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VisionVue: Remote Visual Acuity Testing

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Abstract: Our innovative vision acuity testing system is a transformative solution for improving access to quality eye care, particularly in rural and underserved areas. By offering both Snellen charts for literate users and E charts for non-literate individuals, coupled with speech and hand recognition for input, our system ensures inclusivity and ease of use across diverse populations and also reduces reliance on specialized personnel, making quality eye care more accessible and adaptable to diverse community needs. Through the implementation of our system, we aim to empower individuals to take control of their visual health, facilitating continuous monitoring for early detection of potential issues and personalized recommendations, thus contributing to the overall improvement of eye care accessibility and community well-being.

Keywords: Snellen chart, E chart, Visual acuity test, Speech recognition.

I. INTRODUCTION

Central to the Vision Vue initiative is the development of a user-friendly interface using Flask, a Python-based micro web framework. This interface is thoughtfully designed to accommodate individuals with varying levels of literacy, employing voice input for users and individuals during vision acuity testing. By embracing inclusivity, Vision Vue ensures that everyone has the opportunity to undergo accurate and comprehensive vision assessments, regardless of their educational background.A key feature distinguishing Vision Vue is its integration of Snellen and E charts into the remote testing platform. The Snellen chart, a standard tool used in clinics, is presented for users, allowing them to orally provide alphabet inputs via the voice recognition system. On the other hand, the E chart is also incorporated, providing a different optotype for users to identify. The inclusion of both charts ensures a thorough evaluation of visual acuity across a range of optotypes.One of the standout features of Vision Vue is its integration with a MySQL database, facilitating seamless storage and retrieval of user data and test results. This database-driven approach not only streamlines the testing process but also enables the generation of personalized reports, providing users with a clear and concise overview of their eye health status.Powered by a sophisticated blend of technologies including Python, Speech Recognition Library, Python Text-to-Speech Conversion Library (pyttsx3), and Google Web Speech API, Vision Vue offers a seamless and intuitive user experience. These technologies work harmoniously to ensure accurate interpretation of user responses, enhance accessibility, and deliver real-time feedback during vision testing.

The adaptability and scalability of Vision Vue make it a versatile solution capable of addressing the unique needs of diverse communities. By harnessing technology and adopting a user-centric approach, Vision Vue aims to make significant strides in reducing preventable vision loss and improving overall eye health outcomes on a global scale. In essence, Vision Vue represents a transformative initiative in the field of eye care, offering a lifeline to communities with limited access to traditional healthcare services. Through innovation, inclusivity, and a commitment to empowering individuals, Vision Vue sets a new standard in visual health management, promising a brighter future for individuals worldwide.

II. LITERATURE SURVEY

In [1] AutoVAT: An Automated Visual Acuity Test Using Spoken Digit Recognition with MFCC and CNN - Speech recognition, Mel Frequency Cepstral Coefficients (MFCC), and Convolutional Neural Networks (CNN) for spoken digit classification, likely linked to the Snellen chart for visual acuity testing.

In [2] Hand recognition based on convolution neural network - Utilizes CNN with unspecified layers, preprocesses Kinect data combining color-depth images, segments gestures, trains CNN with Error Back Propagation, adds SVM for classification, and evaluates with recognition rates, comparing with BoF-SURF+SVM and Skin color model + CNN.

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In [3] Improving Vision-Based Distance Measurements Using Reference Objects - The research focused on designing and evaluating methods aimed at improving how robots use visual information to measure distances. This includes creating algorithms, estimating possible errors in measurements, and testing these methods using an Aibo robot to confirm their effectiveness, especially when referencing specific objects in the environment.

In [4] Face Detection and Recognition Using Face Mesh and Deep Neural Network - Introduces a model for detecting and recognizing faces using Face mesh technology, trained with labeled datasets and real-time images.

III. SCOPE AND METHODOLOGY

The main aim of the project it will help people to test their eyesight at home without going to an eye clinic. It replicates the standard eye chart test used in clinics, providing accurate results on the user's optical health.

The software will be user-friendly, giving instant feedback and helping individuals monitor their eyesight regularly. By making eye tests more accessible and automated, the project intends to address issues of unstandardized testing in rural areas, reduce undetected eye problems, and allow for early detection of vision issues. The goal is to simplify routine eye check-ups, making them accurate, easy, and available to everyone.

The methodology for the project involves several key steps and considerations to ensure the successful creation and implementation of eye charts for visual acuity testing, specifically focusing on the Snellen and E letter charts.

Firstly, an in-depth understanding of the structures and principles behind standard eye charts like Snellen and E charts is crucial. This involves studying the arrangement of letters or symbols, their decreasing sizes to indicate varying visual acuity levels, and the notation system used for assessing vision.

The development process begins by compiling a diverse database that encompasses variations in letter choices, spacing, and overall layout for Snellen charts, and different 'E' variations and arrangements for E letter charts. This comprehensive approach ensures the effectiveness of the generated charts in assessing visual acuity across a broad spectrum of individuals and conditions.

The implementation of the Snellen-like eye chart is carried out using the Tkinter library for graphical user interface development. This involves creating rows of optotypes (letters or symbols) with different visual acuity levels, dynamically calculating and displaying the size of each optotype based on a specified formula.

The formula for calculating the optotype size considers the visual acuity notation (e.g., 20/20) ensuring accurate representation on the screen. The Snellen chart application progresses through each optotype or row every 10 seconds, simulating a standard eye chart test. The calculated optotype size is displayed on the chart, providing feedback to the user and facilitating customization based on specific application requirements.

Similarly, the E chart application is designed as an alternative to the Snellen chart, particularly beneficial for overcoming language and letter recognition barriers. It features rows of 'E' symbols in various orientations (up, down, left, and right.

The application integrates hand-tracking capabilities using the MediaPipe library, allowing real-time hand tracking through the computer's camera. This interactive feature enhances user engagement, especially for individuals unfamiliar with the alphabet or young children learning letter recognition.

The methodology emphasizes a systematic approach to chart creation, graphical interface design, and user interaction, ensuring accuracy, usability, and adaptability across different testing scenarios. By leveraging technologies like Tkinter, MediaPipe, the project delivers innovative solutions for visual acuity testing, catering to diverse user needs and enhancing the overall testing experience.

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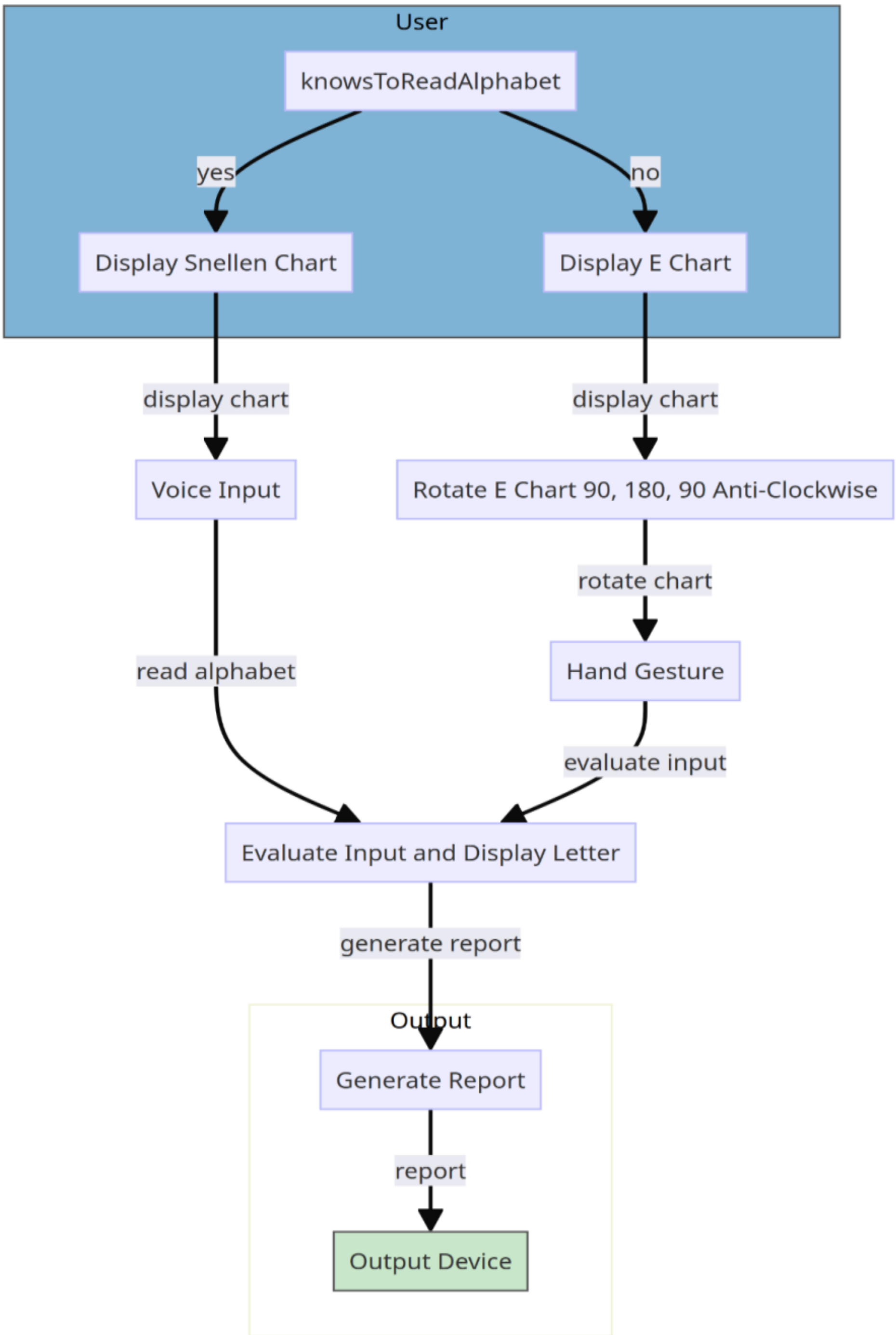

Fig 1. System Architecture

IV. CONCLUSION

In conclusion, our innovative vision acuity testing system, leveraging Flask for interface development, voice and hand recognition technologies, and dynamic adjustment features, addresses the challenge of inaccessible eye care services in rural and underserved communities. By catering to both literate and non-literate individuals, we have created a more inclusive and adaptable solution, reducing reliance on specialized personnel and extending quality eye care to remote areas. The integration of improved gesture image training ensures high accuracy in user responses, enhancing the reliability of testing outcomes.

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For future work, we aim to further refine the system's usability and accuracy, possibly integrating additional languages and dialects for wider accessibility. Moreover, expanding the system's capabilities to include more comprehensive eye health assessments beyond acuity testing would enhance its utility. Collaborations with healthcare providers and community organizations could facilitate the implementation and adoption of this technology, ultimately improving eye care access and outcomes for diverse populations.

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