International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 10 Issue: 10 | Oct - 2026 SJIF Rating: 8.659 ISSN: 2582-3930

SMARTVISION "A Guided Navigation Assistant for Blind People"

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ABSTRACT

Visually Blind People poses profound challenges to personal mobility and independent living, affecting over 285 million individuals worldwide. The traditional navigation system often a lack of real-time feedback and fail to provide detailed situational awareness in complex environments. To address these limitations, our paper proposes A system that is Smart Vision (a guided navigation system for blind people) it is an advanced, hands-free wearable assistive eyewear framework that designed to provide real-time guiding assistance and multi-modal environmental awareness for blind people. The proposed system integrates a multi-sensor array—combining ultrasonic sensors and camera modules—with an edge computing architecture, enabling the system to identify surrounding obstacles for real-time processing. By implementing high-efficiency computer vision, including lightweight YOLO object detections, and estimates target distances with high accuracy. The processed environmental information is continuously transformed into low-latency voice instructions and intuitive haptic feedback, delivering real-time spatial awareness that enables seamless navigation and provides the user with confidence during decision-making. Ultimately, A Smart Vision delivers a robust, cost-effective, and fully integrated navigation assistant that significantly improves safety, autonomy, and quality of life for visually impaired users.

Keywords: Assistive technology, real-time object detection, haptic auditory feedback.

I. INTRODUCTION

Vision plays an critical role in understanding the surrounding environment and navigating safely from one place to another. For blind individuals, navigating unfamiliar or crowded environments can be challenging because they cannot visually identify obstacles, pathways, or the direction in which they should move. These challenges have created a need for simple and practical wearable systems that can assist blind people in their daily navigation. Several assistive systems have been developed to help blind users detect obstacles and understand their surroundings. Camera based systems can capture the environment in front of the user, while image processing techniques can be applied to analyse the captured images and detect obstacles in the user's path. The detected obstacles can then be used to determine a suitable direction of movement. 1 Audio feedback provides an effective way of communicating this information to the user without requiring a visual display. Based on these requirements, our project "Smart Vision" is designed as a wearable navigation assistant for blind individuals. The system consists of smart glasses with a camera and an earphone for audio feedback. The camera captures images of the surrounding environment, and image processing techniques are used to detect obstacles present in the user's path. After detecting an obstacle, the system determines the

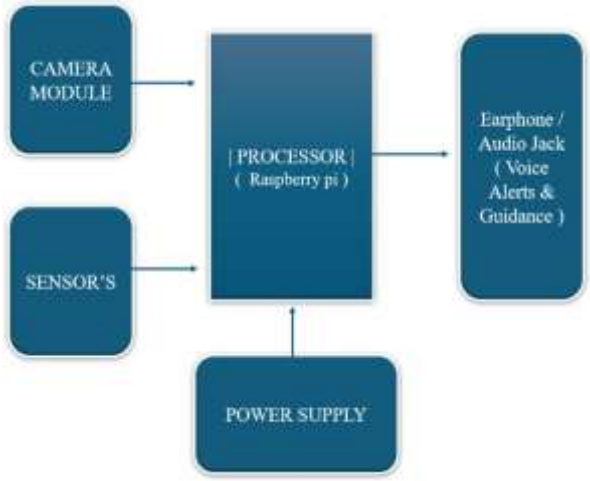
appropriate direction and provides simple audio instructions through the earphone, such as move forward, move backward, turn left, or turn right. The main objective of our project is to provide timely and simple directional guidance without requiring the user to operate a screen. By combining computer vision with ultrasonic distance metrics, the system helps the user comprehend the surrounding environment and navigate safely. The proposed system aims to provide a simple, lightweight, affordable, and user-friendly solution that can support the mobility, safety, and independence of blind individuals.

II. LITERATURE SURVEY

Smart glasses provide an effective wearable platform because they are positioned on the user's head and can sense the environment in the direction of movement. They also allow information to be communicated through audio, making them suitable for hands-free navigation assistance. Several studies have investigated smart eyewear and other wearable setups for obstacle detection and blind navigation guidance. Hassan and Tang [1] proposed a low-cost smart glasses system using a Raspberry Pi 2, a camera and an earpiece. The camera was mounted on the glasses for capturing information from the surrounding environment, while the earpiece was used to provide audio output. The study describes the advantage of a head-mounted device because it naturally follows the user's viewing direction and reduces the need for additional direction instructions. This work demonstrates the suitability of combining glasses with an earpiece for providing hands free assistance to blind users. Bai et al. [2] developed smart guiding glasses for blind users in indoor environments. Their system focused on obstacle detection and guidance using a combination of depth and ultrasonic sensors. For completely blind users, auditory cues were developed to indicate the direction in which the user could move. The system was tested in complicated indoor environments and demonstrated the use of wearable glasses for detecting obstacles and providing directional guidance through audio. This study is particularly relevant to the proposed Smart Vision project because both systems focus on obstacle detection and communicating movement directions to blind users through audio feedback. Chetan B G et al. [3] presented a wearable assistive system for blind users that combines environmental sensing with audio assistance. The study discusses the use of wearable devices for detecting nearby obstacles and providing information to the user through sensory and audio feedback. It also reviews wearable approaches such as head-mounted systems and smart glasses for assisting blind users during movement. The study supports the use of wearable sensing and audio feedback as a method of providing assistance when obstacles are present in the user's surroundings. Varshney et al. [4] evaluated the usability of smart vision glasses with blind users through a six-month study involving 26 participants. The system included sensing components and provided assistance for navigation and walking. 2 The study reported that walking assistance could be challenging in crowded environments. This work highlights the importance of reliable environmental sensing and effective guidance when smart glasses are used to support blind users during navigation. Kumari and Hammady [5] presented a smart glasses-based system that combines environmental sensing with auditory feedback. The system used a camera mounted on smart glasses and communicated detected information to the user through audio. The study also considered the response time between environmental sensing and auditory feedback. This work demonstrates the importance of timely audio feedback in a wearable navigation system, where information needs to reach the user quickly during movement. Paygude and Hambarde [6] reviewed smart vision systems based on image recognition and discussed their application in assisting blind users. The review highlights important requirements for wearable systems, including real-time processing, accuracy and response time. These factors are relevant to obstacle detection systems because the detected surroundings need to be processed quickly so that appropriate guidance can be communicated to the user through audio feedback. Asiri et al. [7] conducted a systematic review of technologies used to support blind users in areas including mobility, safety and

environmental understanding. The review discusses wearable and sensor-based systems as approaches for providing assistance during daily activities. The study also highlights the importance of usability and considering the practical requirements of users. These findings support the development of a simple wearable system that provides useful navigation assistance through audio feedback. Nanda et al. [8] proposed compact smart eyewear incorporating environmental sensing, distance measurement and audio feedback. The system demonstrates how wearable eyewear can obtain information about the surrounding environment and communicate it to the user through audio. The study further supports the use of glasses as a wearable platform for navigation assistance and the use of audio feedback for communicating information related to the user's surroundings. Overall, the reviewed literature shows that wearable glasses can be used to assist blind users during navigation by sensing obstacles and providing information through audio feedback. The studies demonstrate the importance of environmental sensing, timely response and directional audio guidance for safe movement. Among the reviewed works, the integration of obstacle detection together with auditory direction cues shows the highest utility. Based on these studies, the proposed "Smart Vision" our project focuses on a glasses-and-earphones-based navigation system. The system detects obstacles in the user's path and provides appropriate directional guidance through the earphones, helping the blind user decide the direction of movement.

III. GENERALIZED BLOCK DIAGRAM



IV. COMPONENTS DETAIL

1. RASPBERRY PI: The Raspberry Pi was selected as the central controller as we wanted our project to be feasible and due to its versatile SOC (system on chip). This acts as the central processing unit (CPU) or the "brain" of your project. It is a credit-card-sized single-board computer that runs a Linux-based operating system (typically Raspberry Pi OS). It processes the incoming video frames from the camera module using programming languages like Python and libraries like OpenCV. It simultaneously reads distance data from the ultrasonic sensor and coordinates system-wide operations.

2. CAMERA MODULE: We used a camera module as the system's visual sensor, or "eyes." It connects directly to the Raspberry Pi's dedicated MIPI Camera Serial Interface (CSI) port via a ribbon cable. The module captures real-time high-definition video frames or static images of the surrounding environment and passes this data to the Pi for computer vision tasks like object detection, facial recognition, or motion tracking.

3. ULTRASONIC SENSOR (HC-SR04): This functions as the spatial or distance sensor. It works on the "Time-of-Flight" principle by emitting high-frequency sound waves (ultrasonic pulses) and measuring how long it takes for the echo to bounce off a nearby object and return. In a Smart Vision project, it acts as a proximity trigger, blind-spot monitor, or obstacle detector to ensure safe navigation or to wake up the camera when an object gets too close.

4. JUMPER WIRES: The jumper wires are the physical conductors used to establish electrical connections. They bridge the General-Purpose Input/Output (GPIO) pins of the Raspberry Pi to the pins of the ultrasonic sensor and power distribution lines. They come in Male-to-Male, Male-to-Female, and Female-to-Female configurations to easily plug into components or breadboards without needing to solder.

5. POWER SUPPLY: The power supply serves as the foundational energy source, ensuring everything running safely by providing steady, regulated electrical energy. A Raspberry Pi usually needs a stable 5V supply through either a USB-C or Micro-USB port, depending on which model you have. Ensuring your power supply can continuously deliver enough current 4 (typically between 2.5A and 5A) will protect

us from random system crashes, lag from under voltage throttling, and damage to add-ons like a camera module.

V. SOFTWARE USED

The software architecture for this Smart Vision Guiding Assistance system is built on a Raspberry Pi OS ecosystem using Python 3 as the primary programming language, executing a lightweight object detection model like YOLOv5/v8-nano pre-trained on the COCO dataset to identify everyday hazards. Image frames captured via the camera module are managed using the OpenCV library for real time resizing and preprocessing, while the RPi. GPIO Zero Python modules handle physical sensor interfacing by calculating distance metrics from the HC-SR04 ultrasonic sensor via time-of-flight pulses. To deliver seamless accessibility, the detection outputs and proximity warnings are synthesized into clear audio prompts using text-to-speech engines like eSpeak or gTTS. Critically, the system relies on Python's threading library to run the heavy computer vision pipeline and the low-latency sensor monitoring in parallel, ensuring immediate, life-saving audio alerts for blind users without system lag.

VI. CONCLUSION

Thus, we have successfully reviewed different research papers on this topic "SMART VISION", we have analysed that this topic is very useful for the emerging communication network.

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