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IOT BASED INTELLIGENT WALKING SYSTEM FOR VISUALLY IMPAIRED

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***Abstract*— Individuals who are visually impaired often face challenges while navigating through the society around them. Unfortunately their struggles are often misunderstood by people who are not in their shoes. However, in recent years, technology has made significant advancements, providing new tools and solutions that can greatly improve the lives of impaired individuals.**

In this paper, we have proposed an application called The Smart Walking System. This application combines the power of GPS technology with IOT to provide real-time information about the user's surroundings. By identifying obstacles, navigating unfamiliar environments, and providing access to important information like news updates and weather reports, Smart Walking System has the potential to greatly enhance the lives of these individuals.

Our goal through this research is to highlight the difficulties faced by the individuals who are impaired visually and show how technology can be used to create a more inclusive world. With more projects targeted at helping these individuals live independently with greater dignity, we believe that we can make a real difference in the lives of these individuals. We are optimistic that with collaborative efforts, we can create a brighter future for everyone, regardless of their physical limitations.

Keywords*— *Visually Impaired Individuals, Technology and Accessibility, Smart White Cane, Real-time Information.

I. INTRODUCTION

Vision deficiency remains a problem impacting numerous individuals globally. Lately, various automated supportive gadgets have emerged to aid those with sight issues in navigating dynamic surroundings with ease. A broad spectrum of navigational applications and instruments is available to help users swiftly and securely maneuver around barriers and other encountered dangers. However, only a handful have demonstrated effectiveness. Such devices are referred to as ETAs, - 'Electronic Navigation Aids'. The primary aim of the suggested approach is to create an integrated, dependable, automated support device for users, utilizing sensors to ensure their safe movement. This proposed technique focuses on the development of a guidance system called 'IOT BASED INTELLIGENT WALKING SYSTEM FOR VISUALLY IMPAIRED', which is considerably more efficient, reliable, and cost-effective compared to current systems. The research posits that utilizing this system informs users of obstacles in their way, enabling them to move with a reduced likelihood of accidents.

[1] The challenges faced by this population include continuous orientation, changing directions. Many Devices,

[2]Individuals with visual impairments often have to rely on others for assistance in navigating their surroundings. While the white cane is a useful tool for many, it may not always be enough, especially in unfamiliar environments. This can severely limit their mobility and independence, making them dependent on others.[2].

[3]Statistics from both the World Health Organization and the National Federation of the Blind indicate that globally, there are approximately 253 million individuals are living with loss of sight ,out of whom 36 million are completely blind. Out of this staggering number, over 15 million reside in India, making it the country with the largest population of visually impaired individuals worldwide. Some innovators have attempted to address these challenges by using IR sensors. While IR sensors have shown potential, they are ineffective in sunlight since they contain infrared rays that can be detected by photodiodes present in the sensors [3].

II. RELATED WORKS

[1] Adrian Mocanu 2020, et al. proposed a system based on color-coded navigation, requiring city infrastructure adaptations and utilizing a color-detecting white cane. Our proposed system does not require infrastructure changes and offers more comprehensive guidance and feedback through multiple sensors and user interfaces.

[2] M. Marimuthu 2020, et al. proposed a wearable IoT device in the form of a smart navigational shoe. While this

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system provides a unique approach to navigation, our proposed system offers the advantage of a more familiar and user-friendly walking aid, while still employing advanced sensor technology and user feedback mechanisms.

[3] Mr. Sunil Yadav 2020, et al. proposed a sensor-enabled walking stick with an ultrasonic module and a piezo buzzer. While similar in some aspects, our proposed system expands upon this design by incorporating additional sensors, power management features, and a more advanced microcontroller to provide enhanced guidance and safety to the user.

[4] Mr. Mukesh Prasad Agrawal 2018, et al., proposed a smart stick with various sensors and a microcontroller. While this system shares similarities with our proposed system, we have further improved upon the design by implementing additional power management features, such as the piezo-electric plate, and a more powerful microcontroller capable of handling multiple sensors, thus providing a more comprehensive solution for visually impaired individuals.

III. METHODOLOGY

As depicted in the below Fig 1, the 12V rechargeable lead-acid battery is connected to the conversion circuit, which converts the 12V power supply into a 5V supply. The output of the conversion circuit is connected to the filter circuit, which produces a stable 3.3V supply to power the ESP32 microcontroller board.

The ESP32 microcontroller board, which acts as the central hub of the system, has connections to various components:

- Reset Switch
- LCD Display (16x2)
- Speaker
- Vibration Motor
- Micro SD Card
- Ultrasonic Sensor
- Panic Switch
- Piezo-electric plates.

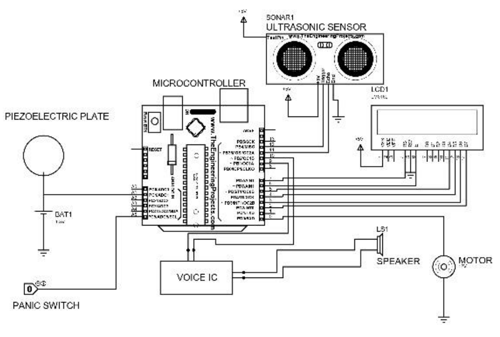


Fig. 1. Circuit Diagram of The System

IV. WORKING PRINCIPLE

A. Hardware Integration Of The Proposed System

As depicted in Fig.1, the hardware components are integrated with the ESP32 microcontroller on the PCB board as follows:

The ultrasonic sensor typically has four pins: VCC, Trig, Echo, and GND. VCC is connected to the 3.3V power supply from the filter circuit, and GND is connected to the ground. The Trig and Echo pins are connected to digital input/output pins on the ESP32 microcontroller. The TRIG pin sends a pulse signal to initiate the emission of sound waves, while the ECHO pin receives the reflected signal. The time difference between sending and receiving signals is used to calculate the distance to the detected obstacle.

The LCD display, which has 16 pins, connects six of its pins to the ESP32 for communication. RS, RW, and E are connected to digital pins on the microcontroller, while data pins D4, D5, D6, and D7 also connect to digital pins. The remaining VSS and VDD pins are connected to the ground and the 3.3V supply from the filter circuit, respectively. The V0 pin is connected to a variable resistor for contrast adjustment.

The speaker and vibration motor are connected to the ESP32 microcontroller using Pulse Width Modulation (PWM) pins, sharing a common ground with the ESP32 board, and powered by the 3.3V supply from the filter circuit.

The microSD card breakout board connects to the ESP32 board using the SPI (Serial Peripheral Interface) protocol. The SPI pins (MOSI, MISO, SCK, and CS) are connected to corresponding pins on the microcontroller, while VCC and GND pins are connected to the 3.3V supply and ground, respectively.

The panic switch is connected to one of the digital input pins on the ESP32 microcontroller, when pressed triggers the GPS module in order to send the user's location as feedback to a set of predefined contacts.

The piezo-electric plate connects to an energy harvesting circuit, which then connects to the battery charging controller. The energy harvesting circuit includes a rectifier, voltage regulator, and charging controller, which together manage the charging process for the 12V lead-acid battery.

Finally, the reset switch connects to the reset pin on the ESP32 microcontroller and the ground, allowing the system to restart its operation when pressed.

B. Software Implementation

The LiquidCrystal library is included to enable communication with the LCD display, which allows displaying relevant information such as connection status, distance measurements, and device status.

Libraries for HTTP communication, Wi-Fi connectivity, and JSON handling are included to facilitate data transfer and processing. These libraries enable the system to communicate with remote servers, fetch location data, and parse JSON data.

The DFRobotDFPlayerMini library is included to manage audio playback using the DFPlayer Mini module, which plays warning sounds when an obstacle is detected within a specified distance.

Constants are declared for the LCD display pins connected to the ESP32, and an LCD display object is initialized. This ensures proper connections between the microcontroller and the LCD display module.

Pins for the ultrasonic sensor's echo and trigger pins, the vibration motor, and the panic switch are declared and configured as input or output. This allows the microcontroller to read and control these hardware components as required.

The ultrasonic sensor is triggered by sending a pulse to the TRIGpin, which causes the sensor to emit an ultrasonic sound wave. The reflected wave is received by the echo pin, and the time taken for the wave to travel back is used to calculate the distance to the obstacle.

The duration of the received echo pulse is measured using the pulseIn() function, and this information is used to calculate the distance to the obstacle in centimeters.

When an obstacle is detected within a specified distance, the system initiates audio playback using the DFPlayer Mini module and activates the vibration motor. This provides auditory and tactile feedback to the user, alerting them to the presence of an obstacle.

The state of the panic switch is read using the digitalRead() function. When the panic switch is pressed, the user's current location is fetched using an HTTP GET request to an API. The location data is then sent to predefined contacts via the location() and iot() functions, providing a way to share the user's location in case of emergency.

The setup function initializes variables, pin modes, and libraries required for the system's operation. The main loop function runs repeatedly, allowing the program to continuously update and read inputs, perform calculations, and provide feedback to the user.

During the Wi-Fi connection process, the system displays connection information on the LCD. This helps users understand the status of the Wi-Fi connection and troubleshoot connectivity issues if needed.

The device's name and purpose are displayed on the LCD during the setup process, providing users with a clear understanding of the device's functionality.

The measured distance to the obstacle and the state of the panic switch are continuously displayed on the LCD, keeping the user informed about their surroundings and the device's status.

The system uses a delay of 1 second between each loop iteration to ensure the microcontroller has enough time to process the data and prevent sensor overload.

The location() function fetches the user's current location using an HTTP GET request to an API and parses the received JSON payload. The extracted latitude and longitude information is then used to generate a location string to be sent to the server.

The iot() function sends the sensor data, including the user's location, to a server using an HTTP POST request. The function first checks if the device is connected to Wi-Fi and creates a JSON payload containing the sensor data before sending the request.

The location and sensor data are sent to a server using a POST request, allowing remote monitoring of the device's status and enabling location tracking if required.

Error checking and handling are incorporated throughout the code to ensure the proper functioning of the system and to notify the user in case of any issues. This includes checking for errors during the initialization of the DFPlayer Mini module, establishing a Wi-Fi connection, and sending data to the server.

The panic switch functionality provides an additional safety feature, which can be utilized by the user in case of emergencies. When pressed, it sends the user's location to predefined contacts, allowing them to respond quickly and provide assistance if needed.

The proposed system's software implementation is designed to be modular and easily adaptable. This allows for future enhancements, such as integrating additional sensors, improving the user interface, or optimizing the data processing algorithms.

V. RESULT

In this section, we will describing about the process of acquiring the user’s data on the IoT application.

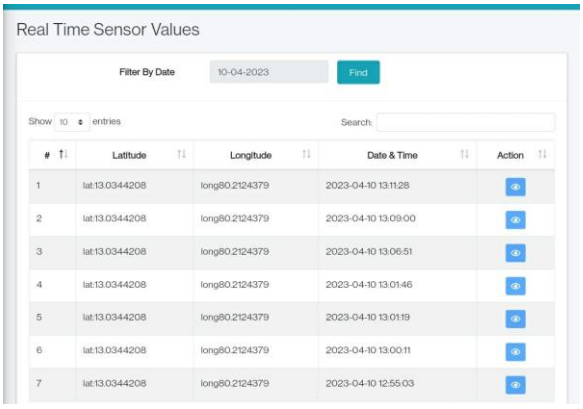
Obtaining Distance Data:
The ultrasonic sensor continuously emits sound waves and measures the time taken for the waves to bounce back after hitting an object. This data is used to calculate the distance between the sensor and the object. The system provides the user with auditory and tactile feedback when an obstacle is detected.

Sending Panic Alerts:
When the panic switch is pressed, the integrated GPS module in the ESP32 microcontroller sends the user's location to predefined contacts. The location data is acquired from the

GPS module and then transmitted using an HTTP request to the IoT cloud application.

Acquiring Location Data:
The IoT cloud application receives the user's location data and stores it in a database. Real-time location updates can be viewed on the IoT-based cloud website.

Viewing Output Data:
The provided output/real-time data is a list of latitude and longitude coordinates, along with timestamps. The data includes the following entries:



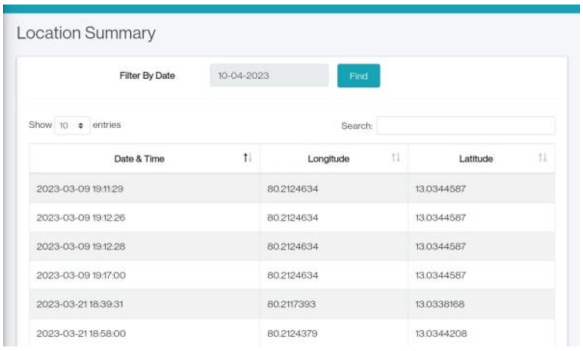
Real Time Sensor Values

Filter By Date 10-04-2023 Find

Show 10 entries Search:

#	Latitude	Longitude	Date & Time	Action
1	lat:13.0344208	long80.2124379	2023-04-10 13:11:28	
2	lat:13.0344208	long80.2124379	2023-04-10 13:09:00	
3	lat:13.0344208	long80.2124379	2023-04-10 13:06:51	
4	lat:13.0344208	long80.2124379	2023-04-10 13:01:46	
5	lat:13.0344208	long80.2124379	2023-04-10 13:01:19	
6	lat:13.0344208	long80.2124379	2023-04-10 13:00:11	
7	lat:13.0344208	long80.2124379	2023-04-10 12:55:03	

Fig.2. Real Time Output



Location Summary

Filter By Date 10-04-2023 Find

Show 10 entries Search:

Date & Time	Longitude	Latitude
2023-03-09 19:11:29	80.2124634	13.0344587
2023-03-09 19:12:26	80.2124634	13.0344587
2023-03-09 19:12:28	80.2124634	13.0344587
2023-03-09 19:17:00	80.2124634	13.0344587
2023-03-21 18:39:31	80.2117393	13.0338168
2023-03-21 18:58:00	80.2124379	13.0344208

Fig.3. Real Time Output

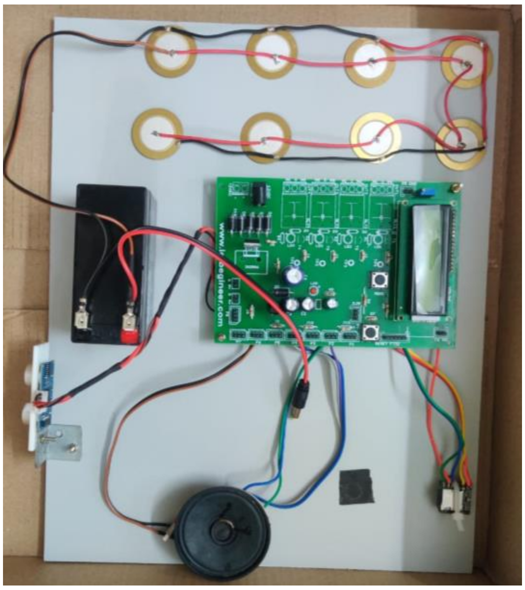


Fig.4. Hardware's Integrated With ESP32 Microcontroller in PCB Board

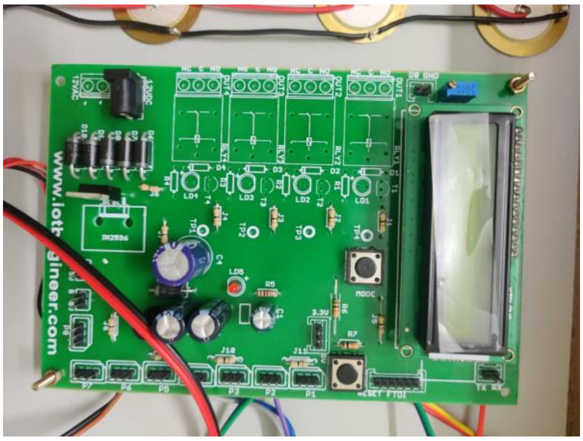


Fig.5. Hardware's Integrated With ESP32 Microcontroller in PCB Board

V. FUTURE SCOPE

There are several potential avenues for further development and improvement of the IoT-based intelligent walking system:
Advanced sensor integration: Incorporate additional sensors, such as infrared, LiDAR, or computer vision, to enhance obstacle detection and provide a more detailed understanding of the user's environment.

Indoor navigation: Develop an indoor navigation system using technologies like Bluetooth Low Energy(BLE) beacons, Wi-Fi fingerprinting, or computer vision to assist visually impaired individuals in navigating complex indoor environments, such as in transportation stations.

VI. CONCLUSION

In conclusion, the IoT-based intelligent walking system is a groundbreaking solution designed to enhance mobility, safety, and convenience for visually impaired individuals. By integrating advanced sensors, efficient power management, and user-friendly interfaces, it significantly improves users' quality of life and has a positive environmental impact. Through incorporating a piezo-electric plate as an alternative power source, the system promotes environmental sustainability.

The adoption of this technology raises public awareness about the challenges faced by visually impaired individuals, encouraging the development of more inclusive spaces and fostering a more inclusive society. Overall, the IoT-based intelligent walking system has the potential to create a significant positive impact on the lives of visually impaired individuals and contribute to a more inclusive and sustainable future for all.

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