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| RESEARCH ARTICLE

AI-Enhanced Multifunctional Smart Assistive Stick for Enhanced Mobility and Safety of the Visually Impaired

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| ABSTRACT

In today's era of rapid advancement in technology, innovative assistive devices are transforming accessibility for visually impaired. Through the integration of assistive health technologies, embedded systems, and software engineering, the Smart Assistive Stick enables people to navigate on their own. Fundamentally, an Arduino microcontroller interprets the reflected signals to provide real-time feedback in the form of voice instructions or buzzer alerts. The ultrasonic sensor detects obstructions in three directions (front, left, and right) within a range of 0 to 30 cm. The stick is lightweight and reasonably priced, enhanced by GPS and GSM modules for location-based services and emergency alerts, and developed with SolidWorks for maximum efficiency and ergonomics. Additionally, the study uses cutting-edge artificial intelligence for object detection in response to the growing demand for affordable assistive devices. The information is then communicated to the user in audio form after captured photos are processed to classify different items, including people, cars, and other impediments. In the end, this dual strategy bridges the gap between accessibility and technology by facilitating independent mobility in a variety of contexts, such as public areas and senior living facilities, while also lowering human effort and raising environmental awareness.

| KEYWORDS

Smart Assistive Devices, Navigation Aid, Visually Impaired Mobility, Ultrasonic Sensors, Obstacle Detection, Voice Navigation, Arduino Microcontroller, GPS and GSM Integration, CNN, Artificial Intelligence.

| ARTICLE INFORMATION

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1. Introduction

Modern life requir the freedom of roaming independently, yet those with visual impairments often face significant difficulties navigating their surroundings. An inventive multimodal sensing system that significantly improves mobility has been created to overcome these obstacles. This innovative gadget employs ultrasonic waves to identify impediments in its surroundings and gives users verbal and buzzer alerts so they may travel with confidence and safety. About 40 million individuals worldwide are estimated by the World Health Organization to be completely blind, and another 250 million are thought to have some kind of vision impairment [1]. Without external help, development becomes impossible ; it's crucial that the navigational aid appear precisely when needed. This gadget essentially works like a cane. The essay explores the many elements, resources, and difficulties that come with creating a sophisticated multimodal navigation perception system for blind users. The project's goal is to assist those who are blind or visually impaired by teaching the system to identify them and detect common things. This technology's capacity to make it easy for blind people to traverse both inside and outdoor areas is one of its main advantages. The smart cane's embedded sensors make it both useful and easy to use. Compared to earlier systems that only used vibration patterns, it offers a more user-friendly experience by recognizing impediments at a distance and providing audible notifications regarding obstructions [2]. This paper's primary goal is to help blind people who are in need. The system's ultrasonic sensor, which is attached to the user's stick, looks for any impediments in the way. The receiver's output will activate if the sensor detects an obstruction, and the microcontroller will detect this change. The stick gives the client a response through the order after identifying the item before the person does. This device will be the most effective solution for overcoming the challenges faced by those with visual impairments [3]. The objective is to develop a tool that will allow blind individuals to freely move around their environment by identifying obstacles in all directions, as well as pits and manholes in the ground. Thanks to advancements in technology, it is now feasible to create electronic aids that enable blind people to move freely. People who are visually impaired have a number of challenges in their daily lives as a result of their incapacity to see and move around. These individuals may use a trained dog to help them navigate the outdoors, but in the end, they need on assistance from others. Because of this problem, the smart stick was developed as a better substitute to assist the blind and visually impaired. This is made possible by a creative link between a vibrator, a buzzer, and an ultrasonic sensor. When the stick identifies an obstruction, it alerts the user by turning on the vibration motor and buzzer. As an alert, the buzzer and vibrator, respectively, emit sound and vibration. The system is designed and programmed using the C programming language. The suggested new technology will allow the visually impaired individual to live independently and move around freely, easily, and safely without any assistance. The technology has proven to be both economical and effective after passing a number of demanding testing [4].

2. Earlier Research

The ability to see is one of a person's most valuable assets. However, the fact that a large number of people worldwide have lost their sight and are now considered blind is an awful reality. It is quite difficult to have no purpose in life, and they will need many types of assistance all of their lives. According to a WHO report, 2.2 million people are blind out of the world's 7.6 billion inhabitants [5]. As a result, people are searching for various smart technologies that might enable blind people to live comfortable daily lives in today's technologically advanced society. The smart stick we have discussed in this paper is easy for blind people to use and fairly priced. It can provide protection. As a result, people are searching for various smart technologies that might enable blind people to live comfortable daily lives in today's technologically advanced society. The smart stick discussed in this study is reasonably priced and easy for those with vision impairments to use. It can protect people from dangers, increasing their mobility and allowing them to move freely and precisely.

This initiative has the potential to improve the quality of life for blind individuals in a number of ways. A wearable gadget using an Arduino Uno that can serve as an obstacle detector and a third eye for blind individuals,combining ultrasonic vibrating gloves with image processing, is one example of a concept and project created by a number of researchers [6].

The outwardly disabled stick, a novel stick designed for those who are clearly challenged, will be used in upcoming lessons. It is proposed that purportedly motivated folks can successfully experiment with pattern-establishing advances using a useful externally blocked stick. An ultrasonic sensor that can distinguish between light and water is attached to the externally fragile stick. Our intended trip's ultrasonic sensors use ultrasonic waves to detect catches up ahead. The sensor sends data to the microcontroller when it detects obstacles. Customers will adore this clever gadget. Furthermore, this smart stick may find use in hospitals, industrial firms, governmental organizations, a number of NGOs and some export/import businesses that work to better the lives of the blind [7].

People with visual impairments always have trouble spotting obstacles when they are moving. Blind people rely heavily on white canes, often referred to as advanced multimodal navigation blind sticks or human or trained dog guidance, while making decisions. White canes are often used by the blind because they are affordable. Conversely, conventional white canes cannot accurately detect obstacles higher than knee height or farther away than the white cane's length. Our goal is to create an intelligent, accessible blind stick that will help the blind navigate [8].

In 2024 E. Uma Rani presented a simple navigation tool that added a single ultrasonic sensor to a typical walking stick to use echolocation to find adjacent objects. Despite issues including a small detection range and background noise, this prototype successfully warned users of impediments using tactile feedback via vibration motors in controlled interior environments. The groundwork for further developments, including the dual-feedback Smart Blind Stick introduced , which provided crucial insights into sensor calibration and feedback optimization [9].

N Illakiya's 2024, study, most of the research on assistive navigation devices for the blind and visually impaired had concentrated on creating simple prototypes that employed microcontroller platforms and ultrasonic sensors to detect obstacles and provide haptic feedback. These early systems mostly used ultrasonic sensors to measure distances and notify users via basic vibration or audio signals, despite being affordable and working in controlled environments. These early devices showed promise for improving mobility, but were constrained by their limited detection range, absence of built-in emergency communication capabilities, and decreased dependability in challenging real-world situations. The difficulties found in these early devices highlighted the need for more durable, multimodal solutions, opening the door for later developments that finally resulted in N. Illakiya's sophisticated Smart Blind Stick [10].

The primary goal of Shimaa Mahdy's research on assistive navigation for the blind and visually handicapped was to create modest prototypes that used microcontroller platforms in conjunction with basic ultrasonic sensor arrays to identify adjacent impediments. Usually offering tactile or auditory feedback, these early devices were successful in controlled settings but had limited environmental adaptability and detection ranges. Furthermore, they lacked sophisticated features that are necessary for managing dynamic, real-world situations, like mobile connectivity and integrated emergency communication [11].

3. Methedology

The Arduino Mega microcontroller, which efficiently controls the hardware and software components of the Multifunctional Smart Assistive Stick for Enhanced Mobility and Safety of the Visually Impaired, is clearly the main processing unit of the device, as shown in Figure 1. Five ultrasonic sensors for obstacle detection, GPS for monitoring location in real time, GSM for communication, a water sensor for detecting water on the ground, and a push button for user contact are among the essential modules that are linked to the Arduino Mega. When impediments are detected within a 0–30 cm range, the microprocessor receives distance data from the ultrasonic sensors, interprets it, and activates feedback devices like buzzer warnings or voice alerts.

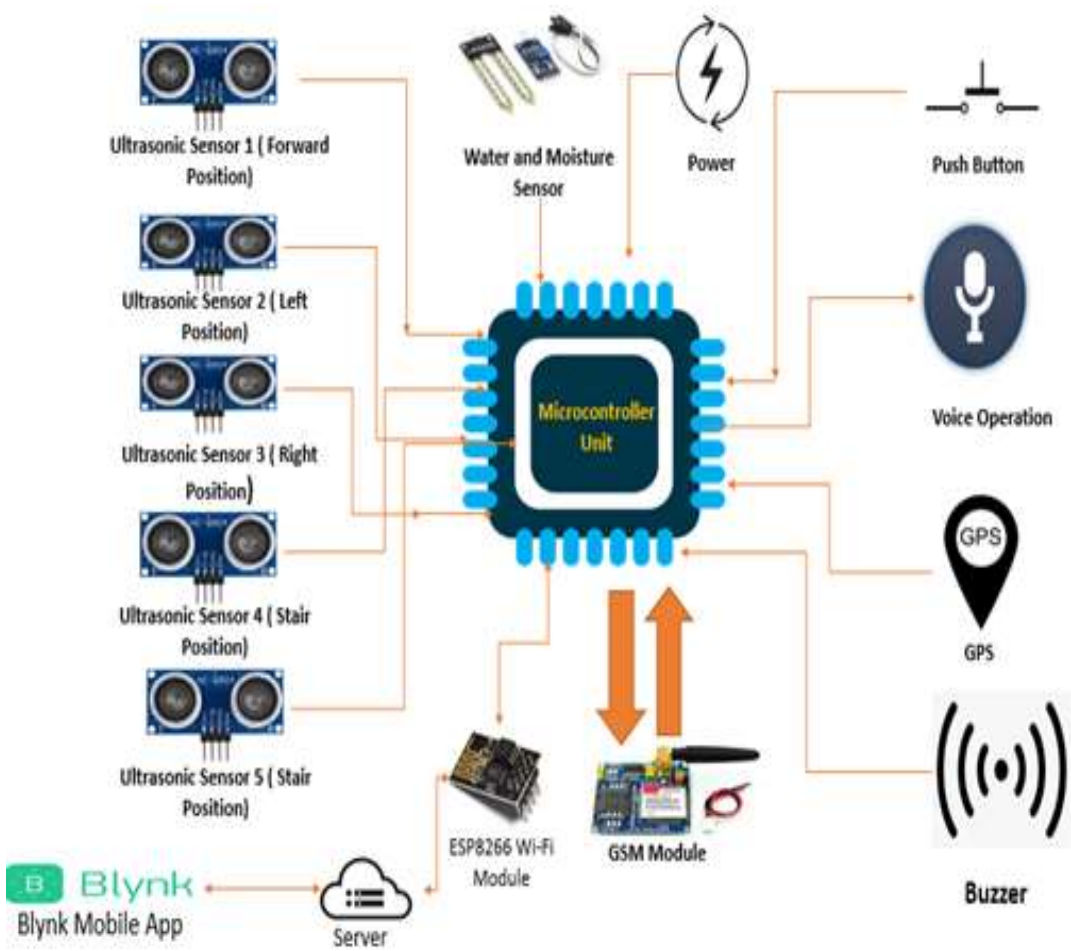

Fig 1. Block Diagram of Multifunctional Smart Assistive Stick for Enhanced Mobility and Safety of the Visually Impaired

While the GSM module enables emergency communication by transmitting location data when the user hits a push button, the GPS module enables the device to track the user's location. By detecting water, the water sensor assists the user in recognizing and avoiding slick surfaces. The system offers complete navigation help through this integration, guaranteeing that visually impaired users may move around their surroundings safely and confidently. It also provides emergency assistance and flexibility in response to different risks.

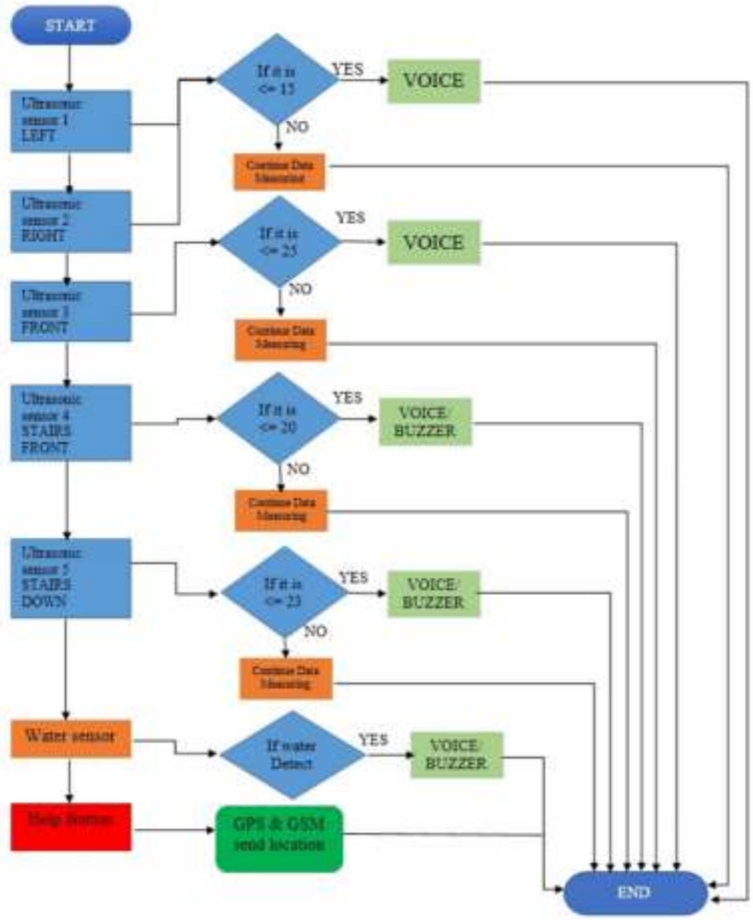

Fig 2. Flow Chart of Multifunctional Smart Assistive Stick for Enhanced Mobility and Safety of the Visually Impaired

The Multifunctional Smart Assistive Stick for Enhanced Mobility and Safety of the Visually Impaired's basic operation is depicted in Figure 2. A push button, a GPS module, a GSM module, five ultrasonic sensors, a water sensor, and other input devices are all integrated into the system to deliver location-based services and real-time feedback. In order to identify impediments in front, left, and right of the user, the ultrasonic sensors are positioned strategically to measure distances between 0 and 30 cm. The device makes sure the user is aware of possible dangers as soon as an obstruction is recognized by sounding an alarm through the buzzer and voice navigation system. By detecting the presence of water on the ground, the water sensor improves safety by allowing the user to steer clear of slick or wet terrain.

The GPS module provides real-time positioning data by continuously tracking the user's location. For those who are blind or visually impaired, this feature is essential because it provides spatial awareness and facilitates navigating new surroundings. When the user presses the push button, the GSM module and GPS combine to broadcast position information to family members or caretakers, enabling the user to ask for help if necessary. In an emergency or when assistance is needed, the push button acts as a straightforward interface for the user to indicate their location. The buzzer and voice guidance system are examples of output devices that are essential for alerting the user to their surroundings. With the use of voice navigation, the user can receive location-based updates or be guided around difficulties. When barriers or changes in the user's environment are recognized, the buzzer simultaneously sounds an alert.

Through the integration of these input and output devices, the smart stick is made to be responsive and intuitive, providing a smooth user experience that improves the mobility, independence, and safety of those with visual impairments. Users may navigate with confidence and get help in an emergency because of the system's clearly understood functionality, which includes essential feedback via tactile and aural cues.

The Multifunctional Smart Assistive Stick's hardware and software components are effectively managed by the Arduino Mega microcontroller, which improves the visually impaired's mobility and safety. To improve obstacle detection and object recognition, an AI-powered image processing sensor has been added to the current modules. Real-time object identification and more thorough user feedback are both possible with the AI sensor.

In figure 3 additionally researchers have added Rasbeery Pi (for AI processing), a camera module (for image capture) ,HC-SR04 (for distance measurement),Power supply as an inputs and for ouput Earphones (for voice feedback).

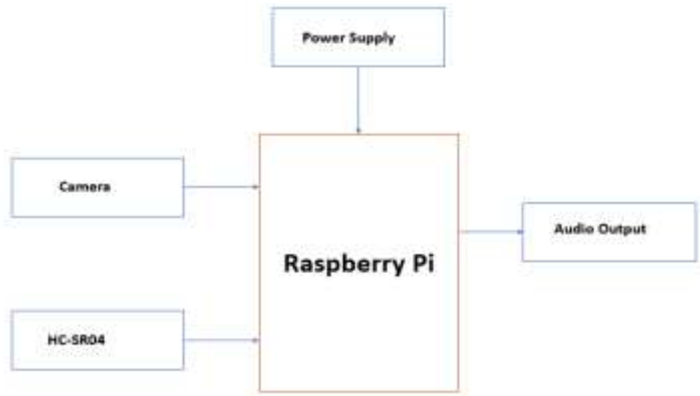

Fig 3. Architecture of Image Processing Algorithm

Research in the field of artificial intelligence (AI) aims to build automated systems that can replicate human perception and decision-making. Convolutional neural networks (CNNs), deep learning, machine learning (ML), and the internet of things (IoT) are some of the important AI technologies that are integrated into the suggested system. The smart stick can identify things, identify dangers, and give the user audible feedback technologies.

The (YOLO) object detection technique, which is based on a Convolutional Neural Network (CNN), is used in the suggested system. Real-time item detection, classification, and location estimation inside an image are all possible with YOLO.

4. Design and Modeling

The Multifunctional Smart Assistive Stick for Enhanced Mobility and Safety of the Visually Impaired is designed specifically for blind individuals and is composed of two key part :

- Mechanical part.
- Electronic part.

4.1. 3-D Model of the Final Blind Stick

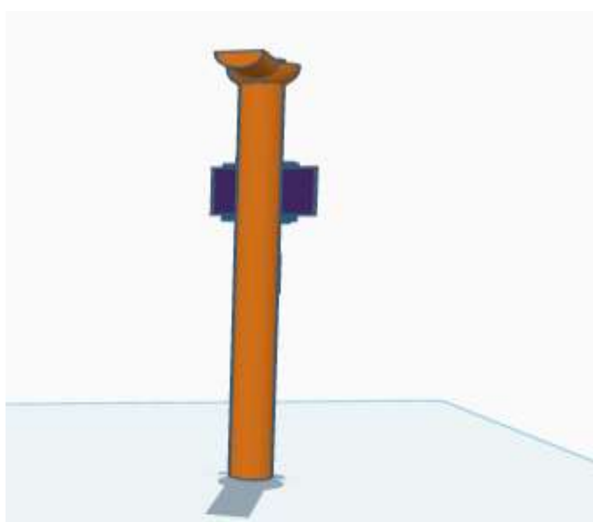

Fig 4. Main stick

The suggested Multifunctional Smart Assistive Stick is practical and affordable due to its simple design and use of widely accessible materials. Standard sticks are used to construct the stick's mechanical construction, and rubber rings are positioned thoughtfully to reduce friction and safeguard the pipes. A safety push button, a crucial component that improves user protection, is located at the top of the stick. By integrating this push button with both GPS and GSM modules, users may simply press it to communicate their whereabouts to those in their immediate vicinity. In an emergency, this feature is quite helpful as it makes it simpler to find the user or notify others if they want aid.

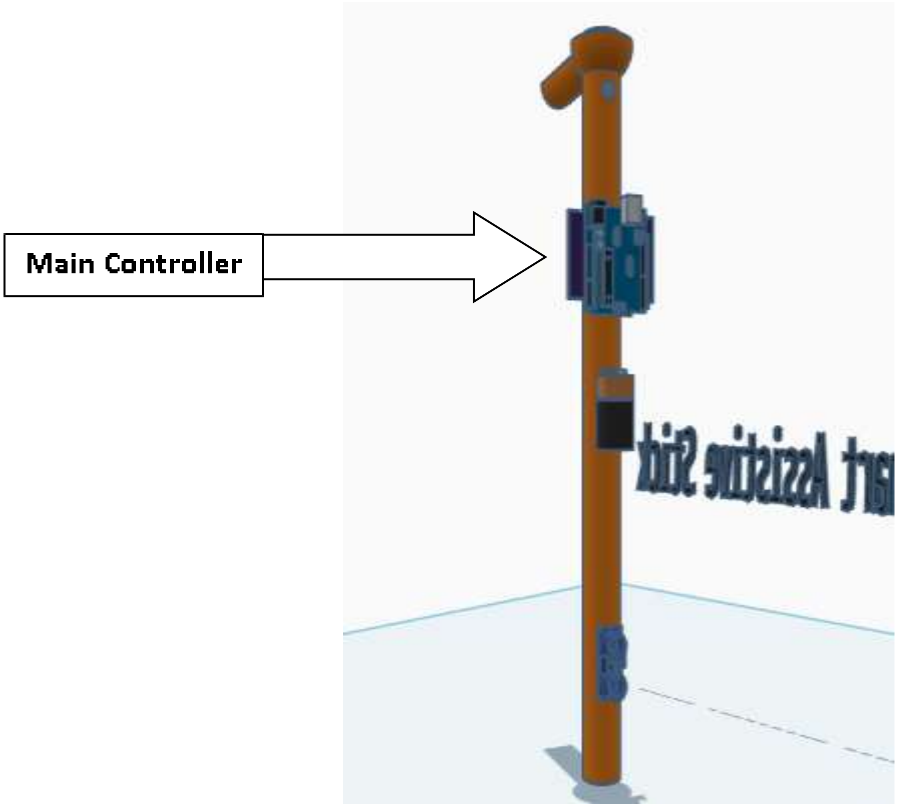

Fig 5. Main Controller box

This is the blind stick model's electronic component. There is a box in the middle of the stick. This equipment is known as the controller box. This is the location of the entire project. In addition to the terms GPS, GSM, and Buzzer, this box has an Arduino Mega. A sound box on top of the box hears any obstruction and stops any major mishaps, while ultrasonic sensors on the front right and left of the box detect any obstacles.

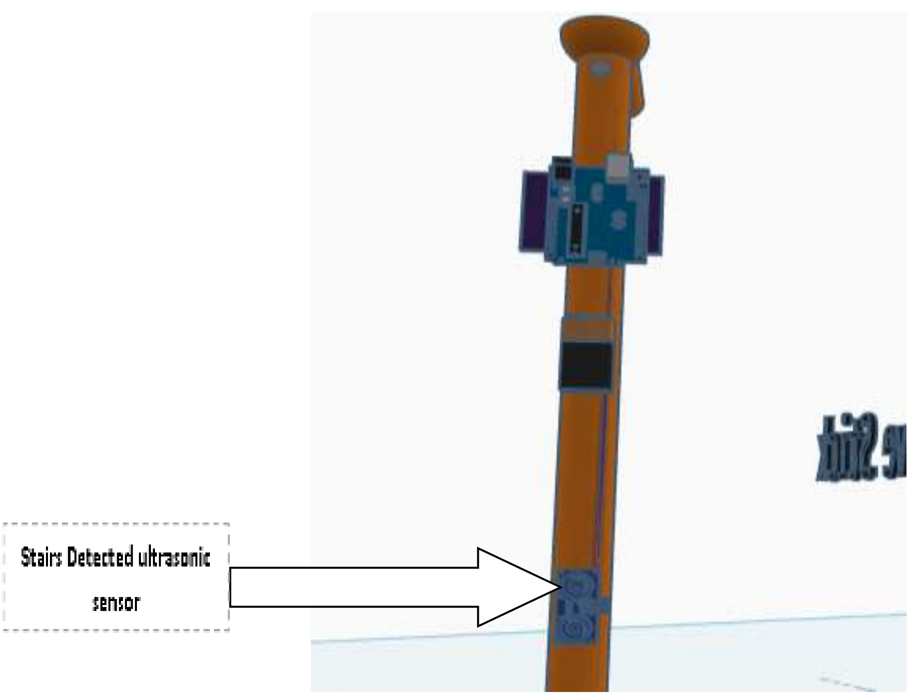

Fig 6. Stairs Detected ultrasonic sensor

This box is fastened to the stick. Two ultrasonic sensors are used in this box. A person may understand the difficulties and distances needed to ascend the steps, as well as whether there are any obstacles at the bottom of the road, thanks to these two sensors—one at the front and one at the bottom.

Fig 7. 3-D Model of the Final Blind Stick

The finished 3-D model of the smart blind stick is displayed here in figure 7. where the others are the electric components and the rod is the mechanical component. The controller box is the one utilized in the center. Here, a sound box is positioned alongside three ultrasonic sensors. A water sensor is employed at the very bottom, and two ultrasonic sensors are used in a box just below. The entire upper portion of the stick has been equipped with a push button.

5. Implemented Models

This project is implemented in two steps: simulation and hardware. The output representations of the hardware model and the simulation model are different. Variations in the test pin's value, which represent shifts in the system's behavior, serve as the simulation's output. The hardware model, on the other hand, demonstrates the output by identifying and reacting to environmental barriers. The stick responds when an obstruction is positioned in front of it.

5.1. Implemented Simulation Model

The simulation model for this project, which uses an Arduino Mega 2560 as the main CPU, is shown in Figure 8. Five ultrasonic sensors (HC-SR04), a soil moisture sensor, a GPS module, a GSM Sim900D module, a push button with SPST functionality, a buzzer that runs on DC power, an animated capacitor, a generic inductor, a 16x2 alphanumeric LCD, a DC motor, and six high granularity interactive potentiometers (POT-HG) are among the essential parts of this model. These parts serve as the simulation's input devices, with sensors gathering and transmitting environmental data to the Arduino. By processing the inputs and producing output via the LCD display and vibration buzzer, the system notifies the user and shows pertinents data. The Arduino controls every step of the procedure, taking in data from the sensors and sending it to the output devices for immediate response.

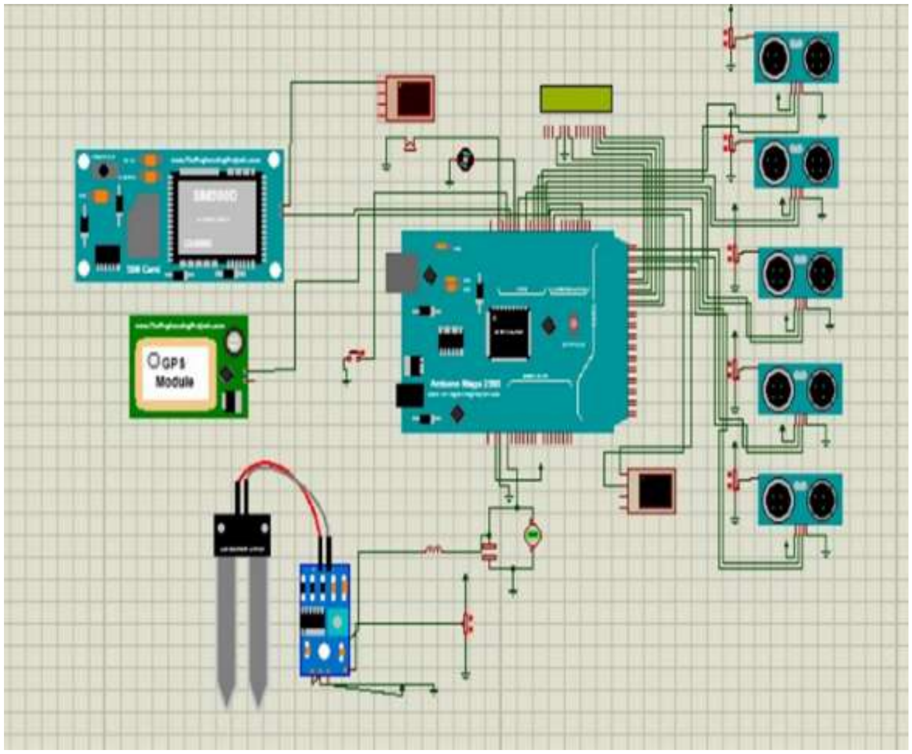

Fig 8. Simulation of the proposed model

5.2. Implemented Hardware Model

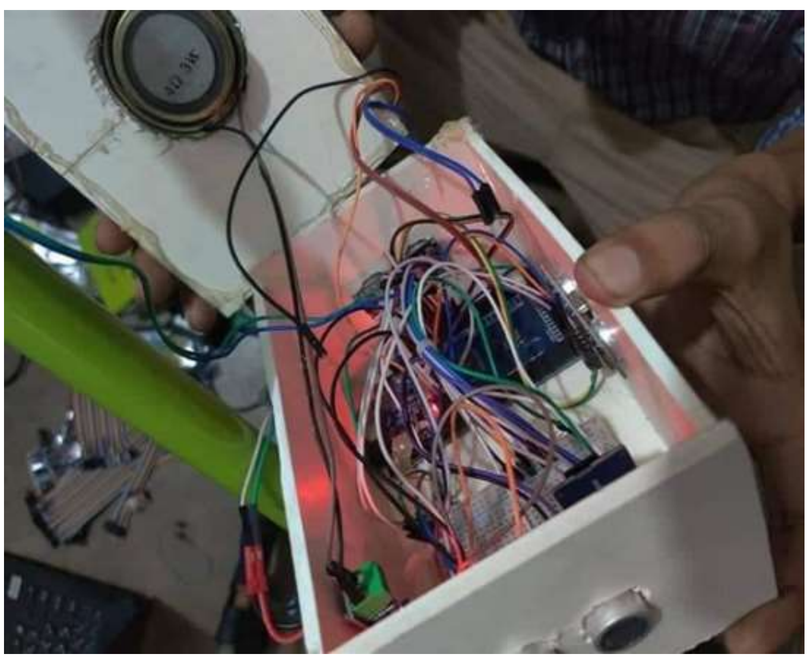

Fig 9. Interior part of Main Controller Box

The microcontroller box, which is composed of a PVC board and is positioned in the middle of the stick, is seen in Figure 9. The Arduino Mega 2560, a breadboard, and three ultrasonic sensors positioned in the left, right, and front corners are among its essential parts. All of the project's components are connected and managed from this box, which acts as its central hub.

Fig 10. Fixing the Sensor with the Box

As shown in Figure 10, the three ultrasonic detectors are positioned on the three sides of the project's exterior component. When obstructions are detected, an audio speaker mounted at the top of the box will sound a buzzer and provide verbal alerts. Furthermore, position tracking is made possible by the GPS and GSM modules, which makes it simple to locate a blind person using Google Maps in the event that they get separated from a partner.

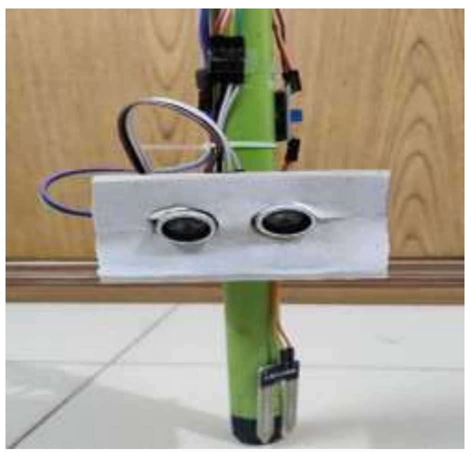

Fig 11. Stairs Detected Sensor

Figure 11 demonstrates two ultrasonic sensors positioned at the bottom of the rod, assisting a blind person detect and measure distance while climbing stairs. By detecting road obstructions like stones and bricks, these sensors help lower the chance of collisions.

Fig 12. Fixing the Push Button and Water Moisture Sensor

The water-detecting sensor and push button, each with a distinct purpose, are shown in Figure 12. In the event of an accident or confusion, the blind person can use the push button at the top of the stick to broadcast their location via GPS to the closest person. The water sensor, which is mounted beneath the stick, sounds a buzzer to warn the user when it detects water or dirt on the path.

Fig 13. Overall External view

Figure 13 demonstrates the full hardware configuration of the project. With three ultrasonic sensors on either side, a sound speaker, GPS, and GSM modules on top, the control box is positioned in the middle of the stick. It also has a push-button at the top to send an SMS signal in the event of an emergency, two sensors at the bottom, and a water sensor.

6. Simulation Result Analysis

After circuit implementation, a critical stage in any project is result analysis. This step enumerates anticipated results according to simulation and hardware performance. Accurate results are guaranteed by a circuit that is wired correctly. Research suggests several methods for creating an ultrasonic smart stick for those with visual impairments. This gadget serves as an assistive tool to help with everyday tasks and offers a practical and affordable option. The smart stick's five ultrasonic sensors improve mobility and safety by detecting obstacles from different directions. This technology is accessible to people from a wide range of socioeconomic backgrounds because to its affordability. The project's long-term advantages for visually impaired users have been highlighted by the determination of its viability. In order to assess system performance, data from a test pin that alters sensor values is analyzed and presented in this part together with important circuit modeling results.

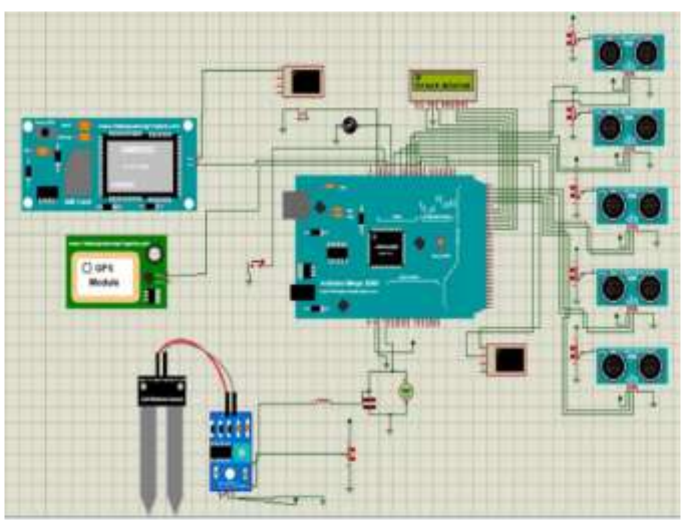

Fig 14. Simulation of the front sensor has detected the result

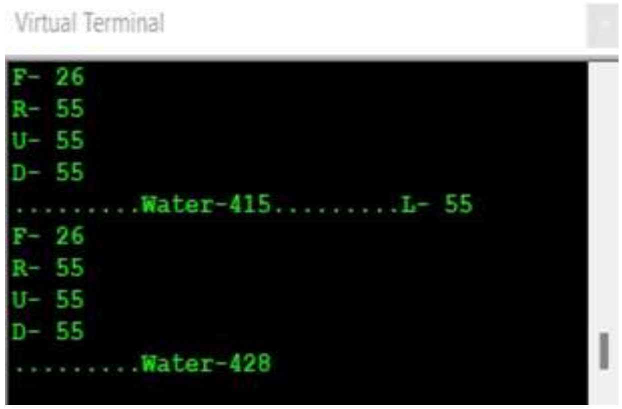

Fig 15. Simulation output of the Front sensor

This simulation model recognizes obstacles in front of it when the front sensor readings are less than 30 cm. The forward detection is then shown via the simulation. In this simulation model, the front (F) value is 26 cm. As a result, the sensor detected obstacles in front of it. It won't be able to find the obstacles if the value is more than 30 cm.

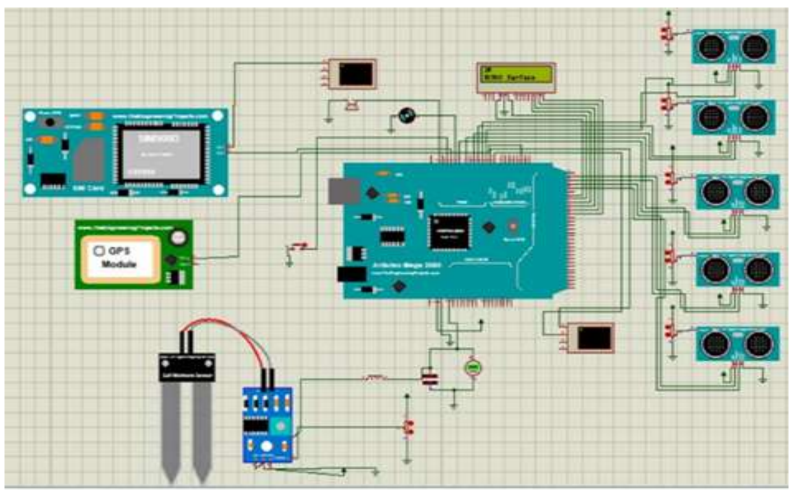

Fig 16. Simulation of the right sensor has detected the result

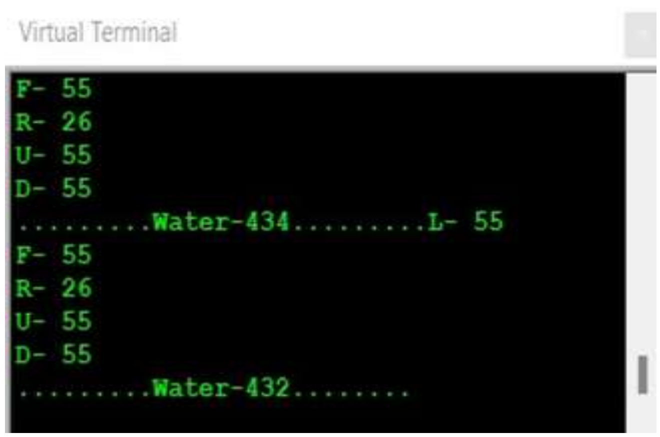

Fig 17. Simulation output showing right sensor

The result is shown in Figure 17 The proper (R) value is 26 cm. A sensor is considered functioning when its right value is less than 30 cm. If the obstacle is more than 30 cm, the appropriate sensor value cannot detect it. Consequently, the simulation's output shows the proper surface.

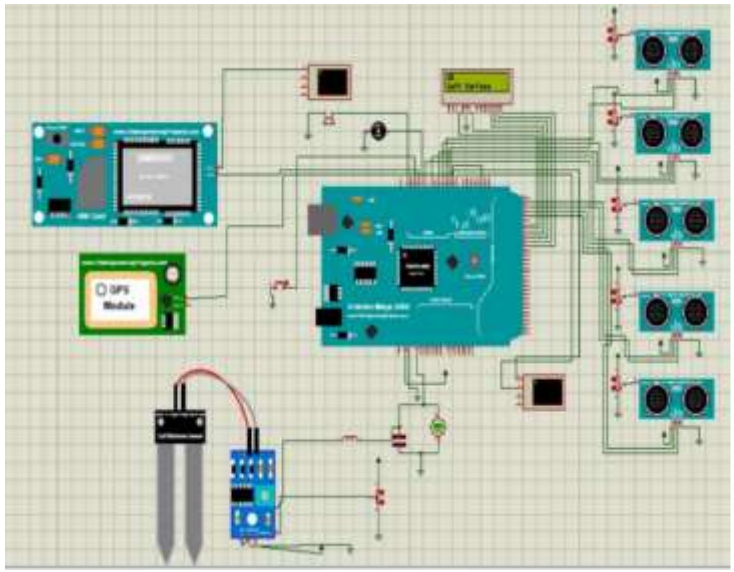

Fig 18. Simulation of the left sensor has detected the result

Fig 19. Simulation output showing left sensor

As illustrated in Figure 19, the sensor will identify obstacles on the left when its left value is less than 30 cm. The output shows the left surface since the left (L) variable in this simulation is 26 cm.

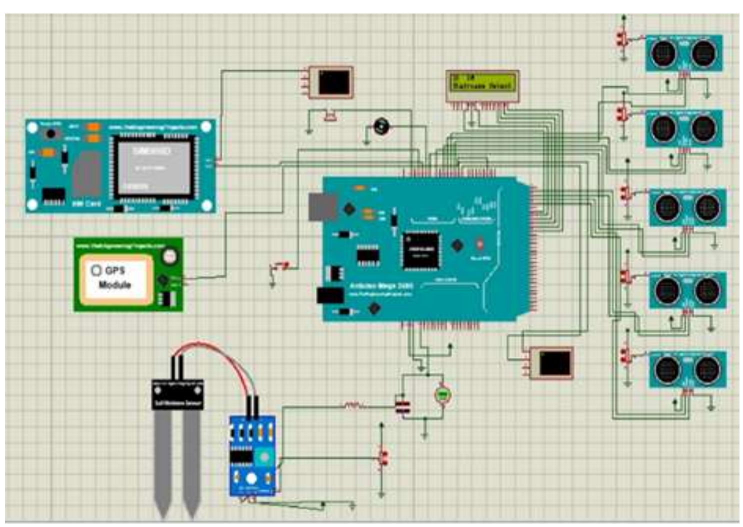

Fig 20. Simulation of the stair sensor has detected the result

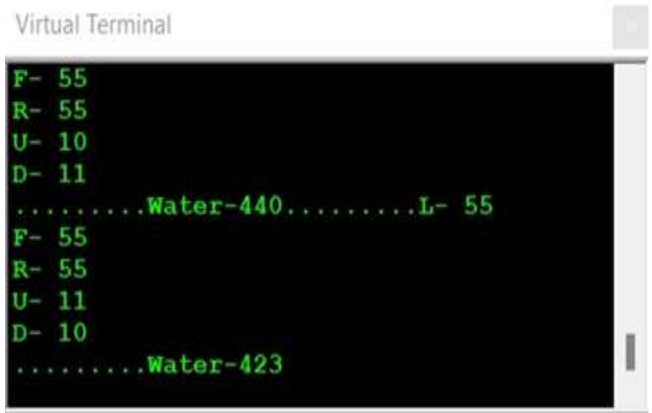

Fig 21. The sensor detects the stair, showing in this simulation output

The stair will be recognized when the Up Sensor and Down Sensor values are less than 15 cm and 20 cm, respectively. The results of the simulation show that the up and down sensors have respective values of 11 and 10 cm. so that the display can show "stair detected."

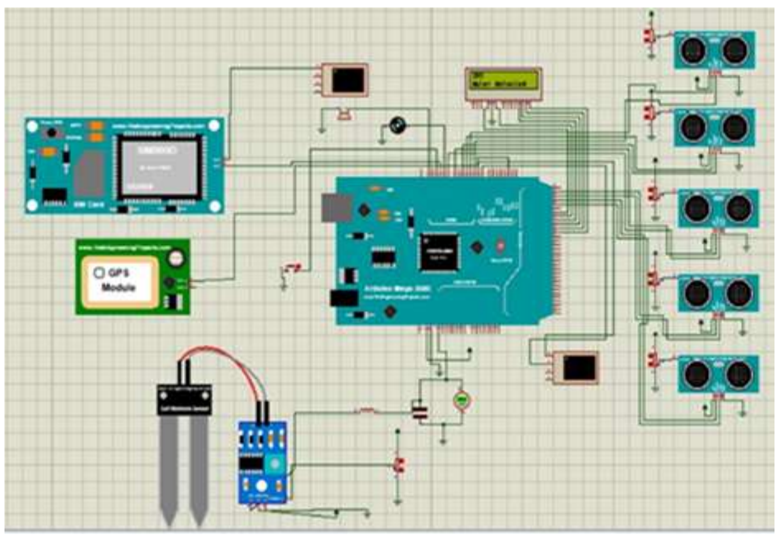

Fig 22. Simulation shows soil sensor detects water

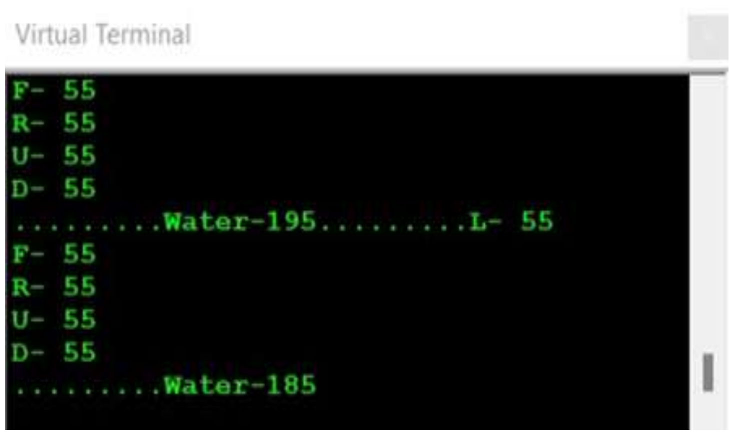

Fig 23. Detected water in simulation results

The soil and water sensors work when the water value is below 200. The output result indicates that the water value is 185. The display thus reads "water detected." If the value exceeds 200, no output will be produced.

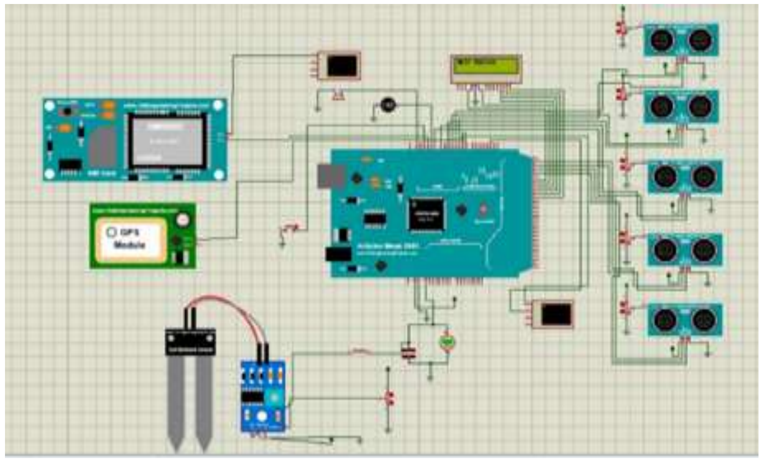

Fig 24. Simulation results when the emergency button is pressed

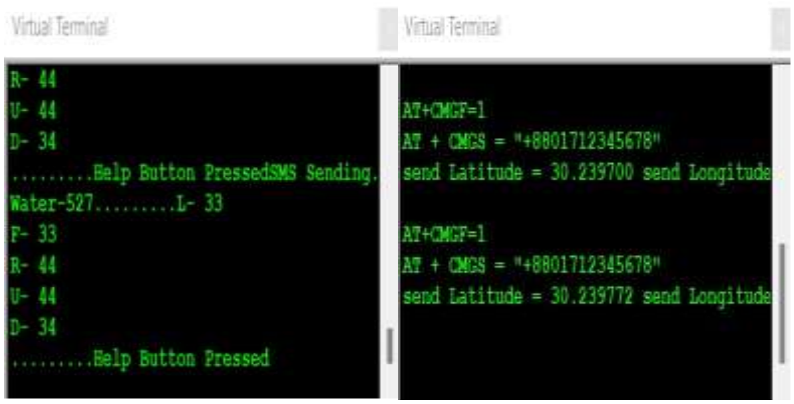

Fig 25. Simulation result of sending massage

In figure 25, the GPS and GSM findings were shown. The result showed that a GSM location message is sent to the specified number when the help button is pressed. Simulation was used to finish this project first, and then hardware was used to implement it. To find the right outcomes, two methods have been applied. The blind man can clearly see the front, stairs, water, right, and left thanks to this stick. These results are true in the simulation. Simulation was handled via Proteus 8.10. The simulation's step-by-step findings are shown above.

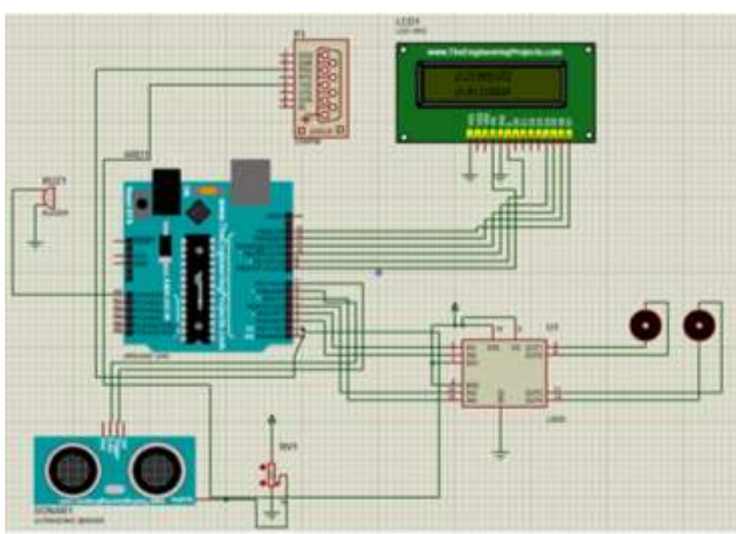

Fig 26. Simulation Shows live Location tracking

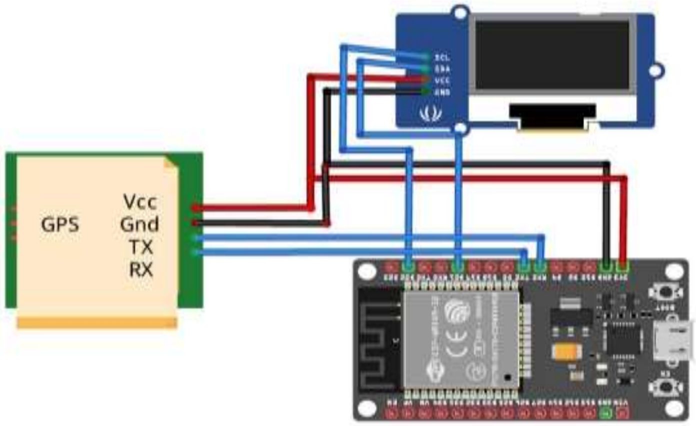

Fig 27. Simulation of Sudden Fall detection

7. Hardware Result Analysis

This project's hardware implementation has undergone successful validation. When objects are placed in front of the stick's ultrasonic sensors, obstacles are detected, and the user is guided by a buzzer and verbal alerts. In addition to providing directional input, the system can detect stairs, water, and obstructions on the left, right, and front. Furthermore, user safety is improved by the integrated GPS and GSM devices. If the user becomes disoriented, they can press a push button that will cause the system to communicate their location to contacts they have stored via GSM. Google Maps provides the recipient with the current position, guaranteeing prompt assistance. The hardware output is shown in detail in the next section.

```
70 -L: 350 -F: 1188 -R: 271 -U: 186 -D: Water: 1
Button= 0
70 -L: 345 -F: 1188 -R: 272 -U: 186 -D: Water: 1
Button= 0
62 -L: 346 -F: 1188 -R: 272 -U: 187 -D: Water: 1
Button= 0
73 -L: 344 -F: 1188 -R: 54 -U: 185 -D: Water: 1
Button= 0
73 -L: 351 -F: 1188 -R: 55 -U: 185 -D: Water: 1
Button= 0
72 -L: 344 -F: 1188 -R: 54 -U: 185 -D: Water: 1
Button= 0
470 -L: 346 -F: 1188 -R: 55 -U: 186 -D: Water: 1
Button= 0
1189 -L: 352 -F: 88 -R: 1185 -U: 185 -D: Water: 1
Button= 0
268 -L: 223 -F: 83 -R: 312 -U: 45 -D: Water: 1
Button= 0
264 -L: 223 -F: 84 -R: 313 -U: 157 -D: Water: 1
Button= 0
267 -L: 222 -F: 82 -R: 314 -U: 186 -D: Water: 1
Button= 0
268 -L: 222 -F: 84 -R: 313 -U: 184 -D: Water: 1
```

Fig 28. No obstacle near the blind man stick

The system's reaction when the smart stick is plugged into a computer without any obstructions is shown in Figure 28. Since no output is produced in this condition, the path is unhindered. The left and right sensors detect obstructions within 15 cm, while the front sensor detects things within 25 cm. Furthermore, the water detecting system distinguishes between different terrain situations by showing a value of 0 when water or mud is detected and 1 for dry areas.

```
Button= 0
30 -L: 25 -F: 224 -R: 65 -U: 1184 -D: Water: 1
Button= 0
1188 -L: 280 -F: 224 -R: 65 -U: 166 -D: Water: 1
Button= 0
1188 -L: 34 -F: 224 -R: 67 -U: 167 -D: Water: 1
Button= 0
1188 -L: 15 -F: 223 -R: 1184 -U: 1184 -D: FrontWater: 1
Button= 0
549 -L: 112 -F: 91 -R: 44 -U: 546 -D: Water: 1
Button= 0
558 -L: 116 -F: 114 -R: 46 -U: 555 -D: Water: 1
Button= 0
1188 -L: 279 -F: 223 -R: 87 -U: 1184 -D: Water: 1
Button= 0
```

Fig 29. Sensor detects the Front side obstacles

The physical outcomes of using an Arduino cable to connect the smart stick to a computer and running the associated code are shown in Figure 29. When an object comes within range, the front sensor, which can detect barriers within 25 cm, initiates a response. In this case, the sensor verified its operation by detecting an obstruction at a distance of 15 cm.

```
Button= 0
33 -L: 1186 -F: 239 -R: 1184 -U: 174 -D: Water: 1
Button= 0
1188 -L: 1186 -F: 238 -R: 1184 -U: 176 -D: Water: 1
Button= 0
45 -L: 362 -F: 10 -R: 1184 -U: 144 -D: RightWater: 1
Button= 0
26 -L: 155 -F: 99 -R: 544 -U: 85 -D: Water: 1
Button= 0
43 -L: 361 -F: 1188 -R: 206 -U: 175 -D: Water: 1
Button= 0
1188 -L: 362 -F: 1187 -R: 206 -U: 175 -D: Water: 1
```

Fig 30. Sensor detects the Right side obstacles

The value of R in figure 30 is 10 cm. The Right sensor calls R. The sensor detects obstructions when the space between them is smaller than 15 cm. The sensor in this figure detects obstructions that are 10 cm away. Voice guidance and a buzzer have so alerted it that it is unable to follow the correct route.

```
Button= 0
1188 -L: 280 -F: 227 -R: 2 -U: 171 -D: Water: 1
Button= 0
16 -L: 281 -F: 229 -R: 3 -U: 172 -D: Water: 1
Button= 0
13 -L: 280 -F: 228 -R: 3 -U: 171 -D: LeftWater: 1
Button= 0
549 -L: 112 -F: 94 -R: 1 -U: 87 -D: Water: 1
Button= 0
1188 -L: 282 -F: 227 -R: 3 -U: 171 -D: Water: 1
Button= 0
1188 -L: 282 -F: 228 -R: 3 -U: 133 -D: Water: 1
```

Figure 31. Sensor detects the Left side obstacles

The smart stick can identify a left-side obstruction within a 15-cm range, as shown in Figure 31. Through the code that is run, the system, which is connected to a computer through an Arduino interface, processes sensor data. The sensor confirms the existence of an impediment by recording a matching value upon detection.

```
Button= 0
92 -L: 212 -F: 101 -R: 226 -U: 19 -D: Water: 1
Button= 0
71 -L: 212 -F: 101 -R: 225 -U: 18 -D: Water: 1
Button= 0
91 -L: 212 -F: 101 -R: 3 -U: 11 -D: StairCaseWater: 1
Button= 0
49 -L: 112 -F: 27 -R: 84 -U: 7 -D: Water: 1
Button= 0
166 -L: 214 -F: 101 -R: 224 -U: 20 -D: Water: 1
Button= 0
168 -L: 212 -F: 101 -R: 224 -U: 19 -D: Water: 1
```

Figure 32. Sensor detects the stairs

The smart stick using sensor thresholds to identify a staircase is shown in Figure 32. When both the up and down sensors simultaneously register less than 20 and 23 cm, stairs are identified. In this instance, staircase detection was confirmed by the up sensor's 3 cm and down sensor's 11 cm detection.

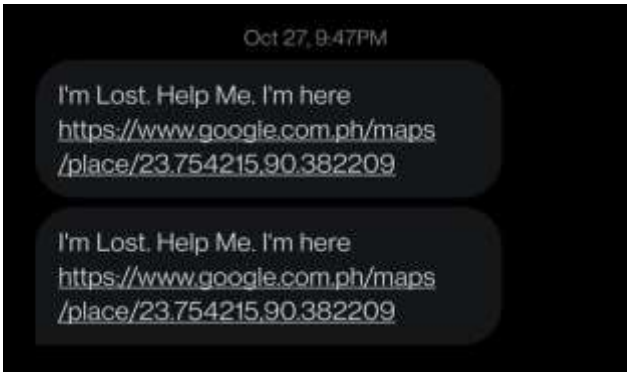

Figure 33. Result shows an emergency message, it sent to the blind person relatives

The GSM hardware findings, showing its emergency alert function, are shown in Figure 33. The technology notifies a specified contact of the user's location when they press the push button.

Figure 34. Live Location tracking Using Blynk App

The Blynk app's map allows the visually impaired to know where the user is at any given time. It tracks the whereabouts of the visually challenged person in real time.

Figure 35. Sudden Fall detection Using Blynk App

As illustrated in Figure 35, the Blynk app will be notified as soon as the Sudden Fall detection feature determines if the user has fallen.

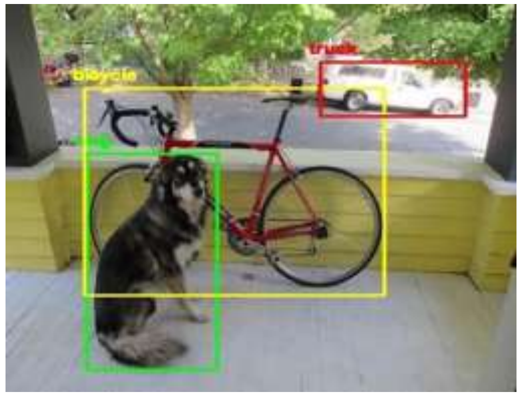

Fig 36. Output with Yolo object detector

The classifier produced the following results. Here, the standard procedure is to take a picture with the camera on the stick and store it in digital format as pixels. After the YOLO algorithm has read the image data as input, as shown in figure 36, various classes of objects—such as a dog, bicycle, and car—in a single image are classified by the CNN present as part of YOLO. These classes of objects are then stored in the internal memory of the RaspberryPi in text format, which is the YOLO's output.

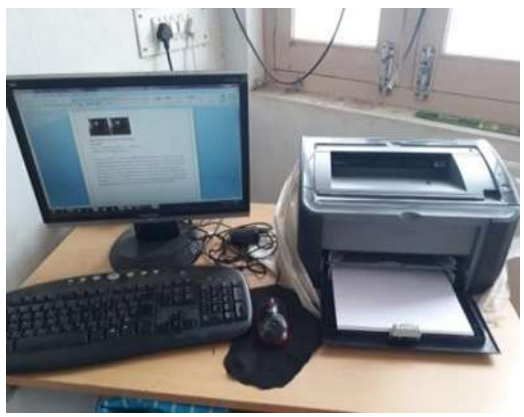

Fig 37. Input to the Camera

The image is categorized by the YOLO algorithm using its learned examples on the Raspberry Pi, and the distance between the object and the blind person is also shown on the screen. Smart Bind Stick with Artificial Intelligence in Real Time. This type of outcome is primarily utilized in the development stage for stick testing and training with an increasing number of objects to improve stick performance.

Fig 38. Output of Object detector

The camera takes pictures of the environment while a visually challenged person moves down a walkway and sends them to the Raspberry Pi. After being trained on a variety of object classes, such as people, cars, bicycles, and water, the YOLO algorithm analyzes these photos and produces text labels that match to them. After then, this text is turned into speech and played through headphones. At the same time, the HC-SR04 ultrasonic sensor determines the distance to every object it detects, giving accurate audio input on the kind and vicinity of obstacles to help with well-informed navigation choices.

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