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Object Detection Helmet with Voice Output

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Abstract

In the pursuit of safety measures for people facing vision-related issues, we build an 'Object Detection Helmet with Voice Output' that helps to detect real-life objects like a person, car, etc. 'Object Detection Helmet with Voice Output' tailored to enhance safety for individuals with vision impairments. The project utilizes Python programming and YOLOv8 for real-time object detection. The system integrates a GPS module for navigation, with NodeMCU facilitating data processing. The implementation involves the integration of components such as the NodeMCU and GPS module to create a functional prototype. By emphasizing real-time object detection and GPS navigation, the system aims to assist visually impaired individuals in navigating their surroundings safely.

Keywords:YOLOv8, Real-time Object Detection, Ultrasonic sensor, Node- MCU, Object Detection Helmet, safety of vision impairments.

1. Introduction

The World Health Organization estimates that approximately 253 million people worldwide live with visual impairments, facing challenges in mobility and independence. Traditional methods of navigation, such as white canes and guide dogs, have limitations in detecting obstacles and providing real-time guidance. To address these challenges, this paper introduces an Object Detection Helmet with Voice Output designed to assist visually impaired individuals in navigating their surroundings safely.

Object detection Helmet with Voice Output' possesses this safety with shield features. This project is very useful for helping people with vision related issues. The 'Object Detection Helmet with Voice Output' project emerged as a response to help people with no vision or very low vision. Historically, visually impaired people use stick for their walk or visiting different places. So this helmet will be advance and easy to use. By using this model properly, the safety of user is going to increase. This helmet will cover more visually surrounding than stick which increases the safety. The significance of this project is clear- it offers safety and clears the gap of traditional methods by using advanced technology.

In 'Object Detection Helmet with Voice Output' we are going to use various components like ESP32 with camera module, Node MCU, GPS module and we are using python and YOLOv8 real time object detection. We are going to provide short-distance alert feature, by utilizing the ultrasonic sensorand buzzer with NodeMCU, which helps users to become aware of their surroundings.

2. Related Previous Work

This section contains overview some related works already done related to this topic which we discussed in the following points.Previous research has explored various approaches to assist visually impaired individuals. One notable project, "Blind Person Smart Helmet" (June 2022) [3], introduced a smart helmet equipped with Arduino, ultrasonic sensor, and GSM module for object detection and location-based guidance. Another project, "Smart Cap – Wearable Visual Guidance System for Blind" (May 2020) [1], utilized Raspberry Pi, camera, and text-to-speech synthesis for real-time object detection and audio information. Additionally, "Smart Helmet for Visually Impaired" (April 2019) [2] integrated computer vision, GPS, and text-to-speech technology for object detection and navigation assistance. These projects laid the foundation for our work in enhancing safety and mobility for visually impaired individuals with our "Object Detection Helmet with Voice Output" project.

3. Hardware Components

i) ESP32 with Camera Module:

Figure 1 esp32 with camera module

As shown in figure 1, the ESP32 acts as the central controller, capturing real-time images with the camera module and initiating object detection. It collects data from the camera and forwards it to the YOLOv8 algorithm for processing.

ii) GPS module:

Figure 2 GPS NEO 6M module

Global positioning system, shown in figure 2, is a satellite-based navigation system that consists of a network of satellites transmitting signals to GPS receivers. These receivers use the signals to calculate their precise location and provide location and time information anywhere on earth.

iii) Node MCU:

Figure 3 Node MCU

NodeMCU, as shown in figure 3, is a low-cost open-source IoT platform that combines the functionality of a microcontroller unit (MCU) with Wi-Fi connectivity. It enables easy prototyping and development of Internet of Things (IoT) projects, including applications like location tracking.

iv) Ultrasonic Sensor:

Figure 4 Ultrasonic sensor

The ultrasonic sensor, shown in figure 4, plays a crucial role in detecting obstacles by emitting sound waves and measuring their reflection time. This data determines if an object is within the specified range, triggering the buzzer to alert the user. It serves as the system's "eyes," providing real-time feedback forsafe navigation.

v) Buzzer:

The buzzer serves as an alert mechanism, triggered by the ultrasonic sensor detecting an object within the specified range, typically 30 cm. Emitting a sound, it alerts the user of the obstacle's presence, crucial for enhancing safety and facilitating smoother movement during navigation.

4. Proposed System Diagram

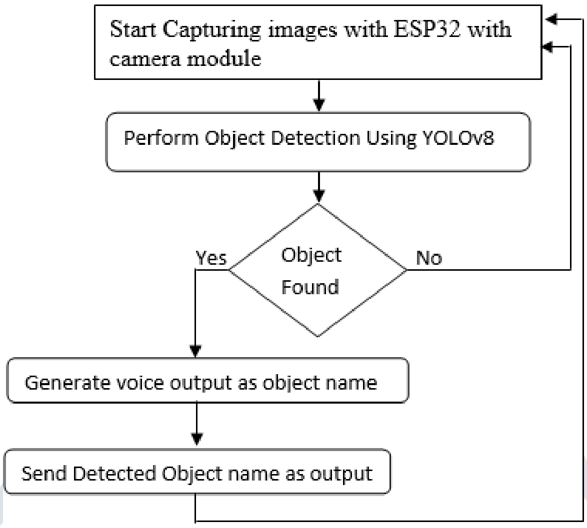
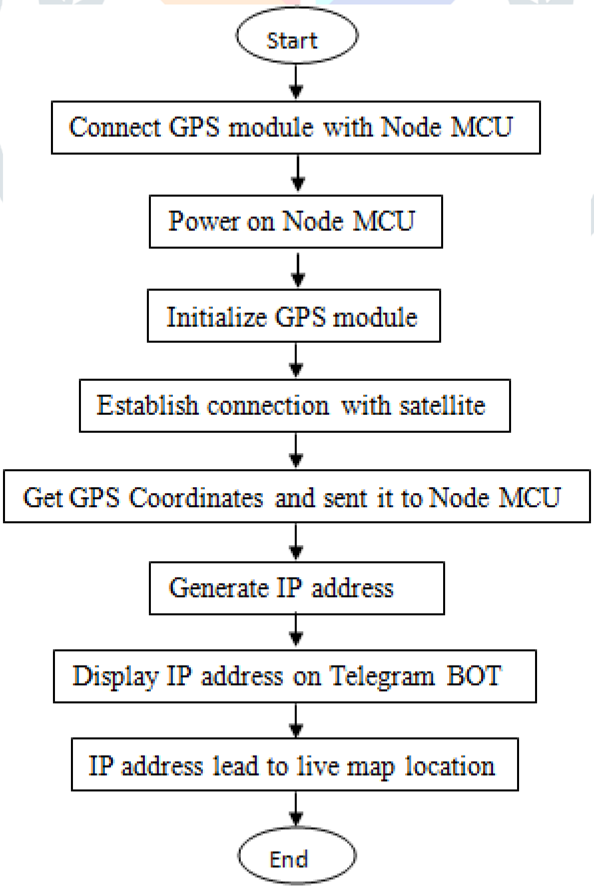


Figure 5 Object detection

Figure 5 represents a loop where the ESP32 continuously captures images using its camera module. Upon capturing each image, the system performs object detection using YOLOv8. Subsequently, if objects are identified, the system generates voice output and transmits the detected objects' information. However, if no objects are detected initially, the ESP32 continues capturing images and providing output.

Figure 6 Location tracking



The flowchart shown in Figure 6 depicts the process starting with the connection of the GPS module with NodeMCU, followed by powering on NodeMCU and initializing the GPS module. Once connected, the system establishes a connection with the satellite to receive GPS signals. During this phase, it continuously obtains GPS coordinates and transmits them to NodeMCU. Subsequently, it generates an IP address and displays it on a Telegram bot for remote access. IP address lead to exact map location of device

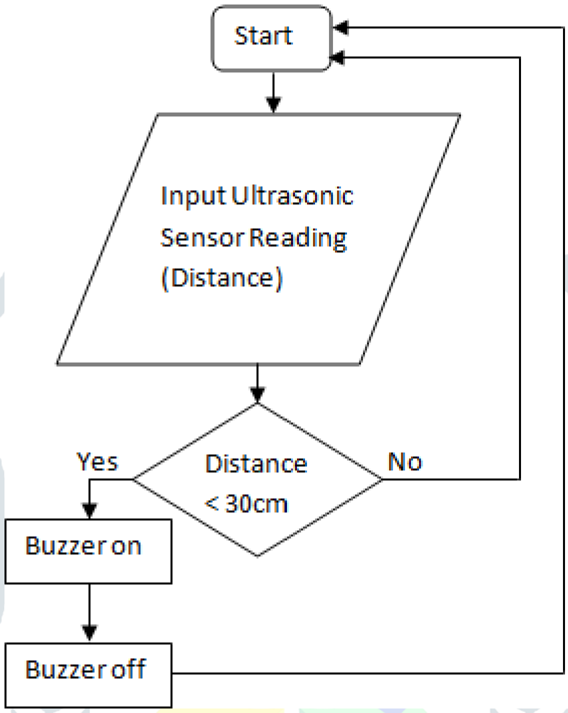


Figure 7 Short distance alert

The flowchart shown in Figure 7, represents the operational logic of a project integrating an ultrasonic sensor, buzzer, and NodeMCU. System initialization is done followed by process of object presence checking using the ultrasonic sensor. If an object is detected, the system measures its distance. If the distance is less than 30 cm, indicating potential danger, the buzzer is activated to alert the user; otherwise, the system remains idle. Throughout, the NodeMCU facilitates communication and control between components. Continuous monitoring ensures real-time situational awareness, contributing to user safety during navigation.

5. Methodology

We have to integrate the GPS location tracking and object detection system onto a normal helmet designed for blind people, consider the following steps:

i) Hardware Setup: We have toconnect the GPS module with NodeMCU for location tracking.Configure ESP32 with a camera module for object detection.We have toconnect the Ultrasonicsensor and Buzzer with NodeMCU for Short distance alert.

ii) Initialization: Power on the Node- MCU and ESP32 with camera module. Initialize the GPS module , ESP32 camera module, Ultrasonic sensor and Buzzer.

iii) GPS Location Assistance: we haveto establish a connection with satellites and continuously receive GPS coordinates, so the system will first connect to satellites to receive GPS signals. The received GPS coordinates will then be sent to the NodeMCU for processing the data. Subsequently, the NodeMCU will process the GPS data and send it to a Telegram bot for displaying IP address on telegram. The IP address will then showcase the current location information, including latitude and longitude, to the user.

iv) Object Detection for Safety: To initiate the process, the ESP32 camera module will commence capturing images. Following this, object detection using YOLOv8 will be performed on the captured images. Upon detection of objects, voice output will be generated to indicate the detected objects.

v) Short distance alert: To initiate the process, the ultrasonic sensor checks for object presence. If an object is detected, the system measures its distance. If the distance is less than 30 cm, indicating potential danger, the buzzer is activated to alert the user; otherwise, the system remains idle. Throughout, the NodeMCU facilitates communication and control between components.

vi) Testing and Optimization: Thorough testing of the integrated system will be conducted to ensure proper functionality, with a focus on optimizing the performance of the GPS location and object detection processes and Short distance alert. Special attention will be given to handling edge cases anderror scenarios gracefully, by ensuring the system maintains robustness, reliability under various conditions.

vii) Maintenance and Updates: For ensuring the system's longevity and compatibility, regular maintenance and updates will be implemented to keep pace with any changes or upgrades in the hardware or software components. These measures will help maintain the integrity and reliability of the system.

6. Result

The figure 8 shows the working model of proposed system which detects the obstacles and buzz sound to alert the person wearing the helmet.

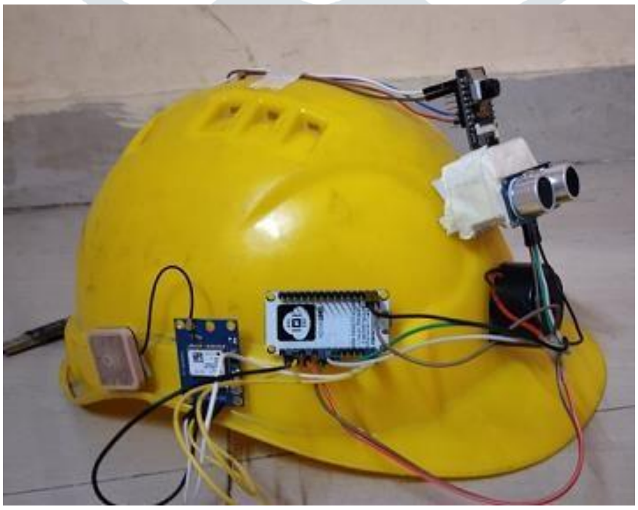


Figure 8 Result

7. Conclusion

Our project seamlessly integrates several crucial functionalities: Object detection using YOLOv8 through an ESP32-based camera module, location tracking utilizing a GPS module with NodeMCU, and short-distance alert using an ultrasonic sensor and buzzer with NodeMCU. By continuously capturing live images and performing object detection, our system provides real-time information about detected objects through voice output. Furthermore, the addition of location tracking enhances user safety by transmitting precise GPS coordinates to NodeMCU, enabling remote access via a Telegram Bot. Additionally, the short-distance alert feature, utilizing the ultrasonic sensor and buzzer with NodeMCU, helps users become aware of their surroundings. Ultimately, our innovation aims to empower visually impaired individuals by offering enhanced situational awareness through a smart helmet solution.

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