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Insightmate: An Inclusive Assistive App for the Visually Impaired

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***Abstract*— Visually impaired people face a lot of challenges in their life and are at a disadvantage in our society. Technology is shaping the future and changing how people live. Technology has the potential to help people partially overcome some of these difficulties. Their lives can be made easier by voice-based mobile applications where the users can instruct the application to perform certain functions without actually seeing the application.**
This paper aims to design and develop a mobile application for visually impaired to help them do the most necessary tasks as they face challenges that include difficulties in reading text, recognizing documents, identifying products, understanding currency, perceiving colors , comprehending scenes, and navigating the environment. Our project aims to empower the visually impaired through a groundbreaking mobile application. Leveraging cutting-edge technology, the app provides a user-friendly interface equipped with advanced voice recognition and navigation features

***Index Terms*— Visually Impaired, Mobile Applications, Assistive Technology, User-Friendly Interfaces.**

I. INTRODUCTION

Visually impaired individuals often rely on others for assistance with various daily activities, including mobility and routine tasks. However, they deserve the ability to live independently, just like anyone else. The Trinetra App is designed to empower visually impaired users by enhancing their daily experiences. This app utilizes advanced technologies such as computer vision, speech recognition, image processing, and Optical Character Recognition (OCR) to assist users interactively. Developed with the Flutter Framework, the Trinetra App is compatible with both Android and iOS platforms. The app can identify objects in the user's surroundings, recognize text, and provide information on time, weather, and phone battery status. All detected and recognized information is conveyed to the user through audio feedback. This paper discusses the design and implementation techniques used, as well as the experimental results achieved.[1].
The Intelligent Eye is an Android mobile application developed to assist visually impaired individuals by offering essential features such as colour detection, object acknowledgment and banknote recognition. Designed with a intuitive interface tailored specifically for visually impaired users, the application consolidates these capabilities into a one device.
This integration decreases both costs and complexity, thereby enhancing the practicality and effectiveness of the application.

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The outcome ensure that the Intelligent Eye delivers the intended features, achieving its primary objectives.[2]. Despite numerous advancements aimed at improving everyday life, there has been limited focus on developing tools specifically for visually impaired persons (VIPs). According to the report published by the World Health Organization (WHO), around 39 million individuals worldwide are blind, facing significant challenges in communication, interpreting emotions, and recognizing common objects. VIPs can often detect emotions through voice, but this method loses effectiveness in noisy environments. They can also identify objects by touch, but this becomes impossible if the object is out of reach. This project addresses these challenges by utilizing artificial intelligence and machine learning to recognize objects and facial expression converting this information into audio feedback for the user.[3]

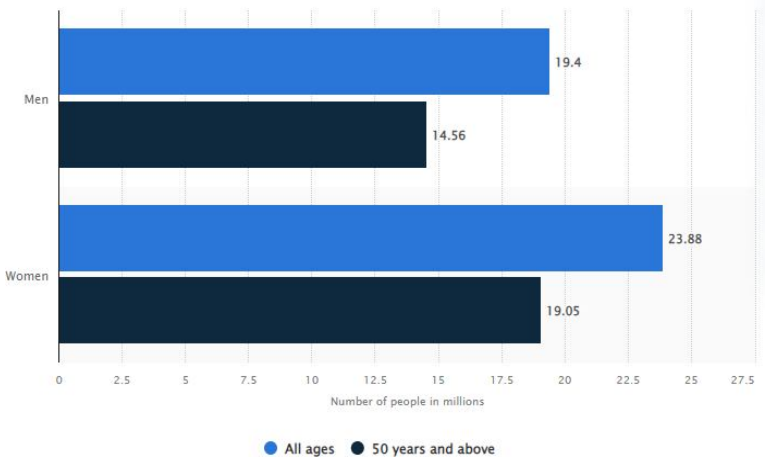

Figure 1: number of people with blindness worldwide in 2024, by age and gender

Visual impairment poses significant challenges, affecting various aspects of daily life such as mobility, reading, and social interactions. Although devices like walking canes offer some assistance, there is a need for more sophisticated solutions to improve the lives of the visually impaired. This project aims to address these needs by integrating smart technology to facilitate daily activities for visually impaired individuals. Using artificial intelligence and image processing, the proposed device can identify faces, objects, and colors, providing feedback through auditory or vibrational alerts. The study includes a survey involving local blind and visually impaired residents to evaluate the device's effectiveness. Implemented using OpenCV and Python, the project focuses on object detection and demonstrates how the smart device can assist users by recognizing obstacles and providing timely alerts. This research represents a step forward in leveraging technology to support the visually impaired community.[4].

Visual impairment significantly impacts many people's lives around the world, making everyday activities such as crossing streets, reading, and socializing particularly challenging. Blind individuals often depend on assistive devices like walking canes to help them navigate and perform daily tasks. Despite ongoing research into blindness, practical solutions remain limited. Many existing approaches propose theoretical ideas but lack effective technological implementations. This project aims to address these challenges by developing a smart device that leverages artificial intelligence and image processing to detect faces, colors, and objects. The device provides feedback through sound or vibration alerts, helping users navigate their environment. The study includes a hands-on survey with local visually impaired participants to test the device's effectiveness. Using OpenCV and Python for development, the project explores various object detection techniques and demonstrates how the device can identify objects and alert users to obstacles. This research contributes to the healthcare sector by offering a technological solution to support visually impaired individuals[5].

A. Proposed System

Prepare your CR paper in full-size format, on A4 paper (210 x 297 mm, 8.27 x 11.69 in). Header from top 1.27cm and footer from bottom 2.89cm.

Type sizes and typefaces: Follow the type sizes specified in Table I. As an aid in gauging type size, 1 point is about 0.35 mm. The size of the lowercase letter “j” will give the point size. Times New Roman has to be the font for main text. Paper should be single spaced.

Margins: top, bottom = 3.25cm, left = 3cm and right = 2.5cm. Use automatic hyphenation and check spelling. Digitize or paste down figures.

II. Proposed Solution

This paper aims in developing a mobile application for blind features

A. Key Features

- *The TTS Engine* leverages cloud-based APIs for converting text into speech and vice versa, utilizing platforms like Google Cloud.
- *Scene Descriptions*, in the app leverages advanced computer vision models, enabling it to recognize and interpret objects within a scene, providing users with detailed verbal descriptions of their surroundings.

Person Recognition is done using the serengil's DeepFace , a pre-trained python model. It helps in facial attribute analysis.

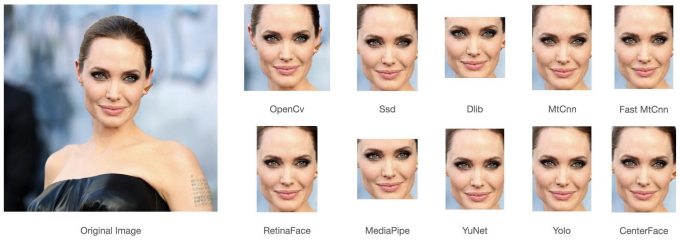

Figure 2: Image recognition by DeepFace when compared with other identification models

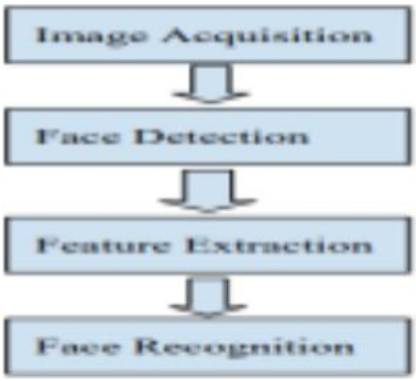

Figure 3: Flowchart of how face recognition works

- SOS Safety Signal feature is integrated with geolocation APIs, allowing users to send emergency alerts along with their location to predefined contacts and emergency services, which can vary depending on the region.
- Community form, usage of React.js to create an interactive and accessible front end, and Node.js with Express for the server side. Incorporating Socket.io for real-time features and PostgreSQL for managing data.
- Volunteer Guidance feature utilizes location tracking and matching algorithms within the backend system, ensuring that users are paired with suitable volunteers, all while taking privacy concerns into account.

Figure 4: Same design of volunteer guidance feature

- Product Barcode Scanner utilizes open-source libraries like ZBar, enabling efficient barcode scanning directly on the device.
  - ZBar is open-source library for barcode scanning that supports multiple barcode formats
  - For Android, ZXing is added as dependencies in the project's build configuration.

B. Algorithms and Functionalities

The app's Short Text Reading and Document Scanning function begins with capturing an image using an enhanced camera. Once the image is captured, Optical Character Recognition (OCR) technology is applied to extract the text, which is then converted into an audible format and delivered to the user. For Object Recognition, a similar process is followed where the image is captured and then analysed using computer vision algorithms to identify objects. These objects are then described to the user through audible
feedback, helping them understand their environment better.
The Volunteer Guidance algorithm is designed to match users with volunteers based on the user's location and needs. The user inputs their location and the assistance required, after which the system matches them with a nearby volunteer. The volunteer is notified and can accept the request, after which they receive navigation instructions to reach the user. The app also enables real-time communication between the user and the volunteer, ensuring the user receives the help they need.
Community Engagement and Forums are facilitated through integration with a forum platform, allowing users to post, comment, and interact with others. The app is designed to encourage social interaction, helping users to connect with others who share similar interests or challenges, thereby fostering a sense of community and reducing social isolation

C. Proposed System

The architecture of Insight Mate is designed for smooth, effective user interface. The Mobile Application serves as the main interface for users, offering features such as voice commands, text-to-speech conversion, and image recognition. These functionalities allow Blind individuals to interact with the app in a manner that suits their needs. The Cloud based Server plays a vital role in processing user requests and performing difficult tasks like image analysis and natural language processing. It also stores user data and ensures seamless synchronization across multiple devices, making the user experience more fluid. Machine Learning Models are central to the app's operation, with models specifically trained to perform tasks like object recognition, text extraction, and voice commands. These models, deployed on the cloud server, are continually updated to improve their accuracy and performance, ensuring that users receive the most reliable results. The app also relies on various APIs to connect with external services and gather additional data. These APIs include speech-to-text and text-to-speech, and translation services, all of which are integral to the app's functionality.
The Text-to-Speech (TTS) engine within Insight Mate utilizes the Google Text-to-Speech API. For Machine Learning Models, the app employs custom-trained Convolutional Neural Network (CNN) models using frameworks like TensorFlow or PyTorch for tasks such as currency recognition.
Scene descriptions are generated using pre-trained models such as ResNet or MobileNet, while color recognition also benefits from custom-trained CNN models. For Person Recognition, the app leverages pre-trained models like OpenCV. These models are essential for ensuring that visually impaired users can accurately identify and interact with objects, people, and their environment.
The app's AI Assistant is powered by Google Dialog Flow or Microsoft Azure Bot Service, providing users with personalized guidance and real-time support. This AI assistant is capable of engaging in conversations, helping users with daily tasks, and responding to their queries. In emergency situations, the SOS Safety Signals feature is supported by the Google Maps API for geolocation services and the Twilio API for sending SMS or voice call notifications. This feature is vital for ensuring the safety of users by enabling them to quickly seek help.
For communication, the Messaging Interface utilizes the Twilio API, which provides an accessible and easy-to-use platform for visually impaired users to stay connected with friends, family, caregivers, and volunteers. The Backend Infrastructure is built on a robust and scalable framework, with a server powered by Node.js or Python with Flask, and a database managed by MongoDB or PostgreSQL.
Authentication is handled by Firebase Authentication or OAuth 2.0, and the app's APIs are custom-built and RESTful, ensuring efficient processing of user requests, data management, and communication between different components of the app.
Finally, the app integrates with External Services such as the Google Maps Geocoding API for geolocation services and the Twilio API for messaging, ensuring that the app remains versatile and responsive to user needs. Figure Below describes the Design Interface of our app.

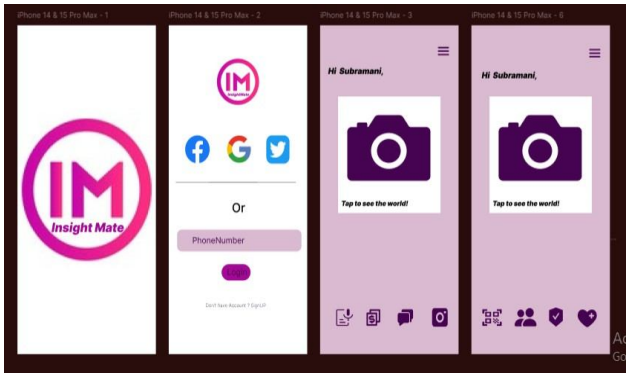

Figure 5. Design of the proposed solution

III. CONCLUSIONS

The "Insight Mate" app is designed to advance assistive technology for visually impaired individuals by offering a robust suite of features that enhance daily interactions and independence. By incorporating capabilities such as object recognition, barcode scanning, and voice-controlled commands, the app provides a comprehensive tool aimed at simplifying tasks and improving accessibility With a strong focus on user experience, "Insight Mate" strives to deliver an intuitive interface that adapts to the unique needs of each user. The application is poised to evolve, incorporating feedback and technological advancements to continuously refine its functionality and effectiveness.

Ultimately, "Insight Mate" seeks to empower visually impaired users, facilitating greater autonomy and confidence in navigating their environment and managing everyday activities. Through its innovative approach and commitment to user-centered design, "Insight Mate" aspires to make a significant and positive difference in the lives of those it serves.

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