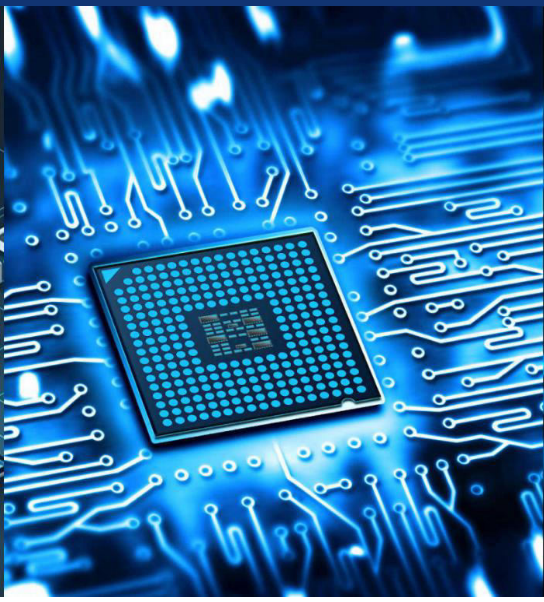
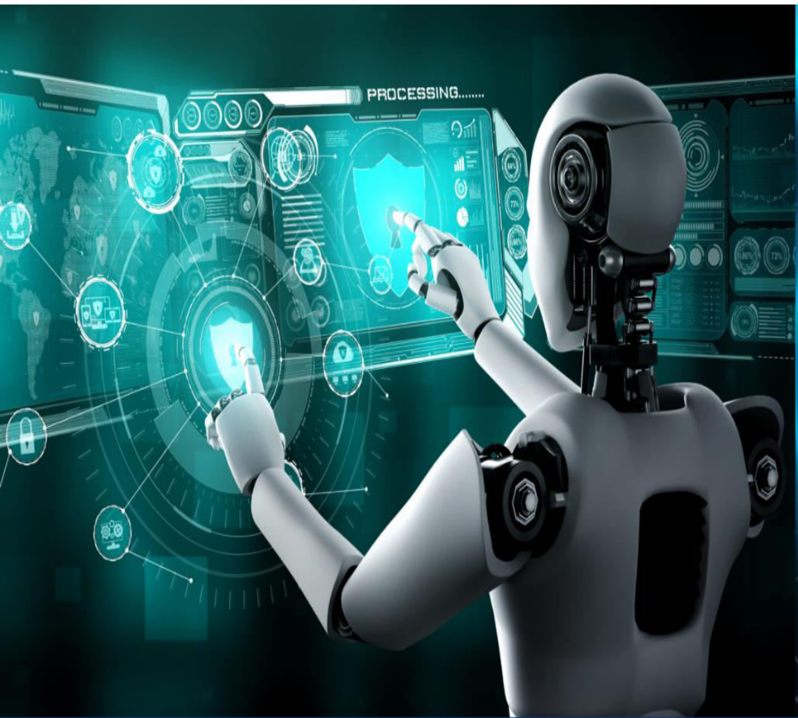
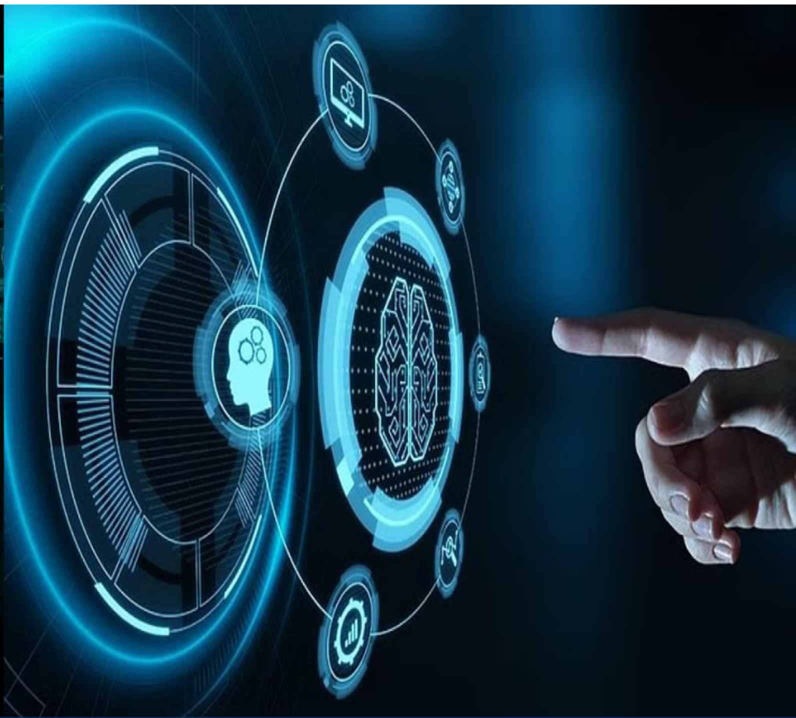
ISSN(O): 2320-9801
ISSN(P): 2320-9798


International Journal of Innovative Research in Computer and Communication Engineering

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)





Impact Factor: 8.771

Volume 14, Issue 1, January 2026

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

AI Powered Wearable Assistance Device for Visually Impaired

Prof. D.C.Pardeshi[1], Mrunal Bhosale[2], Tanishka Gaikwad[3], Aarya Taware[4], Ved Tupe[5]

Guide, Department of Artificial Intelligence & Machine Learning, AISSMS's Polytechnic, Pune, Maharashtra, India[1]

Department of Artificial Intelligence & Machine Learning, AISSMS's Polytechnic, Pune, Maharashtra, India[2-5]

ABSTRACT: Visually impaired individuals face challenges navigating indoor spaces, as obstacles like people, furniture, doors, and electronic devices are not easily perceived. Traditional aids, such as white canes, provide limited feedback and do not describe objects ahead. This project presents an assistive navigation system that performs real-time object detection and provides voice guidance to alert users of obstacles in their path. A custom decision engine evaluates the spatial position of detected objects within a defined danger zone, ensuring that only relevant hazards trigger audio alerts like "Person ahead" or "Obstacle ahead." Timing control prevents repetitive messages while maintaining real-time responsiveness. Implemented in Python with modular detection, decision-making, and voice components, the system was tested in classrooms and corridors under varying distances and lighting conditions. Results indicate that the system can reliably detect obstacles and provide timely audio cues, supporting safer short-range indoor navigation for visually impaired users.

KEYWORDS: Visually Impaired Assistance, Object Detection, Indoor Navigation, Voice Guidance System, Computer Vision, Assistive Technology, Decision Engine, Real-Time Detection.

I. INTRODUCTION

Indoor navigation for visually impaired individuals remains a significant challenge, as obstacles such as furniture, doors, electronic devices, and even other people are difficult to detect without assistance. Traditional mobility aids, like white canes or guide dogs, provide tactile or physical feedback but are limited in their ability to describe the surrounding environment. This lack of spatial awareness can result in accidental collisions, restricted mobility, and reduced independence, particularly in unfamiliar indoor settings such as classrooms, offices, or corridors. With the advancement of computer vision and deep learning, there is an opportunity to enhance navigation assistance by providing real-time feedback about obstacles in the user's path, increasing safety and confidence during movement.

Modern assistive technologies have focused on integrating sensors, cameras, and audio feedback to improve obstacle detection. Many existing solutions rely on ultrasonic sensors or infrared devices, which can detect objects but do not classify them or provide meaningful verbal descriptions. Object detection with camera input enables a richer understanding of the environment, allowing the system to distinguish between people, furniture, doors, and electronic devices, and to alert the user accordingly. However, continuous audio feedback for every detected object can overwhelm the user, necessitating an intelligent filtering mechanism to focus on relevant obstacles only.

This project proposes an indoor navigation system for visually impaired users that combines real-time object detection with a decision engine and voice guidance. The system uses a camera to capture live video, processes each frame to detect obstacles, and determines their position relative to the user's forward movement path using a defined danger zone. Voice alerts are provided only for objects within this critical region, ensuring timely and relevant warnings while avoiding unnecessary distractions. Implemented in Python, the system is modular, scalable, and tested under realistic indoor conditions, including varying lighting and distances. By bridging the gap between detection and actionable guidance, this system aims to improve mobility, safety, and independence for visually impaired individuals.

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

II. PROBLEM STATEMENT

Visually impaired individuals struggle to detect obstacles, people, and pathways in indoor environments. Although object detection models can identify many objects, raw outputs are unsuitable for blind users. Continuous announcements such as “chair, bottle, table” increase cognitive load and reduce usability. The problem addressed in this research is designing an assistive system that not only detects objects but also interprets their relevance and delivers practical navigation feedback using voice guidance.

OBJECTIVES OF THE PROJECT:

The main objectives of this project are as follows:

1. To design an intelligent assistive system that helps visually impaired users navigate safely in indoor environments using real-time object detection.
2. To identify common obstacles such as people, furniture, doors, and electronic devices from live camera input.
3. To analyze the position of detected objects and determine whether they lie in the user’s forward movement path.
4. To generate clear voice guidance messages to warn users about obstacles and guide safe movement.
5. To develop a portable, low-cost, and user-friendly solution that can operate in real time without heavy manual intervention.

III. LITERATURE SURVEY

Assistive technologies for visually impaired individuals have been an important research area in computer vision and human–computer interaction. Initially, most navigation aids were based on traditional tools such as white canes and ultrasonic sensors. These systems were able to detect the presence of obstacles using distance measurements, but they could not identify the type of object in front of the user. As a result, users received only limited environmental understanding and guidance.

Later, camera-based systems were introduced to improve navigation assistance. Researchers started using image processing techniques to capture frames and detect obstacles visually. Early vision-based approaches relied on handcrafted features and classical algorithms for detecting objects. Although these methods improved obstacle awareness compared to sensor-only systems, they suffered from low accuracy, sensitivity to lighting conditions, and difficulty in handling complex indoor scenes.

With the growth of machine learning, data-driven approaches were applied to assistive navigation. Machine learning models were trained to recognize objects from images and video streams. These systems achieved better performance than traditional image processing methods. However, many early machine learning approaches depended on manually selected features and required significant computational resources, which limited their real-time performance on portable devices.

In recent years, deep learning techniques have significantly advanced object detection and recognition. Convolutional Neural Networks and real-time detection models have enabled faster and more accurate identification of people, furniture, and other everyday objects. These models provide smoother and more reliable detection compared to earlier methods. Despite these improvements, challenges such as hardware complexity, power consumption, and the need for simple user interaction still remain.

From the analysis of existing works, it is clear that AI-based vision systems offer better assistance than traditional sensor-based methods. However, there is still a need for a lightweight, practical, and easy-to-use solution that can perform real-time object detection and voice guidance with minimal user effort. The motivation of this work lies in developing such a system to improve indoor navigation support for visually impaired users.

IV. TECHNICAL ARCHITECTURE

The technical architecture of the proposed system describes the overall structure and working flow of the AI-based object detection and voice guidance framework. The architecture is designed to process visual input, analyze detected

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

objects, and generate corresponding audio feedback in a modular and organized manner. Each module is responsible for a specific task, allowing the system to be easy to understand, modify, and extend.

The process begins with the Input Layer, where a camera captures live video frames of the surrounding environment. These frames represent the visual input for the system and are continuously forwarded to the processing modules for further analysis. The Processing Layer consists of two main components: the Object Detection Module and the Decision Engine. The Object Detection Module analyzes each incoming frame to detect objects and their spatial locations. It generates bounding boxes, class labels, and confidence values that describe the detected entities in the scene.

The output from the detection module is then provided to the Decision Engine. This engine examines the positions of detected objects with respect to a defined region in the frame and determines which detections are relevant for audio feedback. This filtering helps in avoiding unnecessary announcements and focuses only on objects that require user attention.The Output Layer handles the interaction with the user. The Voice Guidance Module converts selected detection results into meaningful textual messages such as “Person ahead” or “Obstacle nearby.” These messages are converted into speech using a text-to-speech component and played through an audio output device.

The complete system operates in a continuous processing loop, enabling ongoing analysis and feedback as new frames are captured. The modular architecture allows individual components to be updated independently without affecting the overall workflow.

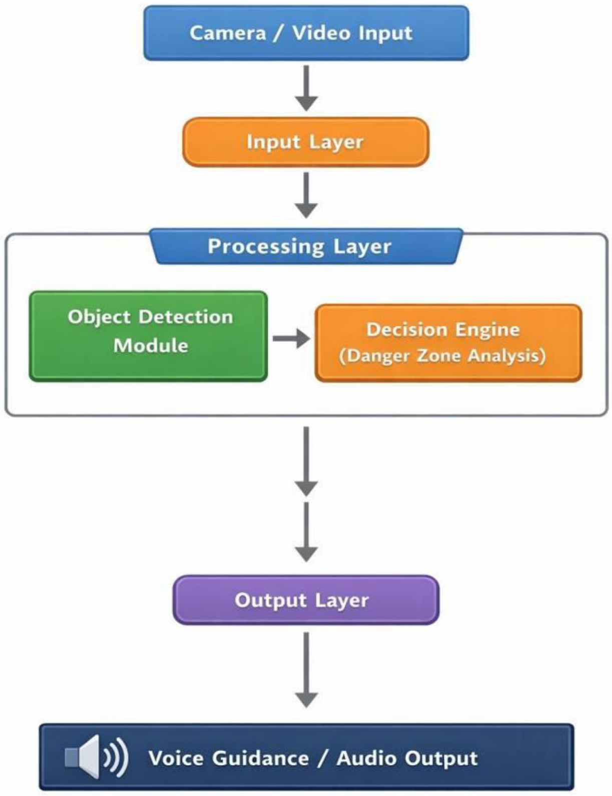


Fig. 1: Layered architecture illustrating the Input, Processing, and Output modules of the proposed system.

V. KEY FEATURES

1. **Real-Time Environment Perception**
   The device continuously captures the surrounding environment using an onboard camera or sensor module. The captured data is processed instantly to understand nearby objects and obstacles in real time.

2. **AI-Based Object Detection**
   Artificial Intelligence models are used to detect and identify common indoor objects such as people, furniture, doors, and other obstacles. This allows the system to understand the scene rather than only measuring distances.
3. **Intelligent Decision Engine**
   A decision module analyzes detected objects and determines which ones are relevant to the user's movement path. Only important obstacles within a defined safety region are selected for feedback.
4. **Directional Awareness**
   The system determines whether an obstacle is on the left, right, or directly ahead of the user. This directional information helps provide clearer guidance instead of generic warnings.
5. **Audio-Based Feedback**
   Detected obstacles are converted into spoken messages using text-to-speech technology. The user receives simple and timely audio alerts such as the presence and position of nearby objects.
6. **Wearable Design Support**
   The system is designed to be lightweight and wearable, allowing users to carry it comfortably without disturbing normal movement during indoor navigation.
7. **Reduced Cognitive Load**
   Instead of announcing every object, the system filters unnecessary information and delivers only useful alerts, preventing audio overload for the user.
8. **User-Friendly Operation**
   The device operates automatically with minimal user interaction, making it suitable even for users with little technical experience.

VI. FUTURE SCOPE

Future enhancements can improve both accuracy and usability of the assistive navigation system. Integrating multiple cameras or depth sensors would provide better spatial awareness and obstacle detection, including objects outside the current field of view.

Machine learning models can be further trained on larger and more diverse datasets to reduce misclassifications and improve recognition of smaller or uncommon objects. Adaptive voice guidance, with customizable alert timing and verbosity, could enhance user experience.

Additional features, such as integration with wearable devices, mobile applications, or IoT-enabled smart environments, can expand the system's applicability, enabling visually impaired users to navigate more complex and dynamic indoor spaces safely and independently.

VII. CONCLUSION

This project presents a human-centric indoor navigation assistive system for visually impaired users, combining real-time object detection with a decision engine and voice guidance. By focusing on relevant obstacles within a predefined danger zone, the system delivers concise and timely audio alerts such as "Person ahead" or "Obstacle ahead," helping users navigate safely without overwhelming them with unnecessary information.

Modular design ensures flexibility, allowing independent updates to detection, decision-making, and voice modules. Experiments in classrooms, corridors, and other indoor environments demonstrate that the system provides reliable and practical assistance. While limitations exist, the framework offers a strong foundation for further development and real-world application in assistive technologies.

VIII. ACKNOWLEDGEMENT

We take this opportunity to express our sincere appreciation for the cooperation and support given by Prof. S. G. Giram, Principal of AISSMS Polytechnic, Pune, and extend special thanks for his constant inspiration and encouragement, which made this project a valuable learning experience for us. We are thankful to the Head of the Department of Artificial Intelligence and Machine Learning, Prof. B. S. Patil, for his timely support and valuable

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

academic guidance throughout the project work. We are very grateful to our mentor Mr. D. C. Pardeshi, whose continuous guidance, technical suggestions, and motivation helped us at every stage of the project and enabled us to complete the work successfully.We would also like to thank all the teachers and professors of our department for sharing their knowledge and assisting us whenever required. Their support played an important role in shaping this project. We also thank our fellow classmates and friends for their cooperation and useful suggestions. Finally, we express our gratitude to the library staff and laboratory staff for providing necessary facilities and cordial support, which greatly helped us in preparing this project report

REFERENCES

[1] B. M., Logesh M., N. Kumar V., S. Prasath, and N. Saranraj, "The Virtual Assistant: A Wearable Device for Independent Living of the Visually Impaired," *International Journal of Research in Technology and Innovation*, 2023. [Online]. Available: https://ijrti.org/papers/IJRTI2303055.pdf

[2] D. D. Brilli, E. Georgaras, S. Tsilivaki, N. Melanitis, and K. Nikita, "AIris: An AI-powered Wearable Assistive Device for the Visually Impaired," *arXiv preprint arXiv:2405.07606v2*, 9 Aug 2024. [Online]. Available: https://arxiv.org/html/2405.07606v1

[3] M. S. A. Baiga, S. A. Gillani, S. M. Shah, M. Aljawarneh, A. A. Khand, and M. H. Siddiqui, "AI-based Wearable Vision Assistance System for the Visually Impaired: Integrating Real-Time Object Recognition and Contextual Understanding Using Large Vision-Language Models," *arXiv preprint arXiv:2412.20059*, 2024. [Online]. Available: https://arxiv.org/pdf/2412.20059.

[4] K. P. Venkat Vivek, J. Vandana, K. Sripooja, and A. Choubey, "A Smart Wearable Guiding Device for The Visually Impaired People," *International Journal for Research in Applied Science & Engineering Technology (IJRASET)*, 2022. DOI: https://doi.org/10.22214/ijraset.2022.44153