An Affordable Low-Cost Wearable Solution for Object Detection in Visual Impairment

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Abstract. This study aims to improve the lives of visually impaired individuals by developing a wearable device using ultrasonic technology. The system consists of an STM32 ultrasonic sensor and a buzzer that detects obstacles in real-time. The device is securely mounted in the user's glasses, and the buzzer sounds when an obstacle is detected. This state-of-the-art assistive technology addresses the immediate demands of improved safety and navigation for the blind. This study aims to overcome barriers to daily life caused by scene damage, reducing mobility and freedom. The wearable solution enables the visually impaired to confidently explore their surroundings. The device blends with error-free regular glasses, allowing the user to respond quickly to obstacles. The buzzer notifies the user when an obstacle occurs, providing them with the opportunity to respond quickly. This state-of- the-art assistive technology can completely change the lives of those with visual flaws, providing additional independence in their daily activities. Innovation plays a crucial role in expanding projects on assistive technology for the visually impaired, providing complete information on wearing solutions. This work aims to create a future of technology that bridges to a freer and fulfilling life for everyone.

1 Introduction

Globally addressing the pervasive problem of visual impairment is a continuous concern, especially when it comes to autonomous navigation and obstacle identification for those who are impacted. Predictive analytics and Internet of Things (IoT) integration is one promising approach [1]. The prototype application's main goal helps and provide bater assistive device that can improve the lives of those who are visually impaired, by providing an affordable and easily available virtual third eye via mobile devices. In order to help visually impaired people discover and recognize objects, this study presents a revolutionary framework that will enable them to navigate independently and become more. aware of their environment [2]. This study

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describes a multi- sensory based system for indoor object detection by validating the object using the support vector machine algorithm, proving the efficacy of the suggested approach. With the ultimate goal of offering insightful information for the benefit of the blind, this research examines and evaluates many real-time object detection approaches [3]. A summary of the technologies that have been used recently to help blind people with their everyday problems is provided. The field of computer vision is investigated for its potential to effectively classify things by using deep learning models and digital images from cameras and movies. This extensive research examines techniques and resources related to camera-based devices, suggesting a system to help people with visual impairments comprehend and convert text patterns to auditory output [4, 5].

2 Literature Review

With a focus on extremely effective obstruction detection, the primary goal is to develop a small, safe, and adaptable framework to help visually impaired people with their daily tasks [6]. A suggested wireless security system monitors and controls events like break-ins and dangerous situations using inexpensive ZigBee and GSM modems. In order to increase coverage, cluster heads use GSM to communicate with a central control room. A PSO algorithm is used to optimize network routing. Depending on user requirements, cluster nodes—which function as embedded devices—are outfitted with ZigBee switches and modems [7]. A three-part strategy is presented to address the difficulties caused by major changes in the environment and geography that result in disasters. A central control room takes choices, such as turning on discharge sensors to regulate gate openings, after sensor nodes gather and manage data. A hooter for danger alerts and critical conditions is part of the system. One innovation in the area of Internet of Things applications is real-time person count tracking, which sends alert messages when certain thresholds are crossed. People can monitor and obtain alerts for important threshold values by installing Internet of Things (IoT)-based monitoring devices in rural regions [8]. This work presents a visually impaired navigation system that uses the monodelph method to determine object distances and the SSD method for item detection. A specially constructed technology that combines picture recognition with a GPS tracking system that can identify several things in a single scenario helps visually impaired people in retail settings [9]. The findings of the research provide the groundwork for the creation of a mechatronic system prototype for the blind that will include multiple or stereoscopic cameras, extra ultrasonic sensors, and machine- learning models for activities that are vital to safety. When compared to other algorithms, the YOLO approach is emphasized for its advantages in object detection because it uses neural networks to anticipate bounding boxes and detect images quickly [10].

3 Block Diagram

The block diagram of object Detection Node (Fig. 1) describes as follow for this project:

- The ultrasonic sensor, STM32 microcontroller, and buzzer are the three primary parts of the wearable gadget intended for obstacle detection. The primary sensory element of the system is the ultrasonic sensor, which is thoughtfully placed on the glasses. Its objective is to release ultrasonic waves and time the time it takes for them to return after colliding with a barrier. After that, the STM32 receives this data to process [11].

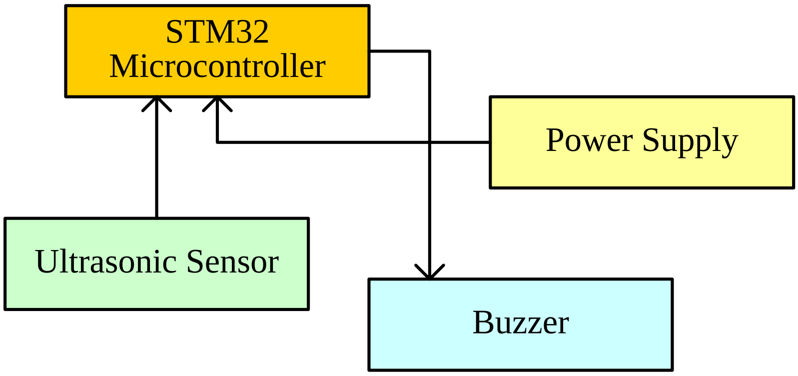

Fig. 1. Block Diagram of Object Detection Node

- The STM32 microcontroller functions as the system's brain, deciphering information from the ultrasonic sensor and making judgments according to established standards. The buzzer is activated by the STM32 when it detects an obstruction within the proximity range. The STM32 is the preferred microcontroller because of its small form factor, making it wearable, and its programmability, which enables the logic required for obstacle detection to be implemented [9, 12].

- The system output alerts the buzzer user hearing when an interruption is detected. This is audio for the visually impaired the input is important because it provides real time information that enables timely action and reporting practice. Buzzer to be used as an alarm the system makes it easy to use and while confidence means close barriers, increasing the barrier to be imposed the overall effectiveness of the search engine. In conclusion, one is included with the wearable device STM32 microcontroller for processing and decision making, ultrasonic sensors and buzzers for environmental collection provide information to the user quickly and easily. When they take it together, these factors provide an efficient system. it is part of the challenges faced by people with vision improving their mobility and promoting loss increased autonomy in their direction environment [7, 8, 13].

4 Hardware Development

The hardware interfacing for the object Detection are as follows (Fig. 2):

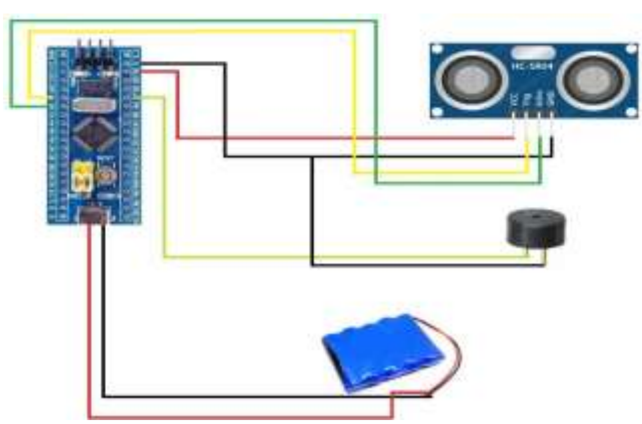

Fig. 2. Connection Diagram of object detection node

- The STM32 board is the brain of the complete system where external power supply has been attached with the 5V and ground pin of battery.

- The ultrasonic sensor has been attached with the STM32 board, GND pin of the ultrasonic sensor has been connected to the common ground and The VCC pin of the ultrasonic is 5v connected to the STM32 board. The ultrasonic sensor has an echo pin It is connected to the pin of A2 on the STM32 board the trigger pin is connected to A1 of the STM32 board [14].

- The buzzer positive is connected to the B7 pin STM32 board and GND are connected to G(GND). Pin to the STM32 board.

5 Implementation of System

The STM32 includes a trigger and echo pin for the ultrasonic sensor, which is connected to the buzzer pin as shown in Fig. 3. The beginning phase of the planning process. Again, the constants are defined as the buzzer's activation status and the obstacle detection threshold distance. After entering the algorithm's main loop, the ultrasonic sensor measures the distance. It is the closest thing. Then the algorithm starts playing buzzer. If it indicates that this range is smaller than the present value threshold. At the same time, a report with its conclusions can be recorded for additional information about the impediment [10, 15]. The algorithm for a wearable assistive technology is available in the scientific literature, utilizing an ultrasonic sensor to detect obstacles and alert users to potential hazards. The system uses a buzzer to signal the absence of approaches and limits the distance if the distance is greater than or equal to the threshold.

Fig. 3. Real-time object detection system

The primary loop's perpetual repetition ensures continuous monitoring of the environment for potential hazards, providing real-time input for users [16]. This system increases safety and independence for those with visual impairments by promptly alerting them to potential hazards. The development of this technology demonstrates the potential of sensor technology, user-centric design, and innovative hardware in solving urgent social problems. As wearable assistive technology continues to improve, it is expected that people with visual impairments will soon be able to navigate their surroundings more easily and independently [17].

6 Conclusion

This study aims to improve independence and accessibility for people with visual impairments, has brought about new assistive technology. With the seamless integration of the STM32 microcontroller, buzzer, and ultrasonic sensors into a wearable device, we effectively developed a system that gives users more confidence in understanding their surroundings. This has proven the efficacy of the obstacle detection system during this project by displaying its capacity to provide notifications in real-time when obstructions are detected within a predetermined proximity. By incorporating this technology into regular eyewear, people with vision impairments can now have a useful and discrete solution that will hopefully lessen the obstacles they encounter on a daily basis. These encouraging results highlight how this wearable device may help visually impaired people become more independent. The system helps users make better decisions by warning them of potential hazards, enabling safer and more certain navigation. The buzzer's sound acts as a quick and easily accessible notification, which enhances the user experience overall. To sum up, the initiative shows the potential to improve the lives of people with visual impairments and is an important step in the field of assistive technology. Through ongoing research, development, and collaboration, it is hoped that analogous advancements will continue to pave the road toward a future that is more inclusive and accessible for everyone.

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