Smart Object Awareness for the Visually Impaired via Raspberry Pi and OpenCV

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***Abstract*— This paper presents the design and implementation of a smart portable assistive device for individuals with visual impairments individuals, offering real-time object awareness using the Raspberry Pi 4B and OpenCV. By integrating a Pi Camera, ultrasonic sensors, and text-to-speech conversion, the system provides auditory feedback about the environment through a spectacle-mounted device. The low cost and portability of this design make it a feasible solution for assistive mobility in day-to-day life.**

Keywords: Optically disabled, Raspberry Pi 4B, OpenCV, Object Detection, Assistive Technology, Spectacle-mounted device

Introduction

Persons with low vision have a hard time getting around by themselves because they are unable to reach to real-time spatial and contextual information. White canes and guide dogs are helpful, but they only partially help people see obstacles. They can't tell what specific objects are or understand scenes. This restriction makes it harder for people with vision problems to be safe and independent, so new assistive technologies need to be made.

Recent advances in embedded systems, computer vision, and machine learning have made it possible to create smart, wearable solutions that help people become more aware of their surroundings. Raspberry Pi-based platforms and Open CV Offer great prospects, though they merely cheap, portable, and can process data in real time. These technologies make it possible to make assistive tools that help people see better by finding things, measuring distances, and giving them audio feedback.

This study proposes a smart wearable system designed to provide real-time object and obstacle awareness to visually impaired individuals. The system leverages the Raspberry Pi 4B as its core processing unit, equipped with a Pi Camera for capturing visual input, ultrasonic sensors for distance measurement, and a text-to-speech (TTS) module for delivering auditory feedback. All components are compactly mounted on a spectacle frame to ensure portability and user comfort, promoting hands-free operation.

Literature Review

Various investigations have helped drive the progress of assistive technologies for the optically

impaired:

1. **A Machine Learning Approached Model to Identify the Object for Visually Impaired Person**

Researchers at Manav Rachna International Institute are working on a study to create a real-time object A recognition tool created to improve persons who are vision problem or have low eye sight. The suggested system is a portable device that can utilize machine learning and the image recognition to find things in the surroundings and let the user know. The study moves the field forward by showing how important it is to have on-the-go object detection that is made just for blind persons.

2. **Assistive Technology using TensorFlow Object Detection in Raspberry Pi**

The goal of this project, developed at Don Bosco Institute of Technology, is to use TensorFlow models to detect objects on Raspberry Pi devices in real time. Coral USB hardware acceleration improves it even more. The goal is to make inference in assistive technology systems faster and more efficient. The implementation demonstrates how Item detection for visually challenged individuals systems can significantly improve their responsiveness with TensorFlow and specialized hardware.

3. **IoT Based Smart Assistance for Visually Impaired Using Raspberry Pi**

A pair of smart glasses that can instantly recognize faces and objects is suggested by this study, which was showcased by BVRIT Hyderabad. Using a Raspberry Pi 4B and a span of Internet of Things sensors, the system combines distance measurement and facial recognition to increase the mobility of visually impaired users. Its contribution is its ability to combine computer vision and the Internet of Things to offer dynamic and interactive assistance.

4. **Portable Camera-based Identification System for Visually Impaired**

This study from Sathyabama Institute of Science and Technology introduces a compact, camera- based vision system intended for object identification. It relies on computer vision techniques and delivers audio output to inform the user about identified objects. The research emphasizes portability and auditory feedback, making it suitable for real-world daily use.

5. **Intelligent Glasses for Visually Impaired People**

Researchers at Sudan University of Science and Technology present smart glasses equipped with high-resolution cameras and edge AI capabilities. These glasses are designed to detect obstacles and provide alerts to users, enhancing situational awareness. The proposed prototype focuses on AI- driven assistance in a wearable format.

6. **Design and Implementation of Real-time Object Detection for Blind using CNN**

This study, which originates from an unspecified source, combines CNN-based real-time image processing with bone conduction audio technology in a smart glasses format. The goal is to improve ambient awareness for visually impaired users by offering non-intrusive spatial audio cues. It emphasizes the seamless integration of sensory technologies for practical daily applications.

7. **Smart Glasses Integrating Bone Conduction and Real-Time Image Processing**

This study, which originates from an unspecified source, combines CNN-based real-time image processing

with bone conduction audio technology in a smart glasses format. The goal is to improve ambient awareness for visually impaired users by offering non-intrusive spatial audio cues. It emphasizes the seamless integration of sensory technologies for practical, daily uses.

8. **Image Processing System for Providing Sound Information**

This study uses image processing and sound mapping to empower those with limited vision perceive their environment by converting visual data into auditory information. Users can use sound to comprehend spatial layouts and object positions thanks to the system's conversion of object locations and environmental visuals into audio cues.

9. **Voice Assisted Smart Blind Stick**

This project proposes a intelligent stick embedded with ultrasonic sensors and Arduino technology to detect obstacles and deliver voice alerts. The system informs users of both the distance to and the type of roadblock they face. It offers a low-cost and accessible solution for mobility assistance.

10. **An Artificial Eye for Blind People**

This research presents a system that uses a Raspberry Pi and text-to-speech technology to detect objects and provide real-time audio feedback. The device simulates the functionality of an artificial eye by alerting users to obstacles, enhancing safety and navigation.

11. **NanoEye: Real-time Object Detection for Blind and Partially Blind**

NanoEye offers a handheld detection system powered by the YOLO algorithm and Raspberry Pi hardware. The focus is on achieving a balance between detection speed and accuracy to help users identify obstacles in dynamic environments. The solution aims to be compact, responsive, and effective.

12. **Real-Time Object Detection for Assisting Visually Impaired People**

Using the YOLOv3 algorithm and voice output modules, this project seeks to recognize multiple object classes in real time and communicate results audibly to users. The model is designed for efficient detection and real-time assistance in various settings.

13. **Integrated Online Localization and Navigation with Voice Assist**

This system integrates object detection with GPS and voice guidance to assist visually impaired users in both indoor and outdoor navigation. The solution uses localization sensors and speech output to offer comprehensive travel support, helping users identify surroundings and reach destinations safely

14. **Intelligent Glasses for Visually Impaired People**

This system combines face recognition, object detection, and obstacle navigation to assist visually impaired users in daily tasks. It leverages Raspberry Pi 4, a Pi camera, ultrasonic sensors, and voice feedback to deliver real-time guidance. modes can be switched by the user at any time via voice commands, enabling personalized interactions for identifying faces, detecting surrounding objects, and avoiding obstacles. The solution offers a low-cost, lightweight, and portable alternative to commercial products, enhancing user independence and situational awareness.

15. **Smart audio Description Glasses with object Recognition and OCR**

The field is rich in isolated capabilities—OCR, object detection, audio feedback—but fragmented in unified UX delivery. *Sight Sage* aims to synthesize and transcend current assistive paradigms by offering contextual intelligence, wearable cognition, and seamless sensory augmentation in one product.

Comparative Analysis

This section provides a side-by-side evaluation of relevant IEEE research papers focusing on assistive technologies for the sight-impaired. The objective is to identify existing methodologies, technologies, and system architectures that align with or contrast the proposed system — **Smart Object Awareness via Raspberry Pi and OpenCV**.

S.No	Paper Title	Objective	Technology / Method Used	Hardware Platform	Output Type	Unique Contribution / Innovation	Limitations
1	A Machine Learning Approached Model to Identify the Object for Visually Impaired Person	Develop real-time object identification for blind users	Machine Learning, Image Recognition	Not specified	Audio	Portable model for object alerts using ML	Lacks hardware specifics; performance and power constraints unclear.
2	Assistive Technology using TensorFlow Object Detection in Raspberry Pi	Improve object detection with Coral USB	TensorFlow, MobileNet	Raspberry Pi + Coral USB	Audio/Visual	High-speed detection with hardware acceleration	Costly hardware (Coral USB); may consume more power.
3	IoT Based Smart Assistance for Visually Impaired Using Raspberry Pi	Smart glasses with face/object detection	IoT, Face Recognition	Raspberry Pi 4B	Audio	Combines facial and object recognition with distance sensing	Heavier wearable load; dependent on consistent lighting for recognition.
4	Portable Camera-based Identification System for Visually Impaired	Compact camera-based system with voice output	OpenCV, TTS	Raspberry Pi / Arduino	Audio	Lightweight device with auditory object recognition	Lower accuracy in cluttered scenes; not suited for fast object tracking.
5	Intelligent Glasses for Visually Impaired People	Obstacle detection with AI smart glasses	Edge AI, Image Processing	High-res Camera, AI Edge HW	Audio	High-res real-time wearable AI device	Expensive and potentially bulky; heat and power concerns.
6	Design and Implementation of Real-time Object Detection for Blind using CNN	Blind assist using CNN	CNN	Not specified	Audio	No internet needed for real-time classification	Limited detail on CNN optimization and deployment hardware.
7	Smart Glasses	Use bone	CNN,	Smart	Bone	Combines	Bone

	Integrating Bone Conduction and Real-Time Image Processing	conduction for blind navigation	Bone Conduction Tech	Glasses	Conduction Audio	visual cues with bone-conducted sound	conduction may be uncomfortable; complex sound mapping.
8	Image Processing System for Providing Sound Information	Visual-to-audio for spatial awareness	Image Processing, Sound Mapping	Not specified	Spatial Audio	Converts visuals to directional sound cues	Lacks object naming; only positional data is given.
9	Voice Assisted Smart Blind Stick	Smart stick with voice alerts	Arduino, Ultrasonic Sensors	Arduino Board	Audio	Obstacle alert via speech; simple and affordable	Short-range detection only; no image or scene recognition.
10	An Artificial Eye for Blind People	Real-time object detection with speech	Obstacle Detection, TTS	Raspberry Pi	Audio	Simulates "eye" using vision-to-speech	May lack contextual understanding or object classification.
11	NanoEye: Real-time Object Detection for Blind and Partially Blind	Handheld fast detection system	YOLO, OpenCV	Raspberry Pi	Audio	Compact and fast YOLO-based object detector	Handheld use can be cumbersome; battery drain potential.
12	Real-Time Object Detection for Assisting Visually Impaired People	Announce detected objects to users	YOLOv3	Not specified	Audio	Voice-based feedback on object classes	Hardware specs unclear; possibly high processing requirement
13	Integrated Online Localization and Navigation with Voice Assist	Assist with GPS and voice navigation	GPS, Sensor Fusion	GPS + Sensor Array	Voice Audio	Combines localization and object detection	GPS unreliable indoors; sensor calibration may be complex.
14	Intelligent Glasses for Visually Impaired	Face & object detection, obstacle	TensorFlow Lite, Ultrasonic, Voice	Raspberry Pi 4 + Sensors	Audio + Vibration	Mode-switching for face, object, and	Complex interaction; may need training to

	People	avoidance				navigation assist	operate efficiently.
15	Smart Audio Description Glasses with Object Recognition and OCR	Audio narration of scene with OCR	YOLOv8, TrOCR, Tacotron 2	Qualcomm XR2 + Bone Conduction	Spoken Audio	Combines vision, OCR, and contextual narration	Expensive platform; real-time narration accuracy depends on model latency.

Conclusion

People who are visually impaired have a difficult time interacting with their environment and navigating it. The Raspberry Pi and OpenCV are used in this research to give smart object awareness in a real-time and affordable manner.

The suggested method improves situational awareness by combining computer vision and audio input, encouraging safety and independence.

References

[1] A. Tri Budi Santoso, B. R W Sudibyo, "Design and Implementation of Real-Time Object Detection for Blind Using CNN," IEEE Xplore, 2022. DOI: [10.1109/IES55876.2022.9888513]

[2] C. MD Rahman, D. Md Jahidul H, "Smart Glasses Integrating Bone Conduction and Real-Time Image Processing for Impaired
Assistance," IEEE Xplore, 2024. DOI: [10.23919/ICCAS63016.2024.10773093]

[3] E. Tilfi J S, F. Sifa N, "Image Processing System for Providing Sound Information as an Assistive Tool for the Visually Impaired," IEEE Xplore,2025. DOI: [10.1109/ICADEIS65852.2025.10933322]

[4] G. K.P.Kambale, H. Shambhavi S, "Voice Assistive Smart Blind Stick," IEEE Xplore, 2024. DOI: [10.1109/ICESC60852.2024.10689820]

[5] I. Kalaivani K, J. Mahalakshmi R, "An Artificial Eye for Blind People," IEEE Xplore,2022. DOI: [10.1109/DELCON54057.2022.9752999]

[6] K. P Devaki,L.S.shivavarsha "Real-Time Object Detection Using Deep Learning and OpenCV," IEEE Xplore, 2019. DOI: [10.35940/ijitee.L1103.10812S19]

[7] M. Isma Hamid, N. Sara masood, "Real-Time Object Detection and Recognition Device for Blind and Partially Blind People," IEEE Xplore,2023. DOI: [10.1109/CATS58046.2023.10424088]

[8] O. Kasish S, P. Prof.Poonam S, "Real-Time Object Detection for Assisting Visually Impaired People," IEEE Xplore, 2022. DOI: [10.1109/OTCON56053.2023.10114050]

[9] Q. Sudhamshu G, R. Jithesh S P, "Integrated Online Localization and Navigation Device with Voice Assistive and Vision Sensing for the Visually Impaired," IEEE Xplore,2024. DOI: [10.1109/GCAT62922.2024.10924023]

[10] S. Sunita J, T. Mitali, "A Machine Learning Approach to Identify Objects for Visually Impaired Persons," IEEE Xplore, 2023. DOI: [10.1109/ICPCSN58827.2023.00105]

[11] U. Amit G, V. Dawan Md, "Assistive Technology for Visually Impaired Using TensorFlow Object Detection in Raspberry Pi and Coral USB Accelerator," IEEE Xplore,2020. DOI: [10.1109/TENSYMP50017.2020.9230630]

[12] W. Sanjay D, X. Dindigal Arjun, "IoT-Based Smart Assistive System for Visually Impaired Using Raspberry Pi," IEEE Xplore, 2023. DOI: [10.1109/ICACRS58579.2023.10405278]

[13] Y. Ashveena A, Z. Bala D J, "Portable Camera-Based Identification System for Visually Impaired People," IEEE Xplore, 2023. DOI: [10.1109/ICOEI56765.2023.10126008]

[14] AA. Ali Mustafa AB, Ahmed Omer, "Intelligent Glasses for Visually Impaired People," IEEE Xplore, 2022. DOI: [10.1109/CICN56167.2022.10008291]

[15] BA. Nandeshwar,BB. Sheelwant, " Smart audio Description Glasses with object Recognition and

Conflict of Interest

The authors declare that they have no conflicts of interest to disclose.

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