manage your Unity projects and installations. Additionally, you can manually add editor versions that are already installed on your computer to your Hub.

Unity Engine: Unity enables developers to build 2D and 3D content across a variety of platforms, including Windows, macOS, Linux, Android, iOS, and Xbox.

GVR Package: An open-source package created by Google to build VR applications for IoS and Android NDK, offering a simplified API, improved device compatibility, and built-in browser pro-file QR code scanning.

Own Material: We created material from Color plate images to display to users. We also created a custom user interface and GVR pointer, so the user doesn't need a driver.

VR Headset: A VR headset, such as the Oculus Rift, will be utilized to deliver the immersive experience required for the visual acuity test. The choice of headset will be based on its resolution, field of view, and comfort, ensuring it can deliver clear visuals and a comfortable experience for extended use during testing. The Meta Quest 3 VR headset is a great fit for delivering visual acuity tests in a virtual environment. Its high-resolution display (2064 x 2208 pixels per eye) makes sure that even small details appear sharp and clear-perfect for tests that rely on visual precision. With a wide field of view of around 110 degrees, it offers a natural and immersive experience, helping users feel like they're really in the test

environment. All of this makes the Meta Quest 3 a smart and user-friendly choice for VR-based eye testing.

Unity C#: The language that is used to develop applications and games using the Unity game engine is Unity C#. C# is a subset of an object-oriented programming language, in the sense that it enables the developer to define classes that are models of objects in the game world, such as characters, enemies, and objects. A good example of this would be the utilization of a script to enable character movement when a button is clicked by the player, or collision detection between objects in the game world.

Standardized Visual Acuity Charts: These visual acuity charts, including the Snellen and ETDRS charts, will be implemented within the VR setting to ensure the accuracy and consistency of the test. The charts will be remodeled into the VR format without compromising their standardized measurements to provide consistent test results.

Adobe Illustrator: is a computer program used for vector graphics editing and creation, which is developed and marketed by Adobe Inc. The software is used for the creation and editing of vector-based graphics, such as but not limited to logos, illustrations, and diagrams. It allows users to create complex and precise artwork using a set of tools and features, which include the creation of personalized brushes and patterns, the use of gradients and effects, and the editing of paths and shapes.

Adobe Substance 3D Sampler: Adobe Substance 3D Sampler is a computer program aimed at scanning textures and material generation. The program is part of the Adobe Substance 3D suite, alongside Substance 3D Painter and Substance 3D Designer. The Substance 3D Sampler workflow allows for the generation of realistic materials based on the scanning of physical samples and the ability to import the samples into software to generate tileable, high-resolution textures.III. METHODOLOGY

Vision Acuity Test

To address the 'distance units problem' in VR, a sub-experiment was conducted in which a VR scene with a unit distance scale was created. The distance scale was stretched to 20 units, and the Snellen chart was positioned at the 20-unit distance scale position. This created a standard distance between the user and the chart, which is required to measure visual acuity. Approximately 30 participants were then asked to walk around the virtual scale and estimate an estimated virtual distance unit as real-world distance units. By doing this, they helped to create the mapping between the real-world distance unit and the virtual world distance unit. To create the depth of the VR scene, in-built depth perception methods in the Unity SDK were used. This helped the real-world distances to be accurately represented in the virtual environment. With the use of a standard distance scale and accurate depth perception methods, the sub-experiment tried to explain the accurate representation of real-world distances in VR environments. The results of this subexperiment have significant implications in developing VR applications, particularly in the healthcare and education domains. The accurate representation of real-world distances is significant in these domains to make virtual environments realistic and effective. [5]

Stereopsis Test

It can be more intuitive and more natural to navigate in a virtual reality (VR) environment with the assistance of a gaze pointer than with a standard controller. One can, with a gaze pointer, target or select objects or targets by pointing to them, and thus buttons or joysticks as the interface become redundant. Where precise targeting or selection is crucial, for instance, in professional training centers or in medical simulation, the feature is of most specific utility. Individuals with physical or mobility impairments can also benefit from its use, where there is a problem with normal controllers. There are, however, some constraints to the use of the gaze pointers in a virtual reality environment. For instance, the technology might not be able to cope with rapid eye movement, and as such, it would not be appropriate for involved or rapid interaction. 27 Furthermore, overuse can cause users with eye strain or visual fatigue; accordingly, interruptions or switching to other forms of input may be required. The objective of the trial is to confirm the participant's capability for accurate estimation of the spatial relations and distances. The participant will be presented with two dice at random positions to perform the trial and will have to select the cube that they perceive is in front of them. This is to be repeated ten times. The test-taker's results will be displayed after completion of all the ten trials. Apart from an indication of their performance in general, the ratings usually comprise the number of correct and incorrect responses. If the individual performs the assessment on various different times, the individual is able to compare their scores to determine whether there is an increase in performance in a temporal context.

Color Vision Test

A color blind individual is unable to perceive certain colors like ordinary individuals. Such a lack can hinder an individual's capacity to differentiate between various colors, thereby making everyday tasks such as reading or driving more challenging. To test for color blindness, a color vision test is frequently used. In this section, we will bandy how we perform the color blindness test. The color blindness test involves showing the party a board or a plate with different multi-coloured blotches or patterns on it. The party is also asked to choose which number they saw on the plate. The plates may or may not be different, and the party will be named from a set of 10 plates. To ensure delicacy,

we've named 15 arbitrary plates from which 10 will appear in different arbitrary order for each party. This is to help the party from learning the plates and passing the test grounded on memory alone. By using a set of 15 plates, we also ensure that each party is tested on a different range of colors and patterns. 28 Once the party has completed the test, they will admit a result indicating whether they're color eyeless or not. This result is grounded on the number of plates they were suitable to rightly identify. However, they're considered to have normal color vision, If the party is suitable to rightly identify all 10 plates. However, they may have some form of color blindness, if they're unfit to rightly identify a certain number of plates.

Workflow
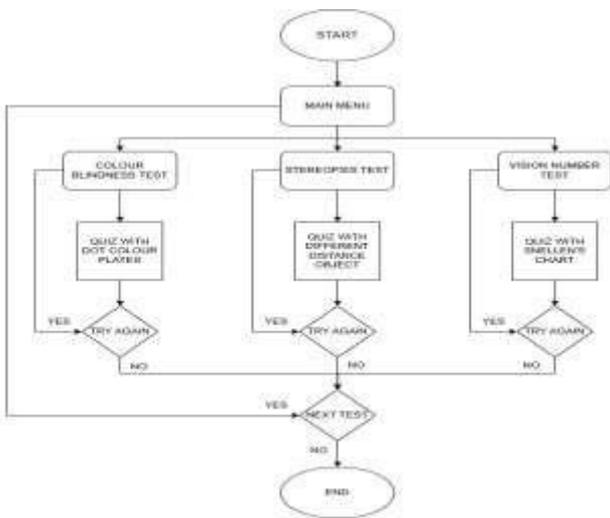
START: The process begins at the Start node.

Main Menu: User is directed to the Main Menu where different options or categories might be available.

Select Test: From the menu, the user selects the specific Acuity Test to perform.

Acuity Test Selection: The system provides different acuity tests:
Color Blindness Test
Stereopsis Test (depth perception)
Vision Score Test (for general vision assessment)

Individual Test Process: For each selected test, the user takes a corresponding quiz:

Color Blindness Test: The test uses Dot Color Plates to identify color vision deficiencies. If the user passes, the flow moves to the Next Test. If the user fails, they are prompted to Try Again.

Stereopsis Test: This test checks depth perception with Different Distance Objects. If passed, the flow moves to the Next Test. If failed, the user is asked to Try Again.

Vision Number Test: The user takes the test using a Snellen Chart to assess visual acuity. On passing, the user moves to the Next Test. If failed, they are asked to Try Again.

Next Test Decision: After completing one test, the system asks if the user wants to take the Next Test.
Yes → Loops back to select another test.
No → The process Ends.

End: If the user chooses not to take further tests, the process concludes

IV. RESULT

1. Color Blindness Test
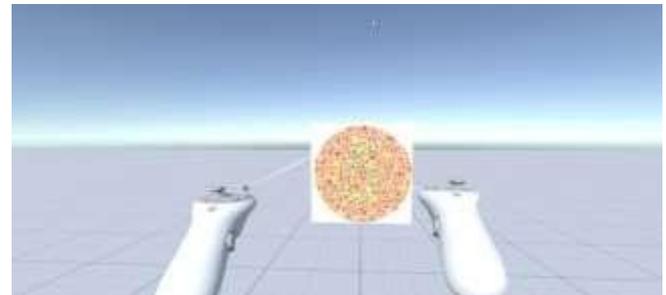

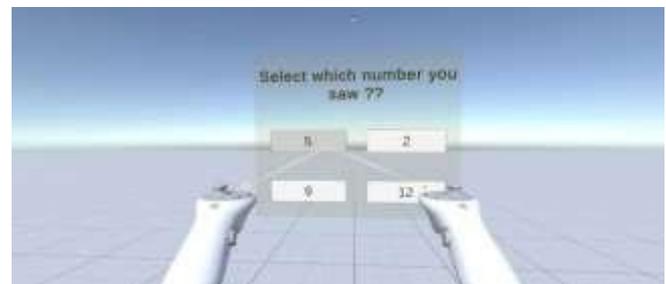Figure 4.1: Instruction for Color Blindness Test

Figure 4.2: The Color plate

Figure 4.3: Options for Color Plate

Figure 4.4: Result for Color Blindness Test

The VR test mimics the Color blindness test using images with colored dots to indicate hidden numbers. Users view each image briefly, record their responses, and receive a score based on the images they identified correctly

2. Vision Acuity Test

Figure 4.5: Instructions for Vision Acuity Test

Figure 4.6: Letter from Snellen Chart

Figure 4.7: Results for Vision Acuity Test

The test based on VR mimics Snellen's chart by showing letters or numbers at varying distances. The readers read and pick their own respective answer, and the system gives a score depending on the number.

3. Stereopsis Test

Figure 4.8: Instruction for Stereopsis Test

Figure 4.9: Object at different distances

Figure 4.10: Results for Stereopsis Test

The VR test mimics depth perception by presenting objects at different distances. Subjects briefly view the objects, choose their perceived distances, and are scored on the correctly perceived depth differences. The immersive environment can enhance focus and accuracy compared to conventional methods. The technique can be used for other eye tests, including visual acuity, depth perception, and contrast sensitivity, and it provides an easy-to-use and accurate testing protocol.

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V. CONCLUSION

The creation of a Virtual Reality-based visual acuity test is an important advancement in vision testing. Building on the immersive nature of Virtual Reality, the project overcomes the shortcomings of traditional visual acuity tests. The iterative development and intense user testing have guaranteed that the end product is accurate and user-friendly, as needed in medical testing.

The application of standardized visual acuity charts in a virtual environment demonstrates the capability of modern technology to complement conventional medical practice. By providing an even testing environment free from distraction, the VR-based test renders the visual acuity tests more accurate. Second, the interface has been designed to support an array of different users, thus making the examination accessible and convenient.

VI. REFERENCES

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