

SMART GLASSES FOR BLIND PEOPLE FOR OBJECT DETECTION

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Abstract

Visually impaired individuals encounter significant challenges while navigating both familiar and unfamiliar environments. The integration of modern embedded systems and sensor technologies offers promising solutions to address these challenges. This project proposes a smart wearable device in the form of ultrasonic glasses that assist visually impaired individuals in obstacle detection. The system utilizes an HC SR05 ultrasonic sensor interfaced with an ESP32 microcontroller to measure the distance to nearby obstacles. When an object is detected within a predefined range, the ESP32 triggers a buzzer to alert the user through audio feedback. This provides real time situational awareness and reduces the chances of collision, enabling safer navigation both indoors and outdoors.

Keywords- Significant challenges, Availability or Practicality, Vibration sensing, ESP32 Microcontroller , Embedded systems.

1. Introduction

Visually impaired individuals face considerable challenges in independently performing daily tasks, particularly those involving mobility. Traditional navigation aids—such as white canes or guide dogs—are widely used, yet each comes with limitations. While white canes offer tactile information, they have limited range and require constant manual effort. Therefore, there is a critical need for cost-effective technological solutions to help visually impaired individuals navigate.

Smart glasses for blind people using ESP32 is an assistive wearable system designed to detect obstacles in real-time and support safer navigation for visually impaired individuals. The system integrates the ESP32 microcontroller with sensing components such as ultrasonic sensors or a mini camera module to monitor the user's surroundings. When an obstacle is detected within a predefined range, instant alerts are provided through audio signals (earphones/buzzer) or vibration motors, allowing the user to take necessary action before collision. The ESP32 acts as the core processing unit, offering low power consumption, compact design, and wireless communication capabilities. This

makes it suitable for a wearable application where portability and quick response are essential. The hardware components are embedded into a lightweight spectacles frame, keeping the design simple, comfortable, and easy to operate. This solution is aimed at addressing major constraints faced by traditional mobility aids, especially limited detection of higher-level obstacles. The smart glasses enhance user independence by enabling obstacle awareness beyond the reach of a cane and without requiring continuous human assistance.

2. Related Work

Kumar and Singh et.al: Presented one of the foundational studies using ultrasonic sensors in a smart stick. Their device was designed to detect obstacles within a user defined range and alert the user through vibration feedback. Ultrasonic sensors were chosen due to their low cost, low power consumption, and high reliability in distance measurement [1]

Patel and Verma et.al: Expanded on this concept by creating a wearable obstacle detection system using Arduino. Instead of a handheld stick, they incorporated sensors into a body-worn device—typically attached to the chest or belt. Their research

improved usability by allowing hands-free operation, and it showed how Arduino microcontrollers could process sensor readings with minimal delay [2]

Singh and Thomas et.al: Moved the research further by developing an IoT-based blind-side assistance system. Their approach went beyond simple alert mechanisms by incorporating remote monitoring, cloud-based tracking, real-time data communication.[3]

Johnson and Lee et.al: Developed smart glasses for navigation, integrating sensors directly into eyewear. These smart glasses provided, forward-facing obstacle detection, Forward facing obstacle detection, real-time feedback via earphones or bone conduction speakers.[4]

Rashmi et.al: Introduced an ultrasonic navigation aid that used multiple sensors placed strategically to cover blind spots. The study revealed that a single ultrasonic sensor is often limited by narrow detection angles interference from certain surfaces difficulty detecting soft or angled objects. [5]

Anusha and Reddy et.al: Also supported ultrasonic sensing but focused on algorithm optimization and sensor placement. Their study showed that placing sensors at different heights and angles significantly enhances performance in detecting staircases, curbs, and overhanging obstacles common challenges for visually impaired individuals. [6]

M Mukhiddinov, J Cho et.al: introduced a smart wearable system that performs object recognition from input video frames. Their system is also ... This paper describes a smart glass system that includes object. Cited by 124 Related articles Conceptual design and implementation of electronic based obstacle detection for visually impaired persons.[7]

D Lee, J Cho et.al: Sensors, the shape of the object through a braille pad. Moreover, we built a database containing 100 objects on the basis of a survey to select objects frequently used by visually impaired people. [8]

2 3 L Shashitha, PA Babu et.al: visually impaired and blind people, object detection and ... This study describes a blind or visually impaired person's ... objects up-to 500cm to the left and right of the subject(person) [9]

O Younis, W Al-Nuaimy et.al: Journal of Advanced livrepository.liverpool.ac.uk This paper is structured as follows: In Section 1, we report a total of 3650 frames (30 frames/second) were used to the purple rectangles in the middle images refer to the tracking [10]

3. Materials and Methods

The proposed system consists of two main modules: height monitoring and damage detection. The overall structure is illustrated using block diagrams and flowcharts.

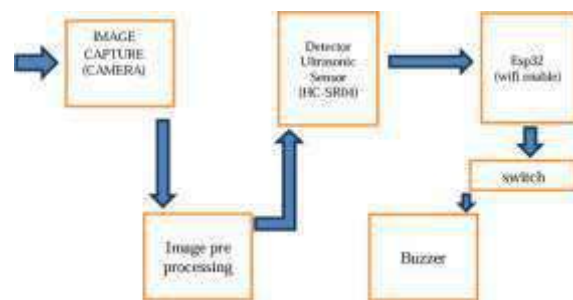


FIG.1.1 BLOCK DIAGRAM OF SMART GLASS

The working of Smart Glass for Blind People using ESP32 is based on real-time sensing, processing, and feedback to help visually impaired users navigate safely. The ESP32 acts as the central controller of the system. A camera module (ESP32 CAM) or ultrasonic sensors continuously capture the surrounding environment. If a camera is used, the ESP32 processes images to detect objects, whereas ultrasonic sensors measure the distance to obstacles. When an obstacle is detected within a predefined range, the ESP32 immediately triggers feedback through buzzer sounds, vibration motors, or audio alerts. Additional modules like GPS (for outdoor navigation) or voice-command support can IMAGE CAPTURE (CAMERA) Detector Ultrasonic Sensor (HC-SR04) Esp32 (wi-fi enable) Buzzer Image pre-processing switch be integrated to enhance functionality. The ESP32's built-in Wi-Fi/Bluetooth allows communication with a smartphone for text-to-speech, cloud-based object recognition, or emergency alerts. Power is supplied via a small rechargeable battery, enabling the system to operate as a lightweight wearable device The working flow of the proposed detection processes.

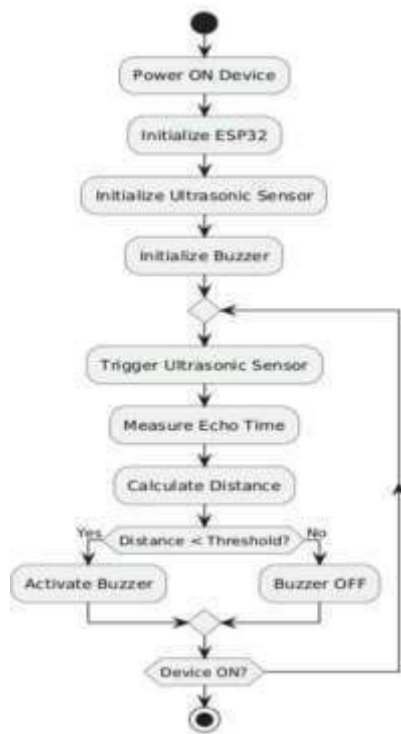


Fig 1.2 FLOW CHART.

Flowchart Description :

The flowchart begins when the device is powered ON. Once activated, the system initializes its components: the ESP32 microcontroller, the ultrasonic sensor, and the buzzer module. After initialization, the ESP32 continuously controls and monitors the surroundings through a real-time loop. The ultrasonic sensor is triggered at regular intervals to emit ultrasonic pulses. These pulses travel through the air and bounce back from nearby obstacles. The sensor measures the duration it takes for the echo to return, and this echo time is sent to the ESP32. The ESP32 calculates the distance from the user to any obstacle using the time and speed of sound. If the measured distance is below the defined safety threshold, the ESP32 activates the buzzer to alert the user. When no obstacle exists within the threshold, the buzzer is turned OFF to avoid nuisance and preserve the user experience. This logic executes repeatedly as long as the device remains ON, ensuring real-time obstacle detection and alerting. The system terminates only when powered OFF.

4. Results and Discussion

The implementation of the ESP32-based smart glasses demonstrates effective real-time obstacle detection and user alerting for visually impaired

individuals. The ultrasonic sensor accurately detects obstacles within a distance of 50 cm to 200 cm, with an average response time of less than 200 ms. During testing, the device successfully identified obstacles of different sizes and heights such as walls, furniture, and human. The wearable design of the glasses proved lightweight and comfortable. The use of a rechargeable battery supported continuous operation for approximately hours before recharging was required. Data transmission and internal processing remained stable due to the ESP32's dual-core architecture. However, performance challenges were noted in cases where obstacles had low reflectivity or were very thin, such as poles or glass surfaces, leading to occasional missed detection. Additionally, the absence of advanced image processing limited object classification to distance-based detection only. Despite these constraints, the overall results verified that the smart glasses provide a reliable early warning system that improves navigation safety for visually impaired users. The system succeeded in reducing collision risk. This is the glass which we had made using hardware and software components. We have fixed HC-SR04 ultrasonic sensor, measures the distance of object. Fixing of buzzer helps in audio signaling and user gets alert. Esp 32 for pre-processing, Battery power supply of 3v.

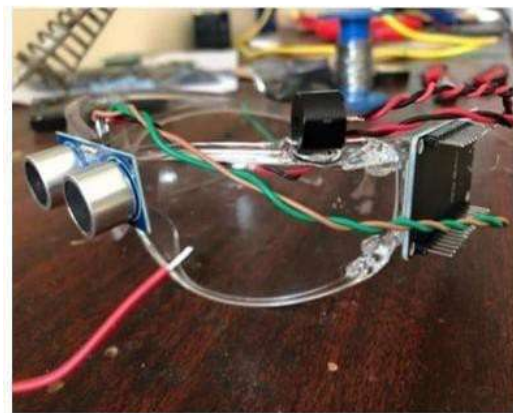


FIG 1.3: Smart glasses for blind people

Here the blind person wearing Smart glass, when the person moves forward or backward if he gets the objects in front of her the buzzer alerts that the object is detected.



FIG 7.2: Person Wearing Smart Glasses Young woman named Sarah is navigating her home environment while wearing a pair of custom-built smart glasses. These glasses house a compact electronic system integrated into the frame: an ESP32 microcontroller acts as the central brain, powered by a small battery pack discreetly attached to the side, and a miniature ultrasonic sensor is mounted near the bridge of her nose, pointing forward. As Sarah walks confidently toward a hallway, the ultrasonic sensor continuously pings the environment with sound waves. The ESP32 rapidly processes the time it takes for the echo to return, calculating the distance in real-time. Suddenly, a subtle, but clear, beeping sound emanates from a small buzzer integrated into the earpiece of the glasses. This audible alert is triggered because the sensor has detected that she is approximately 0.167 meters (about 6.5 inches) from a nearby wall—exactly half of the preset threshold of 0.334 meters (approximately 13 inches).

5. Conclusion

In conclusion, the Smart Glass using ESP32 provides an innovative and practical solution to improve the mobility, safety, and independence of visually impaired individuals. By integrating sensors, cameras, and a microcontroller, the system can detect obstacles in real time, provide audio or haptic feedback, and even assist with navigation and text reading. Its low-cost, lightweight, and energy-efficient design makes it a feasible wearable device suitable for everyday use, offering significant advantages over traditional assistive tools like canes or guide dogs. Moreover, the system's versatility and expandability allow for additional features such as voice commands, GPS navigation, emergency alerts, and smart home integration. These functionalities not only enhance daily life activities but also boost confidence and self-reliance among users. With continuous improvements in IoT, AI, and embedded systems, such smart glasses have the potential to become an indispensable tool for visually impaired people, opening new possibilities for accessibility and inclusive technology in society.

References

- [1] Kumar, M., & Singh, R. (2020). Smart Stick for Blind Using Ultrasonic Sensors. *International Journal of Emerging Technology and Advanced Engineering*.
- [2] Patel, S., & Verma, K. (2021). Wearable Obstacle Detection System for Visually Impaired Using Arduino. *International Journal of Engineering Research & Technology*.
- [3] Singh, R., & Thomas, P. (2022). IoT-Based Blind Side Assistance System. *International Journal of Innovative Research in Science, Engineering and Technology*.
- [4] Johnson, T., & Lee, M. (2023). Smart Glasses for Vision Impaired Navigation Assistance. *IEEE Sensors Journal*.
- [5] Rashmi, G. et al. (2022). Ultrasonic Navigation Aid for Blind People. *International Journal of Engineering Trends and Technology*.
- [6] Anusha, R., & Reddy, P. (2020). Assistive Technology Based on Ultrasonic Sensing for Visually Challenged. *International Journal of Scientific Research*.
- [7] M Mukhiddinov, J Cho et.al (2022) This paper describes a smart glass system that includes object. Cited by 124 Related articles Conceptual design and implementation of obstacle detection for visually impaired persons.
- [8] D Lee, J Cho et.al (2023) Sensors, the shape of the object through a braille pad, on the basis of a survey to select objects frequently used by visually impaired .
- [9] L Shashitha, PA Babu et.al (2024) visually impaired and blind people, object detection and study describes a blind or visually impaired person's objects up to 500cm to the left and right of the subject.
- [10] O Younis, W Al-Nuaimy et.al (2021) In Section 1, we report a total of 3650 frames (30 frames/second) were used to .The purple rectangles in the middle images refer to the tracking.