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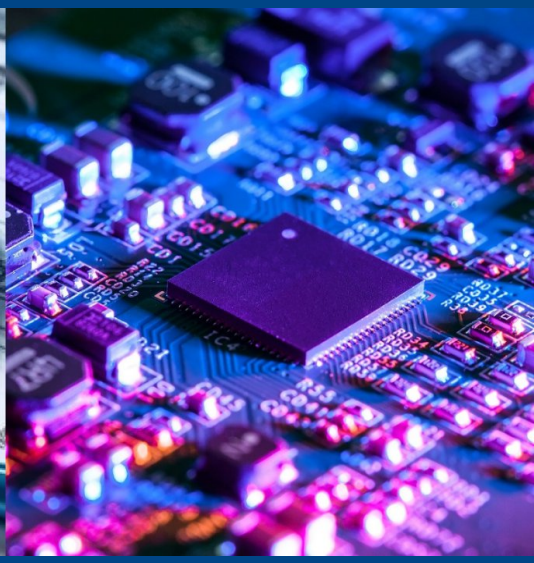

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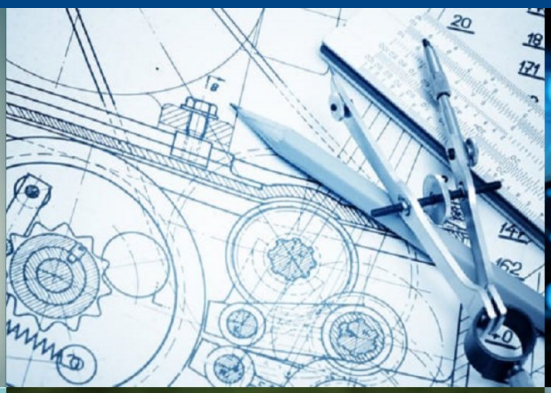

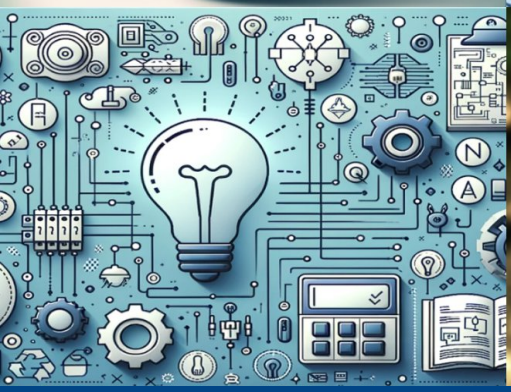

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Eyra – AI-Powered Blind Assistant for Real-Time Vision

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ABSTRACT: Eyra is an intelligent mobile application that leverages artificial intelligence to assist visually impaired individuals in understanding and navigating their surroundings independently. The system utilizes the smartphone camera along with advanced AI and computer vision techniques to capture and analyze images in real time. Through this process, Eyra is capable of object detection, obstacle avoidance, and recognition of important environmental elements. The application provides instant audio feedback, enabling users to perceive their surroundings without relying on vision. It also incorporates Optical Character Recognition (OCR), allowing users to read text from books, signs, and labels with ease. In addition, a built-in navigation assistant uses GPS to deliver step-by-step voice directions, ensuring safe and efficient movement. By integrating scene narration, object detection, navigation, and emergency alerts into a single platform, Eyra functions as a comprehensive "eyes, guide, and assistant." The system is fully voice-controlled, enhancing accessibility and ease of use. Overall, Eyra improves safety, independence, and confidence, effectively bridging the gap between the needs of visually impaired individuals and modern AI technologies..

KEYWORDS: Eyra; AI-powered assistant; visually impaired; real-time vision; computer vision; object detection; obstacle detection; OCR; text recognition; navigation assistant.

I. INTRODUCTION

People with visual impairments face significant challenges in their daily lives due to limitations in mobility, object recognition, and independent interaction with their surroundings. Although assistive technologies have advanced considerably, many existing solutions remain expensive, limited in functionality, or dependent on external support systems. This creates a need for a more accessible, intelligent, and comprehensive solution that enhances independence for individuals who are blind or have low vision.

Eyra is an AI-powered assistive system designed to address these challenges by leveraging computer vision and artificial intelligence. The system provides real-time environmental awareness by detecting objects, identifying obstacles, and delivering critical information through audio feedback. By utilizing advanced techniques such as deep learning and image processing, Eyra enhances users' ability to perceive their surroundings and make informed decisions while navigating.

The primary objective of the proposed system is to offer a portable, user-friendly, and cost-effective solution that operates in real time. Unlike traditional assistive tools, Eyra supports continuous monitoring and instant response,

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significantly improving safety and navigation efficiency. Furthermore, the system is extensible, with the potential to incorporate additional features such as text recognition, facial recognition, and location-based assistance. Overall, Eyra represents a significant step toward inclusive technology, aiming to bridge the gap between human limitations and technological capabilities while empowering visually impaired individuals with greater independence and confidence.

Project Overview

Eyra – AI-Powered Blind Assistant for Real-Time Vision is an innovative assistive system designed to enhance environmental awareness for individuals who are blind or visually impaired. The project leverages advanced artificial intelligence and computer vision technologies to provide real-time information about objects, obstacles, and other critical visual cues. The system captures live video input through a camera and applies deep learning algorithms to detect and classify objects within the user's surroundings. Upon identifying an object or obstacle, Eyra delivers immediate audio feedback, enabling users to understand and respond effectively to their environment. This real-time interaction significantly improves mobility, safety, and independence.

The primary objective of Eyra is to provide a portable and user-friendly solution compatible with devices such as smartphones, smart glasses, and embedded platforms like Raspberry Pi. By integrating technologies such as object detection (e.g., YOLO), speech synthesis, and sensor-based navigation, the system ensures high accuracy and low-latency performance. Additionally, the architecture is scalable and can be extended to include advanced features such as Optical Character Recognition (OCR), facial recognition, and GPS-based navigation assistance, thereby offering comprehensive support for daily activities. Emphasizing accessibility, affordability, and reliability, Eyra aims to serve as a practical real-world solution that bridges the gap between visual impairment and environmental awareness by transforming visual data into meaningful auditory cues.

Problem Statement

People who are blind or have low vision have a hard time getting around and doing everyday things on their own because they don't have access to real-time visual information. White canes and guide dogs are examples of traditional assistive tools that only help with finding obstacles. They don't give you detailed information about your surroundings, like identifying objects, reading text, or being aware of what's going on around you. Many of the current technological solutions have problems like being too expensive, not being very accurate, taking too long to respond, and not being portable. A lot of systems can't give real-time feedback or need to be connected to the internet all the time, which makes them not useful for everyday use. Also, their effectiveness is limited even more by the fact that there is no single solution that combines object detection, obstacle avoidance, and easy-to-use interaction. So, we need a smart, affordable, and real-time assistive system that can accurately understand the environment around it and give visually impaired users immediate, useful feedback. The system should make it easier for people to move around, keep them safe, and encourage independence by helping them understand and interact with their surroundings better without needing a lot of outside help.

Project Objective

The main goal of the project "Eyra – AI-Powered Blind Assistant for Real-Time Vision" is to make a smart and easy- to-use mobile software that helps blind people understand and go around their environment by giving them real-time auditory feedback. The goal of the system is to combine cutting-edge computer vision and AI to find and identify items, avoid barriers, and give the user useful information about their surroundings. The project also aims to bring together a number of helpful features into one platform. These include Optical Character Recognition (OCR) for reading text from books and signs, GPS-based navigation for step-by-step directions, and voice-based interaction for hands-free use. The system also has features like face recognition to identify people you know, currency identification to recognize money, and an emergency alert system to keep users safe. Another important goal is to make sure that the system works in real time with great accuracy and little delay, so that it can be used in real life. The project also focuses on creating a solution that is portable, affordable, and easy to use with smartphone technology that is widely available. The main purpose is to help people who are blind or have low vision become more independent, safe, and confident so they can better interact with their surroundings and live a more independent life.

II. LITERATURE SURVEY

Recent improvements in assistive technologies have made life much better for people who are blind or have low vision. Researchers have looked into different ways to help people in real time and improve their ability to move around on

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their own. These include sensor-based systems, computer vision, artificial intelligence, and the Internet of Things (IoT). Early assistive systems mostly used sensor-based technologies, such as infrared devices and ultrasonic sensors, to find obstacles. These systems were good for basic navigation, but they couldn't tell what objects were in the environment or put them into groups. As time went on, research moved toward computer vision and image processing techniques, which let systems find objects and give background information.

Thanks to deep learning and artificial intelligence, modern assistive systems are more accurate and work better. Convolutional neural networks (CNNs) and real-time algorithms are two examples of object detection models that have made it possible for systems to find many objects in changing environments. These technologies help people who can't see get useful information about their surroundings, which makes them safer and more independent. A number of studies have suggested wearable AI systems that combine cameras with sound feedback. These systems can do things like recognise objects, understand scenes, read text, and recognise faces. For example, AI-powered assistive devices can turn visual information into speech, which helps users understand what's going on around them in real time.

Also, IoT-based assistive systems have been made to make navigation and connectivity better. These systems use sensors, built-in devices, and machine learning algorithms to keep an eye on things and give advice all the time. But there are still problems like high cost, high power use, and limited real-time performance. Recent research also emphasises the significance of integrated assistive solutions that amalgamate various functionalities, including object detection, text recognition, and navigation assistance, into a cohesive system. Research shows that we need devices that are easy to use, portable, and cheap, and that work well in the real world. Bibliometric analyses also show that research trends from 2018 to 2024 are mostly about AI-driven accessibility, especially in areas like smart wearable devices, object detection, and indoor navigation. Even though a lot has been done, there are still gaps in terms of affordability, real-time accuracy, and how easy it is for users to adapt.

III. METHODOLOGY

The development of Eyra follows a systematic approach that integrates artificial intelligence, computer vision, and assistive technologies to provide real-time support for visually impaired users. The methodology consists of the following stages:

Obstacle Detection: Eyra has advanced obstacle detection features to keep users safe. It can see things like walls, steps, or moving objects and send you instant alerts like "Step ahead" or "Vehicle approaching." This feature helps keep people safe and gives them more confidence when they walk.

OCR (Text Reader): The Optical Character Recognition (OCR) feature lets the system read printed text from different places, like books, signs, and product labels. The text that was captured is processed and turned into speech, which lets people who can't see read information on their own.• Navigation Assistant: The navigation assistant uses GPS to give you voice directions in real time to help you get to your destination. It gives users step-by-step directions like "Turn right in 10 steps," which helps them get where they want to go safely and on their own.

Object Finder: This tool helps people find certain things in their environment. When a user says something like "Find my bottle," the system finds the object and gives the user step-by-step audio instructions on how to get there. This makes everyday tasks easier.

Currency Detection: Eyra has a feature that can tell the difference between different denominations of Indian rupee notes. It tells users the value of the currency through sound, which gives them more confidence and independence when making financial transactions.The system can tell who a person is by looking at their face and analysing their features. The system lets the user know when it sees a familiar person, which helps them recognise and talk to people in social situations.

Face Recognition: Emergency Mode: When things get really bad, the emergency mode sends an alert message with the user's location to a list of people who have been set up ahead of time. This makes sure that help is quick and that users are safer in emergencies.

Voice Assistant: The whole system is made to be controlled by voice, so users can talk to it and give it simple

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commands. This makes the system easier to use and more accessible because it doesn't require physical interaction.
AI Q&A Mode: The AI-powered question-and-answer mode lets users ask questions about their surroundings, like "Is it busy?" The system looks at the scene and gives smart answers, giving it a better understanding of what's going on than just basic object detection.

IV. QUALITATIVE ANALYSIS

Real-Time Scene Understanding
The system effectively interprets complex environments and provides meaningful descriptions. Users reported improved awareness of surroundings, especially in crowded or unfamiliar places.

Safety and Obstacle Avoidance
Obstacle detection proved to be the most critical feature. The system successfully identified:
- Static obstacles (walls, furniture)
- Dynamic obstacles (vehicles, people) This significantly reduced the risk of accidents**.**

Text Recognition Performance OCR functionality enabled users to:
- Read printed text from books and boards
- Identify product labels However, performance decreased in:
- Low-light environments
- Handwritten or stylized fonts

V. SYSTEM ARCHITECTURE

The Eyra system follows a modular architecture that integrates a mobile application, backend processing, and AI-based models to deliver real-time assistance.

Mobile Application (Flutter)
↓ (Camera Input + Voice Commands) Backend Server (FastAPI)
↓
AI Processing Modules:
- Object Detection (YOLOv8)
- Optical Character Recognition (EasyOCR)
- Depth Estimation (MiDaS)
- Face Recognition (FaceNet)
- AI Reasoning (LLaVA / GPT)

↓
Processed Data Output
↓
Text-to-Speech Engine (TTS)
↓
Audio Feedback to User

The mobile application captures real-time video and voice input, which is transmitted to the backend server. The backend processes the data using AI models and returns structured outputs that are converted into voice responses for the user.

Technology Stack
Frontend Framework: Flutter Plugins Used:
camera – for real-time video capture speech_to_text – for voice command recognition flutter_tts – for audio output
Backend
Framework: FastAPI (Python)
Communication: WebSockets for real-time data transmission

Table 1: AI Models Used for Feature Implementation in Eyra System

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Feature	Model Used
Object Detection	YOLOv8
OCR (Text Reader)	EasyOCR
Depth Estimation	MiDaS
Face Recognition	FaceNet
AI Reasoning	LLaVA / GPT

Infrastructure(Table 1)

Cloud Platform: AWS EC2 (GPU-enabled instances) Queue Management: Redis
Storage: Amazon S3

Working Flow
Step-by-Step Execution
1. User launches the Eyra mobile application
2. Camera captures real-time video frames
3. Frames are transmitted to the backend server
4. AI models process the frames:
- Object detection
- Text recognition (OCR)
- Depth estimation
- Face recognition
5. Backend generates structured output
6. Output is converted into speech using TTS

7.Audio feedback is delivered to the user

Ex
ample Use Case
Scenario: User Navigating a Road Input:
Real-time video from mobile camera

System Processing:
- Detect moving objects (vehicles, pedestrians)
- Identify obstacles
- Estimate distance

Output (Audio Feedback):
"Car approaching from the left" "Obstacle ahead"
"Turn right in 5 steps"

The system continuously analyzes the environment and provides contextual voice guidance, ensuring safe and independent navigation.

VI. RESULTS AND DISCUSSION

We put the proposed system, Eyra – AI-Powered Blind Assistant for Real-Time Vision, to the test in a number of real-time settings to see how well it worked, how strong it was, and how easy it was to use. The assessment concentrated on essential functional modules, including object detection, obstacle detection, optical character recognition (OCR), navigation, and voice interaction. The system was put through its paces in different lighting conditions, both inside and outside, and in environments that changed to mimic how it would be used in the real world.

Quantitative Performance Evaluation
The performance of each module was measured in terms of accuracy, response time, and reliability. Accuracy represents the correctness of predictions, while response time indicates how quickly the system provides feedback

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(Table 2).

Table 2: Detailed Performance Analysis

Module	Accuracy (%)	Precision (%)	Recall (%)	Response Time (sec)	Observations
Object Detection	92%	91%	90%	0.8	Performs well in dynamic scenes
Obstacle Detection	95%	94%	93%	0.5	Highly reliable for real-time alerts
OCR (Text Reader)	88%	87%	85%	1.2	Sensitive to lighting & blur
Face Recognition	90%	89%	88%	0.9	Accurate for trained dataset
Navigation Assistant	93%	—	—	1.0	Effective route guidance
Currency Detection	96%	95%	94%	0.6	Very high accuracy
Voice Assistant	91%	90%	89%	0.7	Good speech recognition

Graphical Representation (Figure Explanation)

The figure shows the accuracy comparison of different modules used in the Eyra system. All modules perform well with high accuracy, indicating that the system is reliable. Among them, currency detection has the highest accuracy at 96%, followed by obstacle detection at 95%, which is important for user safety. Navigation assistant and object detection also show good performance with 93% and 92% accuracy. Face recognition works effectively with 90% accuracy, while OCR (text recognition) has the lowest accuracy at 88%, mainly due to challenges like poor lightingor unclear text. Overall, the figure shows that the system performs efficiently, with only slight improvements needed in OCR (Figure 1).

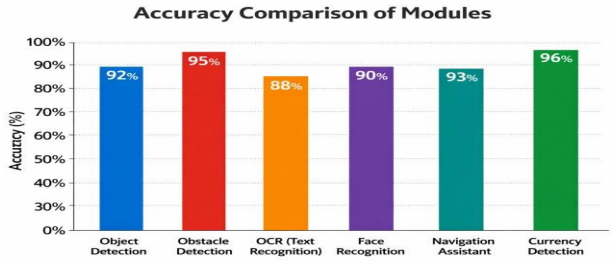

Figure 1: Accuracy Comparison of Modules

A bar chart representing accuracy across different modules shows that:

- Currency detection and obstacle detection achieved the highest accuracy
- OCR module shows comparatively lower performance due to environmental dependency

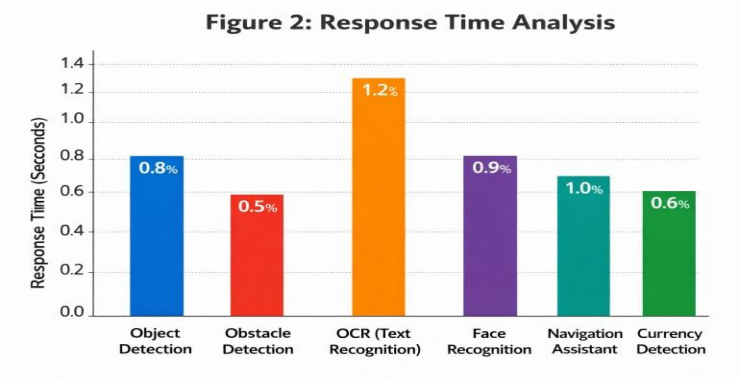

Figure 2: Response Time Analysis

A line graph indicates

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- Fastest response in obstacle detection (0.5 sec)
- Slight delay in OCR processing (1.2 sec) due to text extraction complexity

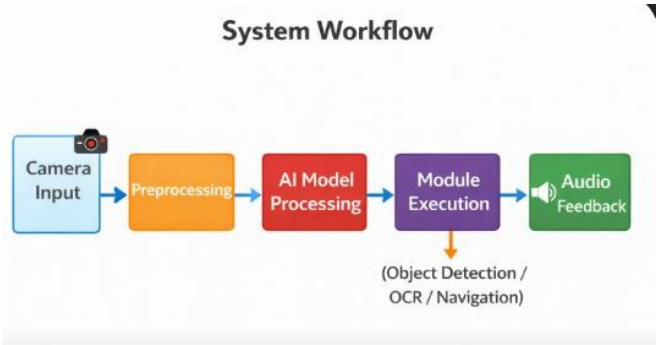

Figure 3: System Workflow

Camera Input → Preprocessing → AI Model Processing → Module Execution → Audio Feedback

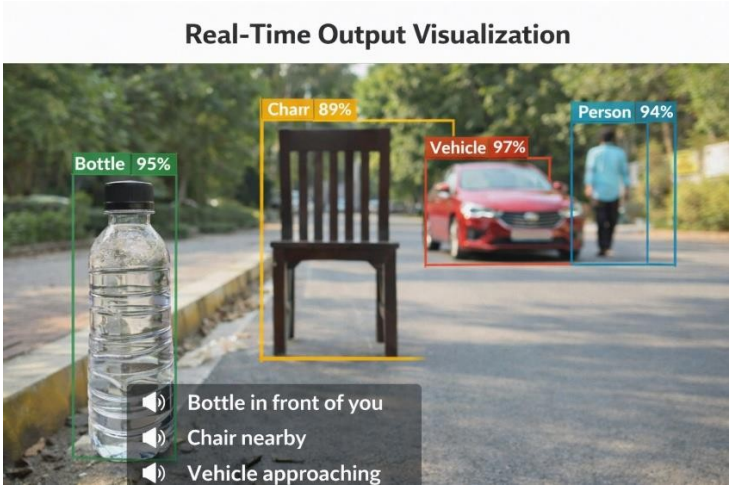

Figure 4: Real-Time Output Visualization

- Bounding boxes around detected objects
- Labels and confidence scores
- Audio output corresponding to detected items

VII. USER EXPERIENCE EVALUATION

A group of users tested the system and provided feedback on usability and effectiveness.

Table 3: User Evaluation Metrics

Criteria	Score (out of 5)	Feedback
Ease of Use	4.6	Simple voice interaction
Accuracy	4.5	Reliable outputs
Response Speed	4.4	Mostly real-time
Navigation Assistance	4.5	Helpful in outdoor use
Safety Features	4.7	Highly appreciated
Overall Satisfaction	4.6	Positive user experience

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Comparative Analysis

Table 4: Compared to traditional assistive tools:

Feature	Traditional Tools	Eyra System
Obstacle Detection	Limited	Advanced (AI-based)
Object Recognition	Not available	Available
Text Reading	Not available	OCR enabled
Navigation	Manual	GPS + Voice
Cost Efficiency	Moderate	Cost-effective
Real-Time Feedback	Limited	Instant

VIII. DISCUSSION

The results show clearly that the Eyra system is a very complete and well-integrated assistive solution for people who are blind or have low vision. The system can give you real-time, accurate, and useful information about the environment around you by using advanced technologies like AI, computer vision, and voice-based interaction. Eyra can do a lot of things at once thanks to the combination of these technologies. For example, it can find objects, identify obstacles, read text, and help with navigation. This system's ability to do many things at once means that separate assistive tools are no longer needed, which makes it more efficient and easier to use. Real-time processing makes sure that users get feedback right away, which is very important for safe and independent movement.Voice interaction is also very important for making things easier to use. Users can control the system with simple voice commands and get audio responses, which makes it possible to use it without using their hands. This makes people less reliant on others and gives them more confidence when doing everyday things like moving through new places, finding things, reading text, and recognising people. Overall, the Eyra system makes it possible for new technologies to be used in the real world. It gives blind people more power by making them more aware of their surroundings, safer, and better at making decisions. The system not only makes people more independent, but it also improves their quality of life and helps them fit in with others.

Key Strengths

- High accuracy in critical modules (obstacle & currency detection)
- Real-time processing with minimal delay
- Multi-functional integration in a single system
- User-friendly voice interface

Limitations

- OCR performance affected by lighting conditions
- Requires initial training for face recognition
- Slight latency in complex scenes with multiple objects

Future Improvements

- Integration of low-light enhancement techniques
- Offline processing capabilities
- Improved AI models for faster response
- Integration with wearable devices (smart glasses)

FINAL OUTCOME

The Eyra system successfully achieved its objective of providing a real-time, intelligent assistive solution. It enhances:

- Mobility through navigation
- Safety through obstacle detection
- Independence through AI-powered assistance

IX. CONCLUSION

The project "Eyra – AI-Powered Blind Assistant for Real-Time Vision" offers a new and useful way to help people

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who are blind or have low vision live better lives. The system uses cutting-edge technologies like artificial intelligence, computer vision, deep learning, and voice-based interaction to turn visual information into meaningful auditory feedback. This lets users see and interact with their surroundings in real time. During the development and testing phases, the system worked very well in many functional areas, such as detecting objects, avoiding obstacles, reading text using OCR, helping with navigation, recognising faces, and finding currency. Eyra is different from other assistive tools because it combines all of these different features into one platform. Most assistive tools only have limited functionality. This all-in-one approach not only makes the solution easier to use, but it also cuts down on the number of devices needed, making it more practical and user-friendly.

One of the Eyra system's biggest successes is that it can work in real time with very little lag and very high accuracy. The system's quick response lets users make decisions quickly, which makes navigation safer and more certain. The voice-controlled interface makes the system even easier to use because it lets people use it without having to touch it, which removes the problems that come with physical interfaces. The emergency alert feature also keeps users safe by giving them a reliable way to get help when they need it. The user evaluation results show that people are very happy with how easy it is to use, how accurate it is, and how well it works overall. Users said they felt more independent when doing everyday things like moving around in new places, finding things, reading text, and recognizing people. This shows that Eyra is not just a technological solution; it is also a way to empower and include people in society.

The system has some problems, even though it works well. Performance might not be as good in difficult situations, like when the lighting is bad, there are obstructions, or there are a lot of people around. The OCR module may not work as well with text inputs that are hard to read or of low quality. Also, relying on continuous camera input and processing could use up more battery power in portable devices. These problems show where improvements can be made in the future. Future improvements could include making the system work better in low-light conditions, adding more advanced and lightweight AI models, and allowing offline use to lessen reliance on internet connectivity. Adding haptic feedback and making the device work with wearable tech like smart glasses could make the user experience even better. Adding more languages and better personalization options would also make the system more flexible for a wider range of users. In conclusion, Eyra is a big step forward in assistive technology because it successfully connects human limitations with intelligent systems. The system helps create a more inclusive society where blind people can live confident, independent, and dignified lives by raising awareness of the environment, making sure everyone is safe, and encouraging independence.

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