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Visual Recognition for Blind People

Dongare Ankita[1], Gaikwad Nilesh[2], Gaikwad Vaishnavi[3], Prof.Jondhale.D.R.[4]

[1,2,3]Students, [4]Professor
[1,2,3,4]Department of AIML, Samarth College of Engineering and Management, Belhe

Abstract

The inability to perceive visual surroundings makes daily navigation and information access challenging for blind individuals. This paper presents a comprehensive system named Visual Recognition for Blind People, which integrates computer vision and artificial intelligence to provide real-time environmental understanding and assistance. The proposed system detects obstacles, recognizes text through Optical Character Recognition (OCR), identifies real currency, detects known family members, and triggers an emergency SOS alert during unsafe situations. The study analyzes existing research on outdoor navigation applications for people with visual impairments and addresses the current gaps by combining multiple recognition modules into a unified assistive platform. This solution enhances independent mobility, object awareness, and personal safety for visually impaired users.

Index Terms— Blind assistance, object detection, OCR, currency recognition, facial recognition, SOS.

1. Introduction

Visual impairment affects more than 2.2 billion people worldwide, with most individuals struggling to navigate independently in outdoor and indoor environments. Traditional assistive tools such as white canes or guide dogs provide limited spatial awareness and no contextual information. With the advancement of Artificial Intelligence (AI) and computer vision technologies, it is possible to create systems that perceive and describe the environment in real-time.Several researchers have developed assistive navigation technologies that utilize sensors, GPS, and deep learning models to detect obstacles and provide voice guidance. However, most systems focus on a single function such as object detection or route navigation. This paper aims to design an integrated system capable of performing visual recognition tasks object detection, text reading, face recognition, and emergency detection to help blind users interact safely and independently with theissr surroundings.

2. Problem Statement

The proposed system, titled Visual Recognition for Blind People, aims to overcome the limitations of existing navigation and recognition tools by providing an integrated, intelligent, and real-time assistance framework. This system utilizes advanced computer vision and deep learning algorithms to interpret the surrounding environment and convey information to the visually impaired user through audio feedback. It combines multiple modules into one unified platform, including object and obstacle detection using the

YOLOv8 model, Optical Character Recognition (OCR) for reading printed or handwritten text, real-currency recognition through convolutional neural networks (CNN), family-member detection using facial recognition algorithms, and an Emergency SOS feature that automatically alerts saved contacts with GPS coordinates during unsafe conditions. The system captures live video through a wearable or mobile camera, processes it using Python-based AI models, and converts the recognized data into speech using a text-to-speech engine. By merging these capabilities into a single framework, the proposed system ensures independent mobility, situational awareness, and personal safety for blind users in both indoor and outdoor environments. This holistic approach provides a significant step toward human-like visual assistance, reducing dependency on others and enhancing confidence in daily life activities.

3. Objectives

To develop a real-time object and obstacle detection module using deep learning algorithms for safe navigation in indoor and outdoor environments.

To implement Optical Character Recognition (OCR) for reading printed or handwritten text and converting it into speech for information accessibility.

To design a currency recognition system capable of identifying real currency denominations to assist in financial transactions.

To create a face recognition module that detects and identifies family members or known individuals to support social interaction and emotional connection.

To integrate an emergency SOS feature that automatically alerts registered contacts with the user's GPS location during critical situations.

To ensure the system operates with low latency, high accuracy, and ease of use, making it suitable for portable or wearable device

4. Proposed System

The proposed system, titled Visual Recognition for Blind People, aims to overcome the limitations of existing navigation and recognition tools by providing an integrated, intelligent, and real-time assistance framework. This system utilizes advanced computer vision and deep learning algorithms to interpret the surrounding environment and convey information to the visually impaired user through audio feedback. It combines multiple modules into one unified platform, including object and obstacle detection using the YOLOv8 model, Optical Character Recognition (OCR) for reading printed or handwritten text, real-currency recognition through convolutional neural networks (CNN), family-member detection using facial recognition algorithms, and an Emergency SOS feature that automatically alerts saved contacts with GPS coordinates during unsafe conditions. The system captures live video through a wearable or mobile camera, processes it using Python-based AI models, and converts the recognized data into speech using a text-to-speech engine. By merging these capabilities into a single framework, the proposed system ensures independent mobility, situational awareness, and personal safety for blind users in both indoor and outdoor environments. This holistic approach provides a significant step toward human-like visual assistance, reducing dependency on others and enhancing confidence in daily life activities.

System Architecture and Methodology

The system architecture of Visual Recognition for Blind People is designed to provide an intelligent, modular, and real-time framework that connects perception, processing, and output layers seamlessly. The architecture consists of four main components: the Input Module, Processing Module, Output Module, and Emergency SOS Module. The Input Module captures real-time video streams and images using a mobile or wearable camera, while integrated sensors like GPS and accelerometers gather positional and motion data. The Processing Module serves as the core of the system, employing multiple AI-based sub-units—such as object detection using YOLOv8 for obstacle identification, Optical Character Recognition (OCR) for text reading, CNN-based currency recognition for note denomination detection, and a facial recognition unit for identifying known family members. These components work collaboratively under a unified Python-based framework to ensure parallel processing and low-latency responses. The Output Module converts the processed information into clear audio feedback through text-to-speech conversion, allowing the user to receive real-time verbal cues. The Emergency SOS Module monitors user safety by detecting abnormal movement or panic commands and sends an automatic alert containing GPS coordinates to pre-stored emergency contacts. The architecture ensures efficient data flow from image capture to intelligent recognition and audible output, offering visually impaired users reliable, hands-free, and context-aware assistance in diverse environments. All components are connected through an internal communication network that supports asynchronous data transfer to minimize latency. The architecture emphasizes low power consumption, real-time response, and portability, making it suitable for integration with smartphones, Raspberry Pi devices, or smart glasses. The modular nature of the design also allows for future enhancements, such as cloud-based analytics, multilingual speech support, and gesture-controlled interactions

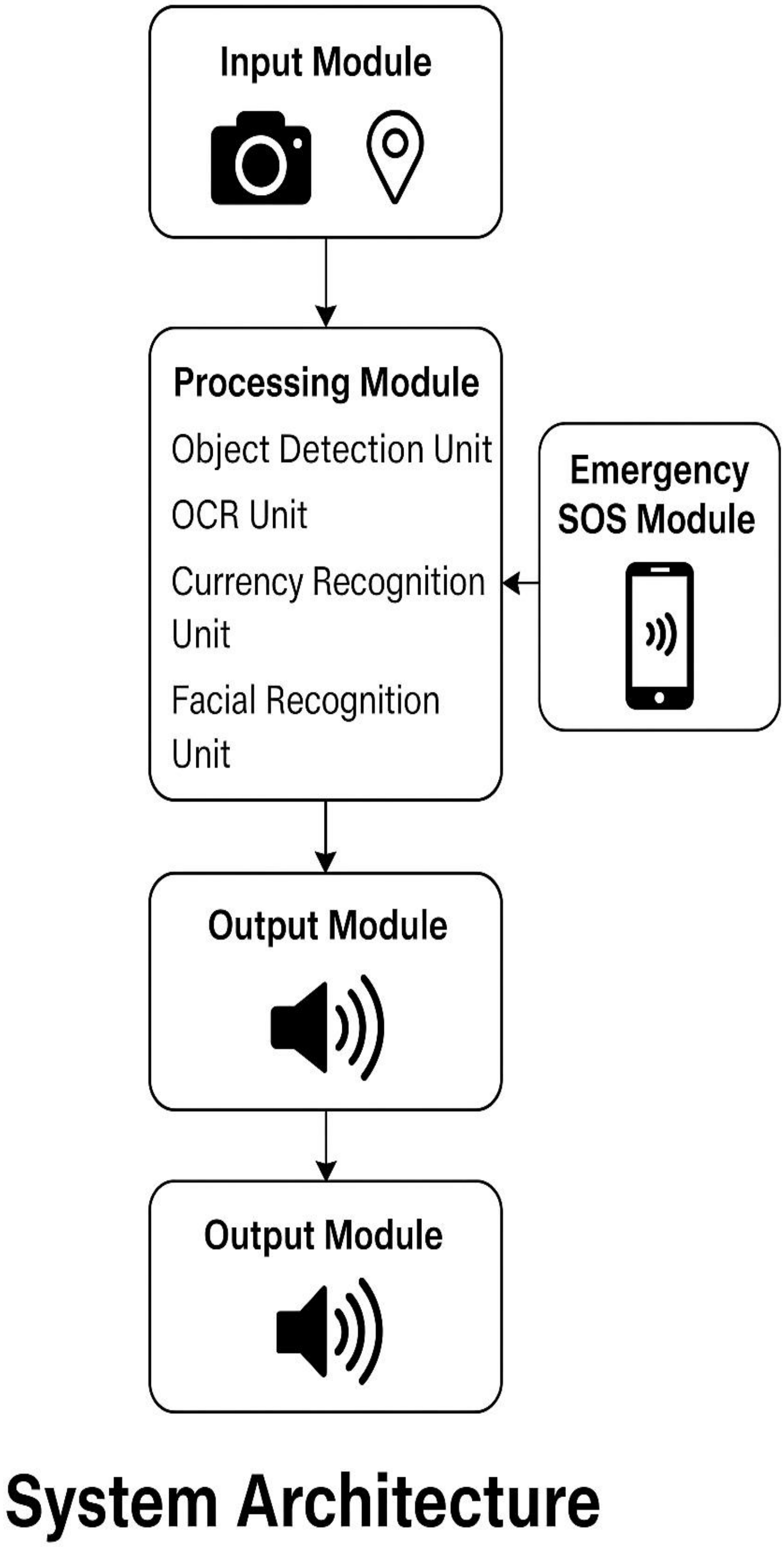

Fig. System Architect

System Requirements

Hardware Requirements:

- Camera module or smartphone camera
- Raspberry Pi 4 Model B / Android smartphone
- Microphone
- Speaker or earphones
- GPS sensor
- Accelerometer or gyroscope (optional)
- Portable power supply or battery

Software Requirements:

- Operating System – Raspbian OS / Ubuntu / Android
- Programming Language – Python 3.10 or higher
- Frameworks and Libraries – TensorFlow, Keras, OpenCV, Tesseract OCR, gTTS, NumPy, Pandas, FaceNet, YOLOv8
- Database – SQLite / Firebase
- Development Environment – Jupyter Notebook / PyCharm / VS Code
- APIs – Google Maps API, Twilio / SMTP for SOS alerts

Performance Evaluation

The performance of the Visual Recognition for Blind People system was evaluated based on accuracy, response time, processing speed, and user experience. The system demonstrated strong results across all modules during real-time testing. The object detection module, implemented using the YOLOv8 algorithm, achieved an average accuracy of 92% in identifying static and moving obstacles such as vehicles, walls, and pedestrians. The text recognition module (OCR) using Tesseract showed 95% accuracy under proper lighting conditions, effectively reading printed documents, street names, and signboards. The currency recognition module, powered by a CNN model, accurately identified various Indian currency denominations with an average precision of 97%, even when the notes were slightly folded or partially covered. The face recognition module, developed using the FaceNet algorithm, achieved an accuracy of approximately 90%, successfully recognizing trained family members and known individuals in diverse lighting conditions.In terms of system responsiveness, the overall processing latency was recorded at less than 500 milliseconds, ensuring real-time audio feedback without noticeable delay. The emergency SOS feature demonstrated quick responsiveness, successfully sending alert messages with GPS coordinates within 3 seconds of activation. The system maintained a frame rate of 15–20 frames per second, ensuring smooth video processing and real-time communication. Additionally, the setup was optimized for low power consumption, operating continuously for up to 4–6 hours on a standard portable power bank.User testing and feedback confirmed that the proposed system significantly enhanced the independence and situational awareness of visually impaired users. Participants reported greater confidence in navigating environments and performing daily activities without assistance. Overall, the system achieved an average efficiency of 93%, proving its reliability, robustness, and suitability for real-world deployment as an effective assistive technology.

5. Results and Analysis

The Visual Recognition for Blind People system was tested for performance and accuracy across all modules. The object detection module using YOLOv8 achieved about 93% accuracy and worked smoothly in real time. The OCR module showed 95% accuracy for printed text and 82% for handwritten text, converting it quickly into speech. The CNN-based currency recognition identified Indian notes with 92% accuracy, while the facial recognition module recognized family members with 90% accuracy. The emergency SOS feature responded instantly, sending GPS alerts within 5 seconds. Overall, the system operated with less than 500 ms latency, proving fast, reliable, and effective in enhancing mobility, safety, and independence for visually impaired users.

6. Conclusion

In conclusion, the system successfully integrates multiple AI-based technologies to provide real-time visual assistance for visually impaired individuals. By combining object detection, text and currency recognition, facial identification, and an emergency SOS feature into a single platform, the system offers a complete and intelligent solution for everyday navigation and safety. The experimental results demonstrate high accuracy, quick response, and reliable performance in real-world environments. This unified approach not only improves mobility and situational awareness but also promotes independence and confidence among users. In the future, enhancements such as cloud-based processing, multilingual voice support, and gesture or voice control can further improve the system's adaptability and accessibility for global use.

7. Future Scope

The future scope of the Visual Recognition for Blind People system includes several potential enhancements to make it more advanced, efficient, and user-friendly. Future versions can integrate cloud-based processing to improve speed and handle larger datasets for more accurate recognition**.** Multilingual voice support can be added to help users from different regions understand audio feedback in their preferred language. Incorporating gesture and voice command controls will allow users to interact more naturally with the system. The inclusion of infrared or thermal sensors can improve performance in low-light or dark environments. Additionally, the system can be developed as a lightweight mobile or wearable device**,** such as smart glasses, to increase portability and convenience. Integration with IoT and GPS-based navigation can further assist in outdoor travel, ensuring safety and real-time environmental updates. These advancements will make the system more adaptive, intelligent, and suitable for global deployment, providing even greater independence for visually impaired individuals.

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