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IOT BASED INTELLIGENT AND MULTI-FUNCTIONAL SHOE FOR THE VISUALLY IMPAIRED PEOPLES

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ABSTRACT

Peoples who are visually impaired typically have several challenges while engaging with their surroundings. The major challenge for visually impaired people is figuring out how to get where they want to go. People with good eyesight need to help these visually impaired peoples. Intelligent and multi-functional shoe is a great system that helps the visually impaired peoples finds their way when they walk. So, a special shoe has been made to help visually impaired people walk safely without worrying about running into other people or solid objects. This research paper proposes the design and development of an intelligent and multi-functional shoe for the visually impaired peoples. This system is based on Internet of Things (IoT) technology that incorporates various sensors to assist them in navigating their surroundings. The intelligent and multi-functional shoe has a Ultrasonic sensor (HC-SR04), an IR sensor, and a 6DOF Accelerometer Gyroscope GY-521 (MPU-6050) to detect obstacles, count the number of steps taken by the wearer, and improve their mobility and independence. Additionally, a GPS Module GY-NEO-6M V2 is used to track the wearer's location in real-time, enabling caregivers or family members to monitor their location remotely. The data collected by the sensors are transmitted to a central device via Wi-Fi or Bluetooth, providing real-time monitoring of the wearer's activities. This research paper also provides a comprehensive overview of the implementation details and the results obtained during the testing of the intelligent and multi-functional shoe. The proposed Internet of Things (IoT) based intelligent and multi-functional shoe is expected to provide a low-cost and effective solution for addressing the challenges faced by the visually impaired peoples in navigating their surroundings, and also improve the quality of life for the visually impaired peoples.

Keywords: Internet Of Things, Nodemcu ESP8266, Ultrasonic Sensor, IR Sensor, 6DOF Accelerometer Gyroscope GY-521 (MPU-6050), GPS Module GY-NEO-6M V2, Multi-Functional Shoe.

I. INTRODUCTION

Any sort of vision loss, including complete blindness or partial vision loss, is referred by specialists as being visually impaired [18]. A partial vision loss is also known as legally blind. Although they are not totally blind, they lacked sufficient vision to see things clearly. As a result, there are many things that need to be considered in living their daily life. The majority of them did not have problems moving around their house because they had a tendency to memorize the locations and routes. Therefore, we should be careful to not move any objects without asking. Walking outdoors is another challenge for the visually impaired peoples since they cannot memorize all the routes taken unless they use the same routes every day. Even if they remember the roads taken, they still need to be careful of unexpected obstacles near them [19].

However, as the industrial and technology development keeps increasing in our country, we managed to gain knowledge about one of the most useful devices which are sensors. Sensors are implemented in devices and tools to improve the mobility for visually impaired people [20]. It helps to detect the obstacles automatically using ultrasonic sensors. As an example, instead of using a guide dog and white cane, a smart cane with a sensor has been designed.

The Internet of Things (IoT) is a system of interconnected computing devices, mechanical and digital machines, objects and people that are provided with unique identifiers, unique roles and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction [21]. The IoT brings the power of the internet, data processing and analytics to the real world of physical objects. For consumers, this means interacting with the global information network without the intermediary of a keyboard and screen; many of their everyday objects and appliances can take instructions from that network with minimal human intervention [22],[23],[24]. These devices gather useful data with the help of various existing technologies and share that data between other devices. Internet of Things (IoT) technology is now being used for multiple operations including remote operations such as irrigation systems, military purposes, forests, etc. where human interference needs to be minimized. In practice, Internet of Things is actually an amalgamation of multiple technologies such as cloud technology, which leads to real time analytics, machine learning, commodity sensors, and embedded systems [25],[26]. Sensors, actuators and other ICs are embedded with electronics, Internet connectivity, and other forms of hardware like LED lights and LED displays [17],[27],[28]. These hardware components such as sensors and actuators interact with others over the Internet, and provide the information collectively and can be monitored and controlled remotely with the help of cloud technology.

This work aims to design and develop an IoT based intelligent and multi-functional shoe for the visually impaired peoples that incorporates various sensors to assist the visually impaired peoples in navigating their surroundings. The intelligent shoe includes an Ultrasonic sensor (HC-SR04) that can detect obstacles and notify the wearer through a buzzer. The 6DOF Accelerometer Gyroscope GY-521 (MPU-6050) is used to count the number of steps taken by the wearers. Furthermore, to improve the wearer's mobility and independence, the project incorporates a GPS Module GY-NEO-6M V2 to track their location in real-time. The smart shoe can transmit this location data to another device, enabling caregivers or family members to monitor the wearer's location remotely.

This paper is arranged as follows. A review of the relevant works and literature review is presented in Section II. In Section III and Section IV, the proposed system and methodology for the prototype is explained. Section V explains the result and discussion. The conclusion and future works of the proposed system is presented in Section VI and Section VII. Finally, the references are given in Section VII.

II. LITERATURE REVIEW

Most of the methods in the previous works are about obstacle detection using smart devices to improve the use of white cane by visually impaired people. Other than that, there are tracking systems, image detection and emergency alert systems. However, all the systems in the previous works have their own limitations.

Smart shoe is equipped with smart technology and can be a promising internet-related future health. Given that the ability to walk in various conditions is one of the key aspects of life, the smart shoe has been chosen for this study context. Smart footwear involves consistent gait and mobility assessment for prevention, diagnostic workup, specific disease monitoring, and therapy decisions. Innovative solutions and services to promote and reinvent healthy living and health care are conjectured to take the form of coherent and wearable computing systems [1].

Chandekar et al. [2] presented a paper assessing the existing options for ensuring autonomous mobility for people with disabilities, as well as a fresh idea that would use the embedded sensor in smart shoes to guide a blind person while they navigated and alert them to incoming obstacles. Specifically, the authors attempted to create an easy-to-use Android application for people who coextend the characteristics of smart shoes to meet specific requirements.

Drˇagulinescu et al. [3] presented smart use methods in special medical applications for gait and foot pressure analysis. In combination with validation and repeatability studies for Pedar and other in-shoe systems, the safety system Pedar was also presented. Pedar apps, mainly in medicine and sports, were then presented. The authors of this study provided a useful method for summarizing and choosing information in this area. They believed that their study was a pioneer in system design and functionality enhancements and that it would spur additional research on the use of sensors in intelligent textiles and in-shoe systems in other application domains.

In their study, Jung et al. [4] developed an auto-powered intelligent shoe to monitor a user’s body weight changes. Fluoride polyvinylidene and nanopowder ribbons were applied to form a voltage-type energy harvester and strain sensor. The stretchable sensors were formed from two conductive nanopowder systems (carbon black and multi-walled carbohydrate nanopowder). These circuits draw in energy, transfer data, and change power sources.

Reddy et al. [5] introduced a solution based on Radio-frequency identification (RFID) and Infrared sensor (IR) technology. The unit was placed inside a blind person's shoe. Each time the shoe is worn, the device is switched on with a button on the hand. Voice and prerecorded messages were used, similar to a museum's tourist guide system. 418 CMC, 2023, vol.76, no.1 MATLAB identifies the voice command and produces the correct voice command to follow to the destination.

Seo et al. [6] developed a module that computes the number of steps from Arduino-based wearable smart shoes through data delivery to Android-based smartphones. The computation was to ensure accurate measurement of steps. Moving distance and speed can be measured using a GPS to increase the accuracy of the momentum.

In [7], a smart shoe prototype that could connect to a smartphone through Bluetooth and deliver navigational information via a vibration unit placed around the shoe. Information for both outdoor and indoor navigation can be supplied using Google's navigation database. However, when using Bluetooth, the connection cannot function well if the smartphone and shoes are far from each other. Meanwhile, a device that leads the user by detecting obstructions within the stick's range is designed in [8]. With the help of several sensors implanted in it, it would identify any obstructions in the road. The microcontroller will retrieve data and transmit it as vibrations, alerting the user to potential roadblocks. Unfortunately, users still need to hold the stick all the time while walking. Therefore, only one hand can be used for other purposes or kept free. As for previous work stated in [9], the project used ultrasonic sensors as aid in measuring the distance between obstacles in a blind person's walk. This device assists the user in receiving the best possible track in the form of audio. The sensors are built into the shoe, allowing the blind person to not only identify impediments in front of them, but also detect any large pits along the road. In case of emergency, it also has a panic button that can send SMS. Anyhow, this shoe is not suitable to be used during outdoor activities because the output voice for the alert system may not be heard due to noisy environments. Then, a custom-made shoe that includes features such as object identification, image recognition and real-time navigation to the target destination with obstacle detection and warning has been proposed in [10]. As a result, this technology will assist blind and visually impaired people in walking and exploring unaided without the need for physical assistance. Even so, the hardware used more space as there is more than one module which are WiFi module and Bluetooth module to be implemented together with Raspberry-Pi. In [11], a vibration sensor is used to sense any obstacle. In the headset, customers can hear the guide's instructions. An ultrasonic sensor on the stick is utilized to detect the impediment, which is detected by the camera. The image is transferred to the microcontroller, which determines the object's kind, and then it is communicated as a voice command via the Raspberry Pi's speaker or earbuds. GPS interface is used to identify the exact location. However, this project used Raspberry Pi which is an expensive development board.

Meanwhile, a device that leads the user by detecting obstructions within the stick's range is designed in [9]. With the help of several sensors implanted in it, it would identify any obstructions in the road. The microcontroller will retrieve data and transmit it as vibrations, alerting the user to potential roadblocks. Unfortunately, users still need to hold the stick all the time while walking. Therefore, only one hand can be used for other purposes or kept free. Truong et al. [12] demonstrated the application of an off-shelf Smart Band and two Smart Shoes in monitoring and identifying daily tasks. The authors attempted to present a tool that could answer the problems related to body part placement. The safety systems are combined with multimodal sensors and features for certain activities.

Wu et al. [13] introduced a system controlled by STM32L432KC (an STMicroelectronics micro-controller). A lithium-ion battery-powered the system and the battery is chargeable. A gait event recognition algorithm was used to detect the feet motion status. When the user moves using a foot in the positioning stage (ST), obstacles can be detected. An occurrence of a fall would stimulate the smart shoes to connect to the mobile phone, and emergency contacts would be contacted. The experiments results suggested that Smart Shoes' performance was stable in real-time, with low false alarm rates.

Yang et al. [14] demonstrated the use of clever shoes. These shoes were wearable sensing systems that included the application of a handy soft-instrumented sole and two 3D motion sensors. A new data structure for the

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measured ground reaction and foot motion functioned as a "sensor image". An evolutionary auto encoder was applied, merging the multisensory datasets and extracting the concealed characteristics of sensor images. The proposed method showed its ability to learn joints torques and satisfactory widespread properties.

In their study, Zhou et al. [15] designed rationally as a composite structure. The purpose was to allow the full usage of pressure distribution of a footfall and the delivery of an output of power of up to 580 μW. In addition, the insolation could be operated without affecting power output consistency in harsh environments, including pluvial conditions. On the floor, there were 260 light-emitting diodes. Meanwhile, an 88 μF condenser was charged to 2.5 V in 900 ss. In this study, the authors demonstrated a practical approach to creating a very efficient and heavy-duty intelligent insole for wearable bioelectronics as a viable power source.

In their study, Zou et al. [16] examined TENG-based smart power-generating shoes. The shoes demonstrated the ability to scatter biomechanical energy through ambulatory motion and to apply rhythm tracking and pace biomonitoring for the health parameters of the agnostic.

Abhijit Pathak et al. [32] designed an Intelligent Walking Stick for blind people to find obstacles in the route. To scan these sensors, the authors implement an Ultrasonic Sensor HC-SR04, a buzzer, a DC vibration motor, and an Arduino UNO microprocessor. When the ultrasonic sensor module identifies an obstacle, it activates the buzzer and vibration motor. The system has a voice module that alerts and warns a blind person of potential dangers.

Ayush Wattal et al. [33] proposed a smart belt for the blind that includes an ultrasonic sensor in the belt to identify obstacles. When an obstacle is encountered, a buzzer vibrates, and the system communicates the distance to the blind person through a speaker as an audio message.

Joe Louis Paul I et al. [34] designed a smart navigation system that can assist those who are blind. The system is known as the "Smart eye system'' which consists of a Raspberry Pi as the microcontroller with a camera, sensors, headphones, and other subcomponents connected to it, which is a voice-enabled device that works in challenging situations where the visually impaired person needs it.

Teja Chava et al. [35] proposed a system that integrates a smart shoes and smart glasses to work in tandem, providing the user with enhanced obstacle detection and guidance. The system incorporates ultrasonic sensors, piezoelectric panels for energy generation, Bluetooth communication, and a machine-learning algorithm for mapping indoor environments. Even in the event that one of the modules fails, the system is built to function independently. The proposed system offers an easy-to-use and cost-effective solution for visually impaired individuals to commute independently and safely, with the potential for further enhancements in the future.

Chirayu Asati et al. [36] developed a smart cane for the visually impaired. This research combines techniques to create a more comprehensive solution. One such technique used an ultrasonic sensor to detect obstacles and alert the user through a vibration motor. Another technique was a camera to capture images of the surroundings and classify objects using machine learning algorithms. Overall, the developed intelligent cane provides a more advanced and affordable option for visually impaired individuals to navigate their surroundings.

Electronic Orientation Aids (EOAs) are assistive devices designed to help people with visual impairments navigate their environment. These systems typically use a combination of cameras and sensors to detect obstacles and identify paths. However, EOAs often require additional environmental information to function effectively. One major limitation of EOAs is the challenge of incorporating a complex computing device into a lightweight and real-time guiding device, which can be difficult to achieve [37].

Indriya is a portable device that can be used alongside a smart cane to assist individuals with visual impairments in navigating their environment. This system is capable of detecting obstacles up to three meters away and can differentiate between humans and objects with an accuracy rate of 80%. Before any possible collision, the device provides both vibratory and voice alerts to the user. Indriya uses a relatively small number of sensors for its IoT-based implementation, with support for the Android platform. However, the system may have limitations in accurately detecting steps, slopes, and other features of the environment [38].

Vignesh et al. [39] proposed smart shoe concept for visually impaired individuals involves equipping the shoe with sensors and communication modules to detect and deliver information about the surrounding environment, as well as individualized navigation guidance. This revolutionary invention has the potential to greatly enhance the safety and freedom of visually impaired individuals.

Neel Shah et al. [40] proposed smart shoe technology that combines integrating IoT and energy harvesting capabilities, allowing the shoe to produce power from the wearer's activity. Deep learning algorithms would also be used in the shoes to analyze the wearer's walking style and enhance energy harvesting efficiency. This unique invention has the potential to provide a sustainable energy source for wearable devices while minimizing dependency on traditional power sources.

III. PROPOSED SYSTEM

The proposed system is named as Internet of Things (IoT) based smart water tank level monitoring and motor pump control system. The components that are being used in development of the proposed system model are NodeMCU [8], Arduino UNO [2], [7], Relay module [1], [8], Water depth level sensor [2], [14], Ultrasonic sensor[8], [15], [20], which calculate the water level accurately, LCD display [20], LED indicator, submersible motor pump[2], [9], to flow the water from water storage tank to water tank and Blynk tool [19] for control, and monitoring real time data of water level from the tank.

The proposed system is named as IoT based intelligent and multi-functional shoe. The components that are being used in development of the proposed system model are NodeMCU, Ultrasonic Sensor, IR Sensor, 6DOF Accelerometer Gyroscope GY-521 (MPU-6050), to detect obstacles, count the number of steps taken by the wearer, and improve their mobility and independence, GPS Module GY-NEO-6M V2 is used to track the location in real-time of the visually impaired peoples.

A. Block Diagram of the Proposed System

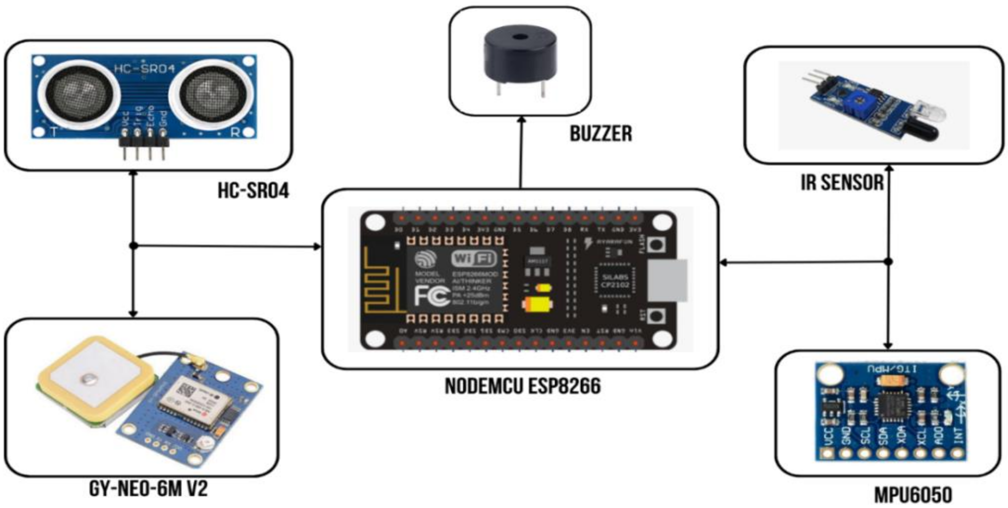

Fig.1: Block diagram of IoT based Intelligent and Multi-functional Shoe

In the block diagram shown in Fig.1, NodeMCU is connected with Ultrasonic sensor, IR Sensor, Buzzer, 6DOF Accelerometer Gyroscope GY-521 (MPU-6050) and GPS Module GY-NEO-6M V2.

The hardware components used in the development of the IoT based intelligent and multi-functional shoe as follows:

B. NodeMCU

NodeMCU: NodeMCU ESP8266 is used in this project as a microcontroller to control and process the data from the various sensors used in the smart shoe. It is an open-source firmware and development kit that allows for easy and rapid prototyping of IoT applications.

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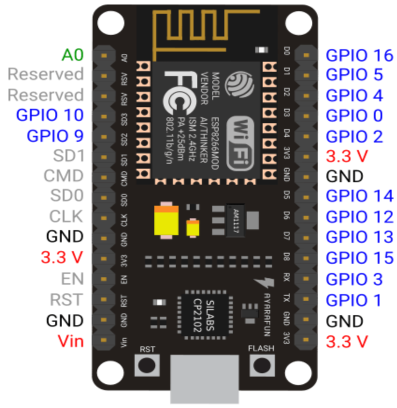

Fig.2: NodeMCU ESP8266

It has built-in Wi-Fi capabilities, which enables the shoe to transmit the location data to another device for remote monitoring. Additionally, NodeMCU is easy to program and can be programmed using the Arduino IDE, making it an ideal choice for this project.

C. Ultrasonic Sensor

Ultrasonic Sensor (HC-SR04): The Ultrasonic sensor (HC-SR04) is used in this project to detect obstacles and notify the wearer through a buzzer. It works by emitting ultrasonic waves that bounce off objects and return to the sensor. The time taken for the waves to return is used to calculate the distance between the sensor and the object. This information is then processed by the microcontroller to determine if there is an obstacle in the wearer's path.

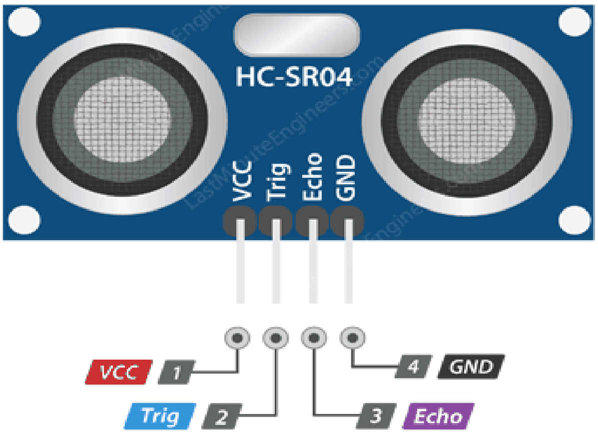

Fig.3: Ultrasonic Sensor (HC-SR04)

If an obstacle is detected, the microcontroller triggers a buzzer to alert the wearer to the obstacle's presence. The use of the Ultrasonic sensor enables the visually impaired wearer to navigate their surroundings more easily and with greater independence, reducing the risk of accidents or injuries caused by collisions with obstacles.

D. 6DOF Accelerometer Gyroscope GY-521 (MPU-6050)

The 6DOF Accelerometer Gyroscope GY-521 (MPU-6050): The 6DOF Accelerometer Gyroscope GY-521 (MPU-6050) is used in this project to count the number of steps taken by the wearer. The sensor is used to track the wearer's movements and count the number of steps taken. This information can be used to provide feedback to the wearer about their activity level and help them to stay active and healthy.

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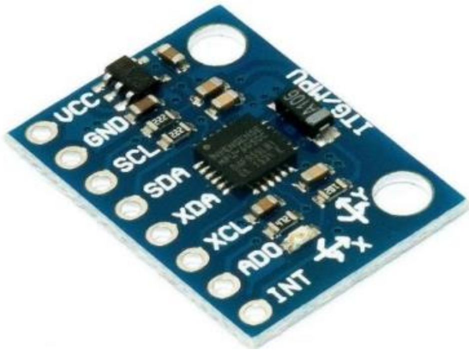

Fig.4: 6DOF Accelerometer Gyroscope GY-521 (MPU-6050)

Additionally, the step count information can be transmitted to caregivers or family members to monitor the wearer's activity remotely. This feature can be especially helpful for the visually impaired who may face additional challenges in staying active and monitoring their activity levels.

E. IR Sensor

IR Sensor: The IR sensor is used to count the number of steps taken by the wearer. This sensor is placed on the sole of the shoe and detects when the foot is lifted and put back down again. This information is then used to calculate the number of steps taken by the wearer.

Fig.5: IR Sensor

The advantage of using an IR sensor is that it is a simple and low-cost solution for step counting, and it does not require any additional hardware or complex algorithms.

Moreover, it is not affected by external factors like vibrations, which can sometimes affect the accuracy of other sensor. By using an IR sensor, the proposed smart shoe can accurately count the wearer's steps and provide real-time feedback, which can help them to navigate their surroundings more safely and confidently.

F. GPS Module GY-NEO-6M V2:

GPS Module GY-NEO-6M V2: The GPS Module GY-NEO-6M V2 was used in the smart shoe for blind people project to track the wearer's location in real time. This is particularly important for the visually impaired who may face difficulty in navigating their surroundings and may become disoriented or lost.

Fig.6: GY-NEO-6M V2

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The GPS module is able to communicate with satellites to determine the wearer's exact location and transmit this data to another device, such as a smartphone or computer, allowing caregivers or family members to monitor the wearer's location remotely. The GY-NEO-6M V2 GPS module is a cost-effective and reliable option for obtaining location data, and its compact size makes it ideal for integration into a wearable device such as a shoe. Additionally, the module has a low power consumption, which is important for devices that need to be portable and long-lasting.

G. Buzzer

Buzzer: A buzzer is an electronic component that produces sound when an electric current is passed through it. In the context of the smart shoe for blind people, a buzzer is used to notify the wearer when an obstacle is detected by the sonar sensor.

Fig.7: Buzzer

The buzzer in this project plays a crucial role in notifying the wearer of the smart shoe about obstacles in their surroundings. The sonar sensor (HC-SR04) detects obstacles and sends signals to the microcontroller, which in turn activates the buzzer to alert the wearer. This helps the visually impaired to navigate their environment more safely and confidently, as they receive immediate feedback about potential obstacles in their path.

IV. METHODOLOGY

A. Hardware Setup:

- Connect the sonar sensor (HC-SR04) to the NodeMCU board's D5 and D6 pins for Trigger and Echo respectively, and connect VCC to the Vin pin and GND to the GND pin.
- Connect the 6DOF Accelerometer Gyroscope GY-521 (MPU-6050) to the NodeMCU board's SCL and SDA pins for I2C communication, and connect VCC to the 3V pin and GND to the GND pin.
- Connect the IR sensor to the NodeMCU board's D5 pin for output, and connect VCC to the 5V pin and GND to the GND pin.
- Connect the GPS Module GY-NEO-6M V2 to the NodeMCU board's Rx and Tx pins for serial communication, and connect VCC to the 3V pin and GND to the GND pin.
- Connect the buzzer to the NodeMCU board's D0 pin for positive and GND for negative.

B. Software Setup:

- Install the Arduino IDE and the required libraries for the sensors and the GPS module.
- Write the code to read data from the sensors and the GPS module.
- Process the sensor data to calculate the number of steps taken by the wearer using both the MPU-6050 and IR sensor.
- Use the sonar sensor to detect obstacles in the wearer's path and trigger the buzzer to alert the wearer.
- Use the GPS module to track the wearer's location in real-time and transmit the data to a remote device using Wi-Fi or GSM module.

C. Testing:

- Tested the sensors individually to ensure they are functioning properly.
- Tested the system as a whole by walking around with the intelligent and multi-functional shoe and checked the accuracy of the step count and obstacle detection.
- Tested the GPS tracking and data transmission to ensure the wearer's location is being accurately transmitted to a remote device.

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Table-1 shows the component and pin connection of the proposed system which is IoT based intelligent and multi-functional shoe.

Table-1: Component and Pin Connection

SN	Component	Pin Connection
1	Ultrasonic Sensor (HC-SR04)	GND – GND ECHO – D6 Trig – D5 VCC – Vin
2	Buzzer	Positive – D0 Negative – GND
3	6DOF Accelerometer Gyroscope GY-521 (MPU-6050)	VCC – 3V GND – GND SCL – D2 SDA – D3
4	IR Sensor	VCC – 5V Output – D5 GND – GND
5	GPS Module GY-NEO-6M V2	VCC – 3V Rx – D1 Tx – D2

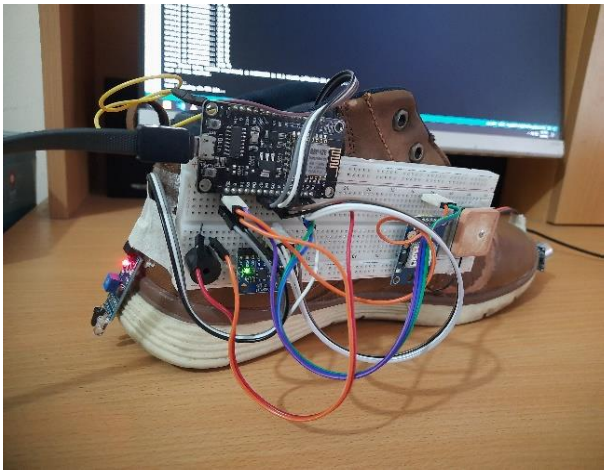

Fig.8: Full setup and pin connection of the System Prototype

The full setup and pin connection of the proposed system which is IoT based intelligent and multi-functional shoe shows in the Fig.8.

V. RESULTS AND DISCUSSION

The complete proposed system which is IoT based intelligent and multi-functional shoe showed in the Fig.9. and the result of the proposed system is showed in Fig.10.

Fig.9: IoT based Intelligent and Multi-functional Shoe

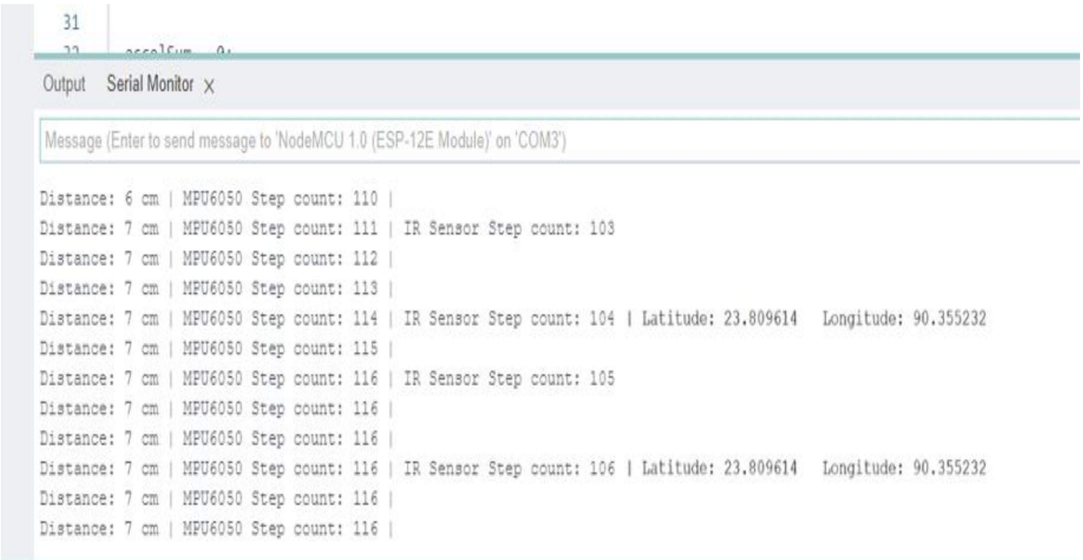

Fig.10: Result of the Proposed System

Overall, the implementation of this project involves integrating various sensors and a GPS module with a NodeMCU board and writing code to read and process the sensor data. The system is designed to assist visually impaired peoples in navigating their surroundings by detecting obstacles, tracking their location, and providing step count information. Testing and deployment are crucial steps in ensuring the system works as intended and can be used effectively by the target user group.

A. Contributions:

The main contributions of an intelligent and multi-functional shoe for the visually impaired peoples based on IoT technology:

- Improved safety: The system can help the visually impaired individuals avoid obstacles and tripping, increasing their safety when moving through their environment.
- Enhanced independence: By providing real-time guidance and assistance in navigating their environment, the system can help blind individuals move more confidently and autonomously, increasing their independence.
- Connected community: The system can be connected to a social network or support group, allowing the visually impaired individuals to connect with others and share their location and status. This can provide a sense of community and support for the wearer.
- Convenience: The system can provide real-time guidance and assistance, eliminating the need for the visually impaired individuals to rely on others to navigate unfamiliar areas.

- Innovation: The use of Internet of Things (IoT) technology in an intelligent and multi-functional shoe is a novel approach to addressing the challenges faced by the visually impaired individuals in navigating their environment.

B. Cost Analysis:

Table-2 shows the total cost of the research work. As this one is the testing prototype, the cost may vary a little bit because when we go for the massive scale production, the cost may be greater or lesser than the present one. After all, we may need to scale up this prototype. We see that the total cost involved for the prototype design is BDT4,000.00 (that is, only four thousand Bangladeshi Taka), which is equivalent to US$40 (US Dollars forty only), approximately [29].

Table-2: Cost analysis of the IoT based intelligent and multi-functional shoe

SN	Component Name	Model	Quantity	Price (BDT)
1	NodeMCU	ESP8266	1	500
2	Ultrasonic Sensor	HC-SR04	1	200
3	IR Sensor	LM393	1	100
4	6DOF Accelerometer Gyroscope (MPU-6050)	GY-521	1	400
5	GPS Module	GY-NEO-6M V2	1	1000
6	Buzzer	-	1	100
7	Breadboard	-	1	200
8	Others (Jumper wire, Cables, etc.)	-	-	1500
Total Amount (BDT)				**4000**

VI. CONCLUSION

In this project, we have proposed an IoT based intelligent and multi-functional shoe that incorporates various sensors to assist visually impaired people in navigating their surroundings. The shoe includes a sonar sensor to detect obstacles and notify the wearer through a buzzer, an accelerometer gyroscope to count the number of steps taken by the wearer, an IR sensor to detect foot movement and count the number of steps, and a GPS module to track the wearer's location in real-time. The shoes sensors work together to provide valuable information to the visually impaired peoples and their caregivers, enabling them to navigate their environment more independently and safely.

VII. FUTURE WORKS

While the proposed intelligent and multi-functional shoe shows promising results, there is still room for improvement and further development. For instance, the shoe's design can be made more comfortable and durable to withstand extended use. Additionally, more sensors can be added to the shoe to provide more comprehensive data, such as a temperature sensor to detect changes in the wearer's environment. Furthermore, the shoe's GPS module can be enhanced to provide more precise location data, which can be used to develop better navigation and mapping applications. Also can be add new available techniques to the review process, which may include edge sensitivity, Voice alerts, Object identification using artificial intelligence, computer vision, machine learning [30],[31]. Regular weather forecasts can be generated in time to alert users to rain and storms in advance. The product can be used more widely by using artificial intelligence and image processing, which can help detect obstacles more accurately. Overall, the proposed intelligent and multi-functional shoe serves as a solid foundation for future work in developing assistive technology for the visually impaired peoples.

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