AI Powered Wearable Assistant For Visually Impaired People

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Abstract- *Blind and visually impaired individuals face continuous challenges in their everyday lives, especially when identifying people, detecting obstacles, and recognizing currency, which significantly affects their independence and confidence. Traditional assistive tools such as white canes and guide dogs provide only limited physical guidance and lack the ability to convey real-time, detailed environmental information. Existing digital solutions often focus on a single function, require multiple devices, or depend heavily on internet connectivity, which reduces their practicality and reliability in dynamic surroundings.To address these limitations, the proposed system introduces an integrated, AI-powered assistive technology that combines face recognition, obstacle detection, and currency identification into a single, compact, and user-friendly device. The system captures real-time visual input through a wearable or external camera and processes it using advanced deep learning algorithms to ensure high accuracy and rapid response. YOLO is utilized for obstacle detection, allowing the system to identify and track nearby objects, while the Grassmann algorithm supports robust face recognition for identifying familiar individuals. Additionally, a CNN-based model handles currency classification to help users conduct financial transactions independently. All detected information is converted into clear, context-aware audio feedback, guiding users safely and effectively through their environment. This unified approach minimizes the need for external assistance, enhances personal mobility, and significantly improves the overall quality of life for visually impaired individuals. By offering affordability, adaptability, and precision, the proposed system stands as an innovative step toward intelligent assistive technology.*

Keywords: Artificial Intelligence, Wearable Technology, Computer Vision, CNN, OCR, Assistive Technology, Visually Impaired

I. INTRODUCTION

Blind and visually impaired individuals encounter significant challenges in performing essential daily activities, from navigating unfamiliar surroundings to recognizing familiar faces and handling currency safely. These difficulties often force them to rely heavily on assistance from others, limiting their independence and affecting their overall quality of life. Traditional assistive tools such as white canes and guide dogs provide only basic navigation support and cannot offer detailed information about the environment, such as identifying moving obstacles, distinguishing between people, or confirming currency denominations.

With the rapid advancement of artificial intelligence and computer vision technologies, there is an urgent need to design more intelligent, integrated, and interactive assistive systems that canaddress multiple challenges simultaneously. Existing digital aids and mobile applications are often limited by poor accuracy, dependency on internet connectivity, and a lack of real-time adaptability in crowded or dynamic environments. To overcome these limitations, the proposed system introduces a comprehensive AI-powered solution that integrates face recognition,obstacle detection, and currency identification into a single device.

By using a wearable or portable camera, the system captures real-time visual input and processes it instantly using advanced algorithms such as YOLOfor object detection, Grassmann based approaches for facial recognition, and CNN modelsfor currency classification. The processed information is then delivered to the user through intuitive audio feedback, helping them make informed decisions quickly and independently. This integration of multiple intelligent modules ensures uninterrupted assistance, supports seamless multitasking, and significantly enhances mobility and safety**.**

II. OBJECTIVES

The primary objective of this project is to develop an intelligent assistive system that enhances the independence of visually impaired individuals. The system aims to provide real time support by capturing and analyzing the surrounding environment using advanced artificial intelligence techniques. By converting visual data into meaningful audio feedback, the system enables users to understand their surroundings and make safe decisions without relying on external help.

Another key objective is to integrate multiple functionalities such as obstacle detection, face recognition,

and currency identification into a single compact device. Instead of using separate tools for each task, the system is designed to deliver a unified solution that simplifies usage and improves efficiency. This integration reduces complexity, saves time and ensure seamless assistance in daily activity.

This project aims to achieve high accuracy and real time performance under different environmental conditions. The objective is to design a user friendly affordable, and portable solution that can be easily adopted in real world scenarios. The system should require minimal technical knowledge to operate and must be comfortable for long term use. The project aims to improve the overall quality of life and promote social inclusion for visually impaired individuals.

III. PROBLEM STATEMENT

Visually impaired individuals face significant challenges in performing everyday activities independently. Navigating unfamiliar environments safely remains a major difficulty due to limited awareness. Traditional aids like white canes provide only basic obstacle detection. They cannot identify objects, people or provide detailed information. Recognizing faces and handling currency are still challenging tasks. Existing assistive technologies focus on single functionalities only. Users must rely on multiple device which is inconvenient. Many systems depend on internet connectivity and lack real time efficiency. Accuracy issues occur in dynamic and low light environment. An integrated AI powered system is needed to provide real time assistance and improve independence. Many existing systems fail to provide continuous assistance throughout the day.

Users often experience delays in response, which can lead to unsafe situations. Existing solutions do not effectively prioritize critical alerts. Maintenance and technical complexity discourage widespread adoption. Real time processing requires high computational power which is often lacking. There is a need for efficient data handling sensitive data like facial recognition. Current technologies lack scalability for future enhancements. Most devices are not designed with user comfort for long term usage. Battery life limitations reduce the practicality of wearable assistive devices.

Visually impaired individuals face significant challenges in performing everyday tasks due to the lack of real time awareness of their surroundings. Existing assistive technologies are often limited in functionality, expensive, or unable to provide accurate and timely feedback in dynamic environments. Difficulties such as obstacle detection, identifying people, recognizing objects or currency and navigating safely in both indoor and outdoor settings reduce their independence and confidence. Therefore there is a need for an intelligent, cost effective, and real time assistive solution that can enhance safety, improve accessibility and support independent living for visually impaired individuals.

IV. METHODOLOGY

A. Data Collection

Camera captures real time images or videos of the surroundings. Continuous input is sent to the processing System.

B. Image Processing

Improves image quality by reducing noise and adjusting brightness. Prepares the image for accurate detection.

C. Object Detection

Identifies objects like people, vehicles, and obstacles. Helps users avoid collisions and navigate safely.

D. Face Recognition

Detects and recognizes known persons. Compares captured faces with stored database.

E. Currency Recognition

Identifies currency notes for user assistance.

F. Audio Feedback

Converts detected results into speech. Provides real time voice guidance to the user.

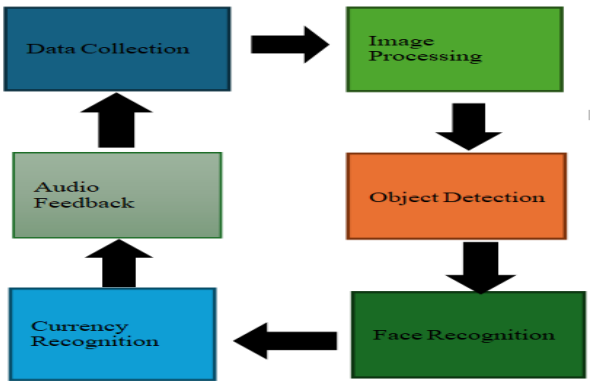

Fig 1: Methodology

V. MATHEMATICAL MODEL

The AI powered wearable assistant can be modeled as a system that takes visual input and produces meaningful audio output. Input image be represented as I(t), t denotes time. The system processes this input using a function f(I) that applies image processing and deep learning algorithms. The output of the system is represented as O(t), which includes detected objects, recognized faces. The overall system can be expressed as:

O(t) = f(I(t)), where f represents the intelligent processing module.

For object detection the system identifies object with Probability scores. Let Oi = { o1, o2,…., on} be the set of detected objects. Pi be the probability of correct detection. The system selects objects where probability exceeds a threshold T such that:

$$Oi \in O \; if \; Pi \geq T$$

The final output is converted into speech using a text to speech function g(x) where x is the processed information. D represent processing delay and A represent accuracy. The objective of the system is:

Maximize A and Minimize D.

TABLE I.AI POWERED WEARABLE ASSISTANT SYSTEM SUMMARY

Module	Input	Processing	Output	User Benefit	Accuracy
Object Detection	Real time image from camera	AI model detects objects	Audio alerts	Avoid obstacles	High Accuracy
Face Recognition	Face Image	Feature matching with database	Identifies person name	Recognizes Known People	Moderate to high
Currency Detection	Currency Image	Pattern recognition	Announces currency value	Identifies Money easily	High Accuracy
Navigation Assistance	Surrounding environment	Path analysis	Voice Directions	Safe Movement	Depends on environment
Audio Feedback	Processed data	Text to Speech conversion	Voice output	Easy Understanding	Real time response

VI. RESULTS AND DISCUSSION

The AI powered wearable assistant model demonstrates effective object detection performance. The confusion matrix indicates that most object classes are correctly classified with minimal misclassification. The normalized confusion matrix further confirms high prediction accuracy across different categories showing the robustness of the model.

A. Sample Object Detection

The sample detection results demonstrates the models ability to identify objects in real world scenarios.This confirms that the system can effectively recognize objects in different environments.

Fig 2. Sample Detection Result Of Object Detection Model

B. Currency Detection Results

The detection of currency notes using the trained model. The system successfully identifies and classifies different denominations which highlights its capability to assist visually impaired users in recognizing money.

Fig. 3. Sample Currency Detection Result Using Object Detection Model

C. Multi Object Detection

It show that the model can detect multiple objects simultaneously. It accurately identifies different vehicle in a single frame providing that the system can handle complex real world scenes.

Fig. 4 Multi Object Detection Result For Vehicle Class

D. Real Time Person Detection

The system successfully detects a human face and places a bounding box around it with high confidence. This confirms that the model is suitable for real time application and can assist users in identifying people nearby.

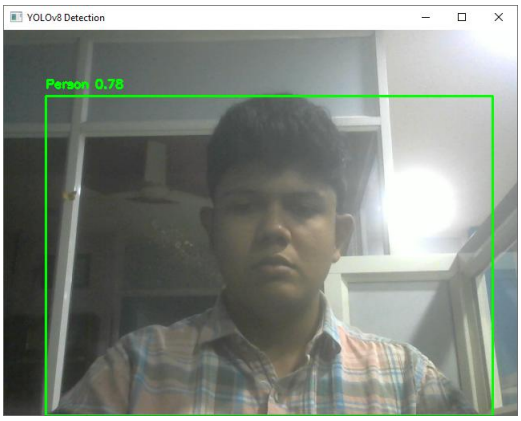

Fig. 5. Real Time Person Detection Using YOLOv8 Model

VII. CONCLUSION

The proposed Face, Obstacle, and Currency Recognition Smart Glasses system provides a comprehensive solution to the challenges faced by blind and visually impaired individuals in their daily lives. By integrating advanced AI algorithms Grassmann model for face recognition, YOLO for obstacle detection, and CNNs for currency recognition into a single wearable device, the system enables real-time, context-sensitive guidance. This multi-functional approach not only reduces dependency on external assistance but also ensures safety, accuracy, and reliability in dynamic environments, allowing users to navigate, recognize people, and manage financial transactions independently.

One of the key strengths of this system lies in its adaptability and user-centric design. The wearable device is lightweight, ergonomic, and portable, ensuring comfortable use over extended periods. Its AI models continuously learn and improve from real-world scenarios, enhancing performance in varied lighting, crowded, or complex settings. By providing immediate audio feedback for navigation, social recognition, and currency handling, the system addresses limitations of existing single-function tools and promotes autonomy, confidence, and social engagement for visually impaired users. Beyond technical capabilities, the project has significant social and practical implications.

It empowers visually impaired individuals to perform essential daily activities with minimal reliance on others, fostering independence and improving quality of life. The integration of multiple assistive functionalities into a single device offers a cost-effective and accessible solution, bridging the gap between traditional aids and modern AI technology.

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