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Design and Implementation of Smart Blind Stick for Obstacle Detection and Navigation System

Abstract: - The design, advancement, and evaluation of an IoT -enabled smart stick that can detect and alert users to obstacles is presented in this study to help visually impaired persons traverse the outside world. A water sensor deployed to identify puddles and other wet surfaces in the user's route, and ultrasonic sensors for detecting obstacles are all used in the suggested design. Additionally, after correctly detecting and recognising items, the user receives voice feedback through earphones regarding various obstacles and objects. The suggested smart stick has two modes: the first detects and recognises obstacles and provides speech feedback; the second mode employs ultrasonic sensors for detecting and response through vibration motors to inform about the direction of the obstacle. The suggested method enables users to alternate between the two modes based on their preferences and the surroundings. Additionally, the user's latitude and longitude values are recorded and uploaded to the IoT platform for efficient tracking through global system for wireless communication modules, allowing the user or device to be tracked in real time on the dashboard. An IoT-enabled environment generates an alert signal in the form of an SMS with Google Maps link generated using latitude and longitude coordinates, and this serves as a panic button for emergency assistance. The smart stick's design includes features such a long battery life, size adjustment, waterproofing, and light weight. Robust features, portability, stability, ease of access, and energy efficiency are all guaranteed by the entire design.

Keywords: Smart stick; Biomedical device; Internet of Things; Obstacle detection; Navigation.

I. INTRODUCTION

Numerous people all over the world have visual impairments or are completely blind. It is very distressing that this disease causes blindness. There are more than 160 million people in the world who are visually impaired, and it is estimated that 37 million of them are completely blind. There is a significant lack of adoption and use of blind navigation technology in India. The blind traveller must rely on some other means of transportation (blind cane, local knowledge, trained dog, etc.) in order to get around [1, 5]. Normal vision, mild vision loss, severe vision loss, and total blindness are the four categories of visual impairment. A person is considered legally blind if they have less than 20/200 vision in either eye or a severely restricted field of vision. People who are legally blind or nearly blind often rely on guide dogs or walking canes to get around. The majority of the time, this crew aims to sneak through their work without anyone noticing [3, 9]. A guide dog's duty is to prevent its human master from colliding with obstacles in the environment. If you're visually impaired, you can use a walking stick to feel out the terrain ahead of you and locate potential hazards. The need for aid devices has never gone away, and it never will. Individuals with visual impairments have access to a number of navigation aids and devices [21]. A person who is blind must be able to navigate independently and identify objects. The Smart Stick is a groundbreaking innovation

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that could drastically enhance the quality of life for the visually impaired. The device's many features make it easier for users to move around in their surroundings, gain access to needed information, and complete otherwise difficult tasks. The Smart Stick's ability to detect obstacles and steer around them is a major plus [12]. The system employs sensors to identify potential hazards and then alerts the user with both auditory and tactile cues. As a result, people who are visually impaired may be safer and more self-reliant on their daily adventures. The GPS navigation system built into the Smart Stick is another crucial component that can facilitate travel in uncharted territories. The device has audio instructions to help the user get where they need to go, making it simpler to get around in crowded places like subways, malls, and other public places. The Smart Stick can greatly improve visually impaired people's lives [18]. The device's many features help users navigate safely, access information, and complete difficult tasks as shown in fig 1.

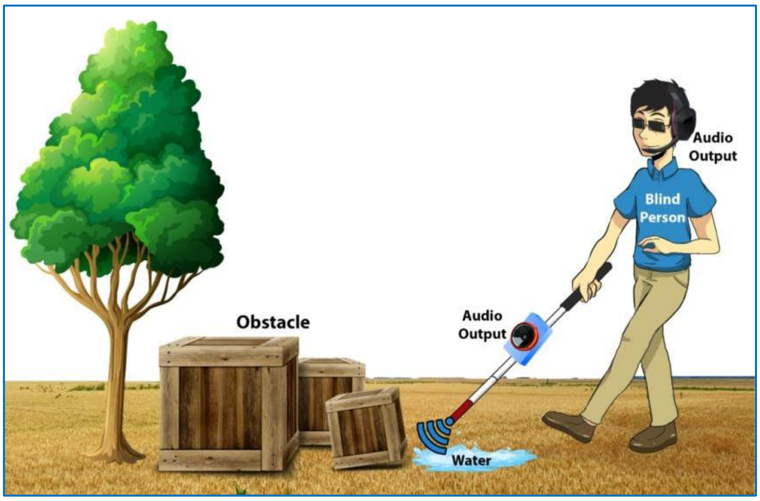

Figure 1. Visually Impaired Person Walking through the surroundings.

There are currently 1.4 billion people residing in India. Around the globe, 8.90 million people experience vision impairment. Ninety percent of the population requires assistance to walk as shown in fig 2. Guide dogs are only used by 3% of the blind population. The remaining 67% all depend on a guide cane. Our paper focuses primarily on those who, due to visual impairments, are unable to independently navigate unfamiliar environments. Researchers hope that their work will lead to improved methods for the visually impaired to navigate unfamiliar environments.

Figure 2: Commercially Available Walking Stick for Blind People

The rest of this paper is organized as follows. Section 2 presents the literature review and discusses several efforts on adaptive technology for the blind. The specifications and operational features of the suggested smart stick are covered in Section 3. Sections 4 present the results and discussions, respectively, while the study is concluded in Section 5.

1.1 BACKGROUND

Our survival depends on sight, which God gave us. We can see nature and life through our eyes. However, many people have trouble imagining such things. They struggle just to survive. Moving worsens the problem. Blind or low-vision people struggle in new public spaces. Thus, a way must be found to help blind people get around. Research estimates that 10–11 million North Americans are blind or visually impaired. Because many of them have trouble navigating and often feel lost or alone, they need more navigational information. If you get lost while navigating, you must figure out where you are and how to get back to your goal.

Visually impaired people rely on a wide range of aids and strategies in order to navigate their surroundings and complete their daily activities. The challenges of living with limited vision can be difficult, but these tools are designed to help people maintain their independence while navigating those challenges [6, 13]. The following is a list of some of the most frequently used tools by visually impaired people:

1. White cane: Blind people use a long, thin cane called a white cane to feel their way around the world. By sweeping the ground in front of them with the cane, the user gains tactile information about the terrain and any potential obstacles. There is a wide variety of white canes available; some are shorter than others, while others have accessories like a rollerball tip or reflective tape.
2. Guide dog: Those who are visually impaired often rely on the assistance of guide dogs. The dog aids the person by showing them the way around hazards and giving them pointers in the right direction. The temperament, intelligence, and aptitude to work with humans are all factors in the selection of guide dogs.
3. Electronic travel aids: Portable electronic travel aids (ETAs) use sensors and other technologies to make it easier for the visually impaired to get around. ETAs have the capability to identify obstacles, offer guidance, and interpret signs and labels. Some can be clipped onto a belt or bag, while others can be held in the hand or hung around the neck.
4. GPS devices: Satellite-based Global Positioning System (GPS) devices reliably pinpoint their locations. GPS devices allow the visually impaired to explore new areas and locate specific points of interest. Standalone GPS units, smartphone apps, and even wearable devices are all viable options.
5. Audio books and devices: Many people who are blind rely on audio books and other listening devices to fulfil their informational and recreational needs. Audiobooks can be purchased on CD, MP3, and as digital downloads. Talking watches and calculators are just two examples of audio devices that can aid the visually impaired by providing verbal feedback on their calculations.
6. Braille devices: Blind people can read and write thanks to Braille, a tactile writing system. Technology that can display braille characters on a screen or translate text into braille is called a "braille device." There are a variety of braille devices available, such as displays, printers, and notetakers.

The goal of this research is to create and make a walking stick with sensors that can help people who are blind or have low vision get around easily. The device should give the person clear, real-time information about their surroundings, including any possible obstacles. The goal is to improve the quality of life for people who can't see by giving them a tool that makes them feel more independent and surer of themselves while going.

II. 2 LITERATURE SURVEY

Kang, S. and Kim Y. in [17] have proposed that an intelligent guiding stick for the blind. It is made up of two DC motors, a microcontroller, and an ultrasonic displacement sensor. The guide stick has a total weight of 4.0 kg and measures 24 cm in width and 85 cm in height. Using proprietary Visual C/sup ++/ software, computer simulations were run to locate the guiding stick's traces at three distinct pathways. To compare the results of the computer simulation with actual experiments, more were done.

Bousbia-Salah M., Bettayeb M., & Larbi A. in [18] have proposed a effective microcontroller-based directions aid for the blind that consists of two vibrating devices, two ultrasonic sensors attached on the user's shoulders, and one integrated into the cane, can identify any obstacle on the ground and provide real-time information about the distance of overhanging obstacles within a 6-meter range along the route of travel ahead of the user. Experimental results support this claim.

Dey N., Paul A., and Ghosh P.in [19] have presented the creation and application of a walking aid for the blind that uses an ultrasonic sensor. A buzzer is used to alert the blind person and an ultrasonic sensor module, HC-

SR04, is utilized to identify obstacles in their route. The PIC microcontroller 16F877A is used in the implementation of the suggested system. This walking stick can be used by blind people to navigate safely. It has a 5 to 35 cm detection range for obstacles.

Sharma T., Apoorva J. and Lakshmanan R. in [20] proposed research can detect barriers in front of the user as well as those that are approaching, and it can classify the obstacles in real time into categories such as car, human, dog, door, or chair, as well as the direction of approach (left, right, or middle). Additionally, the user can program it to recognize the faces of specific pre-selected individuals. User input is provided in audio format. This system is designed to be used in conjunction with the walking stick, thereby broadening the user's field of awareness, rather than to replace it.

Sammouda R., & Alrjoub A. in [21] proposed a system comprising the blind mobile device, WiFi, text-to-speech, voice recognition, GPS, RFID tags, and a reader. When there is an internet connection, the system uses GPS to determine the blind position. If not, it employs RFID tags that are placed both indoors and outdoors on the buildings that are in the path. Indoors, WiFi routers are utilized to determine the location. The blind user can be guided to his location and given directions by the system through text-to-speech and voice recognition.

Dodson A., Moon G., and Moore T in [22] proposed a technology strategy that replaces the requirement for sighted guides and enhances the current aids through field tests. More independence for the blind individual could be provided by the method. According to the analysis, the approach taken by personal navigation systems designed for the sighted is not the best one for assisting blind pedestrians.

Lahav O., Gedalevitz H. and Battersby, S. Brown in [23] proposed study consists of 10 congenitally or adventitiously blind subjects were split into experimental and control groups for this investigation. The study's methodology combined qualitative and quantitative techniques to conduct exploration and orienting tasks in real-world settings through virtual worlds. Findings: 60% of the experimental participants created mental maps based on map models, compared to only 30% of the control group participants. This indicates that the mode of exploration provided to the group participating in the experiment is radically new in mobility and orientation training.

Joseph S., Zhang X., and Dryanovski in [25] have claimed that a path is predicted using a human motion model, which simulates how actual people walk while dodging impediments in the path of their destination. We present the potential of haptic and speech augmentation in augmented reality (AR) as a blind user interface to sense the physical limitations of the real environment. Based on the metric localization at each step, the haptic belt vibrates to point the user in the direction of their travel target. Additionally, a voice guide is used to present the journey route. This is accomplished by accurately estimating the user's location, which is then verified by extracting landmarks using landmark localization. The findings demonstrate that it is possible to help a blind user move freely by giving them the limitations needed for safe navigation.

Joseph S., Xiao J., Tian Y., & Yan F in [26] suggested that their research offers a unique method for interpreting a semantic plan that helps a visually impaired person navigate by using the floor plan maps that are displayed on the buildings. Inferring the way points to each room is made possible by the retrieved landmarks, which include doors, room numbers, and other features. This helps create a mental map of the surroundings so that a navigation framework can be created for later usage. To forecast a path based on how actual people walk toward a goal while avoiding obstacles, a human motion model is employed.

III. 3. PROPOSED MODEL OF VISION SENTRY STICK

The blind navigation stick research begins with the "Start" point, initiating the process of continuously checking for obstacles in the front, right, and left directions using the ultrasonic sensors. If an obstacle is detected, the system activates the respective vibration motor corresponding to the obstacle's location and triggers the voice module to provide audible alerts as shown in fig 3. Following this, the system loops back to the obstacle detection phase, continually scanning for potential impediments. If no obstacle is identified during the initial check, the flowchart directs the process to loop back to the obstacle-checking stage, ensuring constant vigilance for obstacles and maintaining a dynamic and responsive navigation system for the visually impaired user.

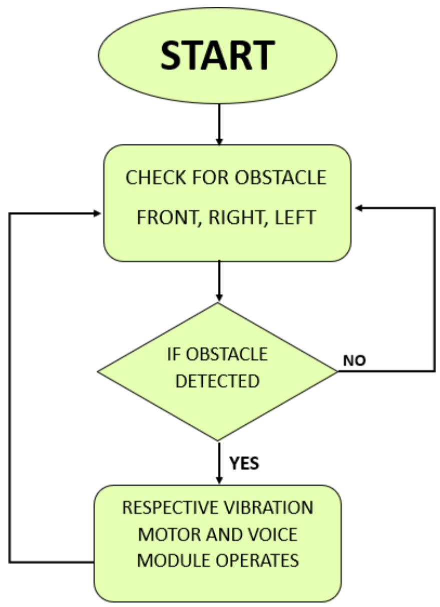

Figure 3: Decision Flowchart for Obstacle Detection

3.1 HARDWARE REQUIREMENTS

The blind navigation stick research integrates various sensors and modules to enhance the user's mobility and safety. The Arduino UNO serves as the central control unit, receiving input from an array of sensors. Ultrasonic sensors detect obstacles in the front and rear, providing distance information to the Arduino. An APR module, interfaced with a speaker, enables audio feedback for directions and alerts. The vibration motor indicates proximity to obstacles, enhancing tactile feedback [27]. The IR flame sensor and PIR sensor enhance environmental awareness by detecting flames and human presence. A 16x2 display communicates important information to the user, such as distance readings and system status. The beep output offers additional auditory cues. The moisture/water sensor ensures environmental safety by detecting wet conditions as shown in fig 5. The overall design prioritizes user-friendly feedback, combining auditory, tactile, and visual elements to create a comprehensive and effective blind navigation solution as shown in figure 4.

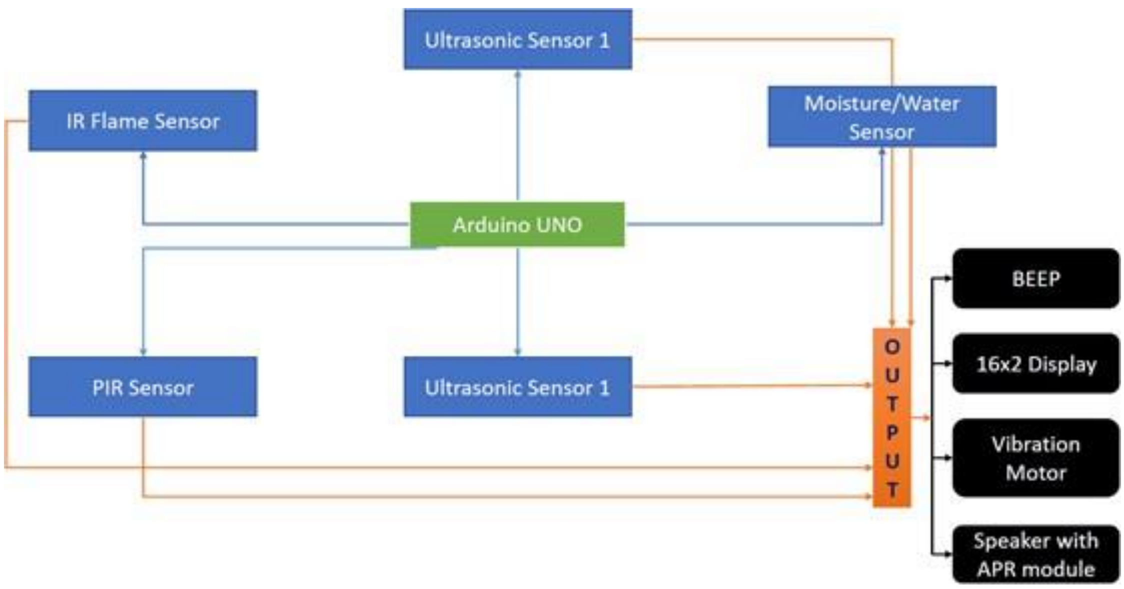

Figure 4: Working Schematic of the Vision Sentry Stick

1. **Ultrasonic Sensor**: An ultrasonic sensor works by emitting high-frequency sound waves (typically in the range of 40 kHz) and then detecting the sound waves that bounce back off of nearby objects. By measuring

the time, it takes for the sound waves to return, the sensor can determine the distance to the object. In a blind navigation stick, ultrasonic sensors can be used to detect obstacles in the user's path and provide warnings or guidance as needed.

2. **Fire Sensor**: A fire sensor is designed to detect the presence of fire or smoke in the surrounding environment. There are several types of fire sensors, but most work by detecting the presence of carbon monoxide, carbon dioxide, or other gases that are produced by fires. When these gases are detected, the sensor sends a signal to the Arduino Uno, which can then trigger a warning or alert.
3. **PIR Sensor**: A PIR (passive infrared) sensor is designed to detect the movement of objects that emit infrared radiation, such as human bodies. PIR sensors work by detecting changes in the infrared radiation that they receive, and then sending a signal to the Arduino Uno when movement is detected. In a blind navigation stick, PIR sensors can be used to detect the presence of people or other moving objects in the user's path.
4. **IR Sensor**: An IR (infrared) sensor works by emitting infrared radiation and then detecting the amount of radiation that is reflected back to the sensor. By measuring the amount of reflected radiation, the sensor can determine the distance to nearby objects. In a blind navigation stick, IR sensors can be used in a similar way to ultrasonic sensors, providing information about the distance to obstacles in the user's path.
5. **Arduino Uno**: The Arduino Uno is a microcontroller board that can be programmed to work with a wide range of sensors and other parts. It works by getting information from sensors, processing that information with a programme, and then sending that information to other parts (such as LED lights, speakers, or motors). In a blind navigation stick, the Arduino Uno can take input from sensors like ultrasonic sensors, fire sensors, PIR sensors, and IR sensors, and then send output through a voice recording module, a vibration motor, or another output device.
6. **Water Sensor**: The water sensor can tell when water or other liquids are nearby. There are different kinds of water sensors, but most of them work by noticing changes in the way electricity flows through or resists water. When water is found, the sensor sends a signal to the Arduino Uno, which can then set off a warning or alert.
7. **GSM module:** In our blind navigation stick, the GSM module serves as a means of communication with external devices or individuals. For example:
    - Emergency Alerts: If the navigation stick detects a hazardous condition, such as heavy rain, it can use the GSM module to send an emergency alert to a predefined contact (e.g., a caretaker or emergency services).
    - Location Sharing: The GSM module can periodically send the user's location coordinates to a designated contact, allowing the user's whereabouts to be tracked remotely.
    - Voice Calls: In case of emergencies or when the navigation stick detects critical conditions, it can use the GSM module to make voice calls to a caretaker or emergency contact for immediate assistance.
    - Text Messages: The GSM module can send text messages containing important information or alerts to a caretaker, providing real-time updates on the user's status or environmental conditions.

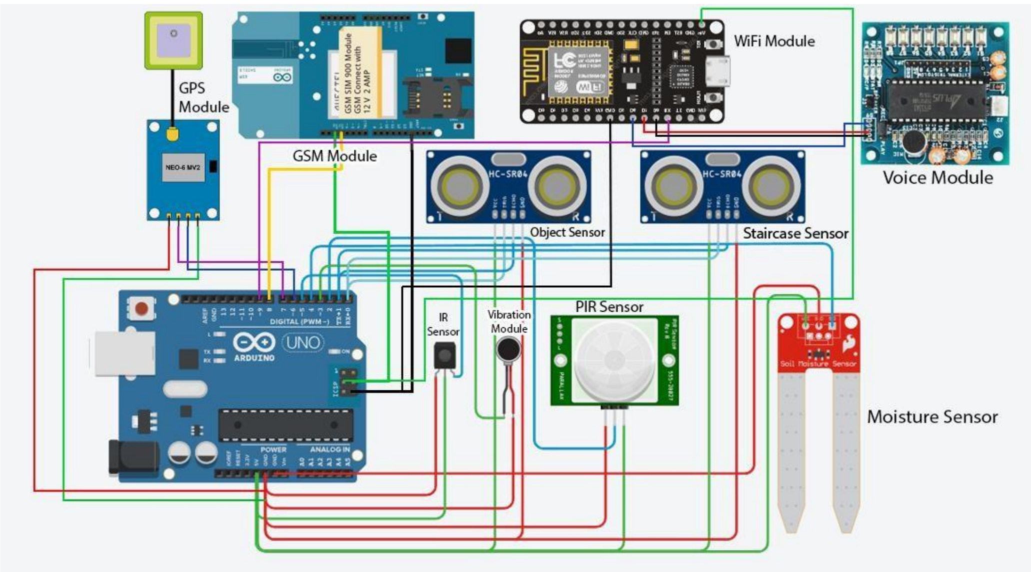

Figure 5: Working Circuit of the Vision Sentry Stick

3.2 SOFTWARE REQUIREMENTS

The blind navigation stick research leverages the Arduino IDE and Embedded C programming language to streamline the development process for its microcontroller-based system. The Arduino IDE provides a user-friendly platform, enabling easy programming and integration of various sensors and components critical for blind navigation. With built-in libraries, debugging tools, and strong community support, the IDE facilitates efficient code development and troubleshooting. Embedded C, known for its efficiency, real-time control capabilities, and low-level hardware access, is chosen for its suitability in resource-constrained environments, ensuring precise control over the blind navigation system's timing and responsiveness. Additionally, Telegram integration enhances the research's functionality by providing real-time notifications, remote monitoring, customizable alerts, group messaging for multiple caretakers, and secure communication, creating a comprehensive solution that combines hardware, programming, and communication elements for an effective blind navigation experience.

3.2.1 Arduino IDE

The Arduino Integrated Development Environment (IDE) is a software tool for uploading and programming Arduino boards. It simplifies the process of programming the Arduino board, allowing users to easily write and upload code to the board, making it a very useful tool for the creation of blind navigation research [28]. Here are some specific ways that the Arduino IDE can be useful in making a research for blind navigation:

1. Easy programming: The Arduino IDE is designed to be simple to use, even for individuals with minimal or no programming experience. It offers a straightforward interface for writing and uploading code to the Arduino board, with features such as code highlighting and error checking.
2. Library support: A number of libraries included with the Arduino IDE simplify the use of sensors, displays, and other components in a research. This can save time and effort when developing a research for blind navigation, as the need to write complex code to interface with these components is eliminated.
3. Debugging support: The Arduino Integrated Development Environment includes debugging tools, such as serial monitoring and breakpoint debugging. These tools can assist developers in identifying and resolving bugs in their code, making it easier to create a research that is reliable and robust.
4. Community support: The Arduino community is very active and helpful, with numerous online resources to assist users with research development. A large community of makers, hobbyists, and professionals use the Arduino IDE, making it easy to find assistance and advice when developing a research for blind navigation.

3.2.2 Embedded C

Embedded C is a popular programming language for the development of embedded systems, such as microcontrollers like the Arduino Uno used in blind navigation researchs. Creating a research for blind navigation is useful for several reasons:

1. Efficiency: Embedded C is designed to be lightweight and efficient, making it suitable for use in microcontroller-based systems. This is crucial for blind navigation researchs where processing power, memory, and battery life are frequently constrained.
2. Real-time control: Real-time applications, such as blind navigation, can make use of Embedded C because it enables precise control over the timing and sequencing of tasks. Because of this, the system is able to react rapidly and accurately to shifting environmental conditions, such as the presence of obstacles or changes in the location of the user.
3. Low-level hardware access: Developers are granted access to the low-level hardware features of microcontrollers by using the programming language Embedded C. These features include interrupts, timers, and I/O ports. Because of this, developers are able to interface with sensors, motors, and other components in a research and exercise precise control over those components.
4. Portability: Embedded C is a popular choice for programmers, and there are numerous compilers and development tools available for it to use on a wide range of different platforms. This makes it simple to create code on one platform and then port it to another, which is essential for blind navigation researchs because a variety of microcontrollers and sensors may be utilised.

5. Code optimization: Embedded C makes it possible to optimise low-level code, which, when done properly, can improve a system's overall performance and efficiency. This is important in researchs involving blind navigation, as the system needs to operate dependably and efficiently in order for it to be effective.

3.2.3 Telegram

Telegram is an app for sending and receiving text messages, files, and notifications. It can be connected to a blind navigation stick to let the caretaker know about warnings and other information about the blind person's navigation as shown in fig 6. Here are some ways Telegram can help with this kind of research.

1. Real-time notifications: Telegram can let a caretaker know right away when the blind navigation stick finds an obstacle or other danger. This can make it easier for the caretaker to act quickly and help when it's needed.
2. Remote monitoring: A caretaker can use Telegram to watch how the user navigates, giving them a better sense of security and letting them step in if they need to.
3. Customizable notifications: Notifications can be changed in Telegram, so a caretaker can only get the information that is most important to them. For example, they can choose to only get a message when the navigation stick finds a big obstacle or when the user gets to a certain place.
4. Group messaging: Group chats can be set up on Telegram, which can be helpful when more than one caretaker is keeping an eye on a user's navigation. This can help make sure that everyone who needs to know is aware of any problems.
5. Secure communication: Messages sent through Telegram are encrypted from end to end, which can help keep sensitive information private and safe.

IV. RESULTS AND DISCUSSION

The Walking Smart Stick for blind people is a great innovation in the field of assistive technology. It is a smart stick that can be used by visually impaired individuals to navigate their surroundings independently, especially when they are in unfamiliar places. The smart stick is designed to use multiple sensors and is integrated with the person's caretaker's phone for active updates of the blind person. With the help of an Arduino board, a piece of electronics capable of detecting obstructions is constructed. During testing, we put the gadget through its paces by positioning a number of objects in front of, and at varying distances from, its sensors. The technology effectively alerts the user and caretakers to the existence of potential dangers ahead as shown in fig 7.

One of the primary benefits of this smart stick is that it enables visually impaired individuals to be more independent. For many blind people, the fear of getting lost or injured in unfamiliar surroundings can be a significant barrier to traveling independently. With the walking smart stick, they can now navigate safely and confidently. The smart stick can detect obstacles in the user's path and alert them to potential hazards, such as trees, poles, or other obstructions. This feature allows users to move around without needing assistance, making them feel more in control of their environment. Another benefit of the walking smart stick is its real-time updates. The smart stick is integrated with the user's caretaker's phone, which provides active updates to the blind person. This feature ensures that the caretaker is informed about the user's location and well-being. In case of any emergency, the caretaker can quickly come to the user's aid. This makes the smart stick a safer and more reliable tool for visually impaired individuals to use.

The minimal distance we used in our tests was 0.5m. The walking smart stick is designed to announce distance in real-time, either in meters or centimeters, depending on which unit was used in the calculation. This is important as it helps visually impaired individuals to estimate the distance to the obstacle and adjust their movement accordingly. To keep things simple for the user, a buzzer is employed, which emits a beep at the presence of any aforementioned obstacles. This makes the smart stick easy to use and understand, even for those who are not technologically savvy. Experiments were carried out to assess the efficiency of the suggested method. We have just scratched the surface of what may be done to create a portable tool that would help the visually handicapped navigate their everyday environments, and the findings are shown here. The sensor circuits, as was previously indicated, provide data about the surrounding area. The object detection circuit de-signed so far has 1-meter accuracy as shown in fig 8. This means that the smart stick can detect objects up to one meter away accurately as shown in fig 6.

It is a simple yet effective device that uses multiple sensors to detect obstacles in the user's path and provide real-time updates to the user's caretaker. The walking smart stick can significantly improve the quality of life for visually impaired individuals by giving them more independence, confidence, and safety. The device is easy to use and understand, making it an excellent addition to assistive technology. This research could be further improved by incorporating additional features such as GPS navigation, voice recognition, and integration with digital assistants like Siri or Alexa, to make it even more convenient and accessible for visually impaired individuals. This smart stick's main advantage is that it gives the visually impaired more freedom to go about their day as they please. Many blind people are reluctant to venture out on their own because they worry about getting lost or hurt. They can now confidently and safely navigate their surroundings thanks to the walking smart stick. The smart stick can identify potential dangers in the user's path, such as trees, poles, or other obstructions, and sound an alarm. Users can get around without help, giving them a greater sense of independence and control.

Figure 6: Live prototype of the Vision Sentry Stick

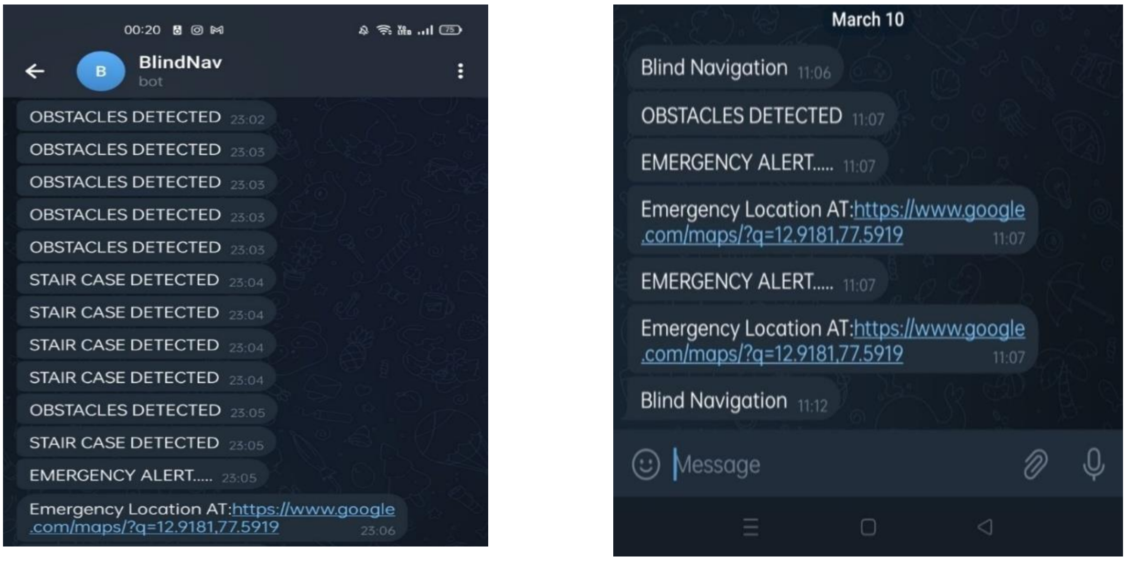

Figure 7: Real Time output in Telegram.

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Ultrasonic Sensor Output:
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Distance to Object: 2.0 meters
Status: Object Detected
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Figure 8: Real Time output of Ultrasonic Sensor.

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**Alert**
Fire Sensor has detected Fire
Please move away from the area immediately.
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Figure 9: Real Time output of fire Sensor.

The Blind Navigation Stick is equipped with a fire sensor that uses heat detection technology. This sensor continuously monitors the surrounding environment for changes in temperature. When it detects a significant increase in temperature, which may be indicative of a fire, it triggers an alert as shown in fig 9. The alert is then researched to the user, typically through auditory and tactile cues. For instance, the stick may vibrate or emit a distinct sound pattern to signal that a fire has been detected, accompanied by a spoken message like "Fire Sensor has detected Fire kindly move away". This alert is designed to help visually impaired users safely navigate away from the fire.

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**Caution**
Moisture Sensor has detected a wet surface.
Please exercise caution in the area.
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Figure 10: Real Time output of Moisture Sensor.

The Blind Navigation Stick is equipped with a moisture sensor that relies on conductive technology to detect the presence of moisture on surfaces. It continuously assesses the material it touches for changes in conductivity, indicating the presence of wet or slippery surfaces. When it detects moisture exceeding a defined threshold, it sends an alert to the user. The user receives this alert through tactile and auditory cues, such as vibrations and spoken messages. For example, the stick may vibrate and announce, "Moisture Sensor has detected a wet surface, caution please" as shown in fig 10. This warning helps the user navigate safely, especially in environments prone to wet or slippery conditions.

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**Emergency Alert**
User is in danger at the following location:
Latitude: 12.6422
Longitude: 77.4402
Please seek immediate assistance or provide help to the user.
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Figure 11: Real Time output of Emergency Alert Sensor.

The Blind Navigation Stick relies on GPS (Global Positioning System) or other positioning technologies to determine the user's precise location coordinates. In emergency situations, such as when the user is in danger, the stick can transmit these coordinates to a central system or a designated contact. The user's location is then used to trigger an emergency alert as shown in fig 11. The alert may include information about the user's location and the nature of the danger. For example, it could initiate a message like "Emergency Alert: User is in danger at [Location Coordinates]". This information enables responders to quickly locate and assist the user in distress.

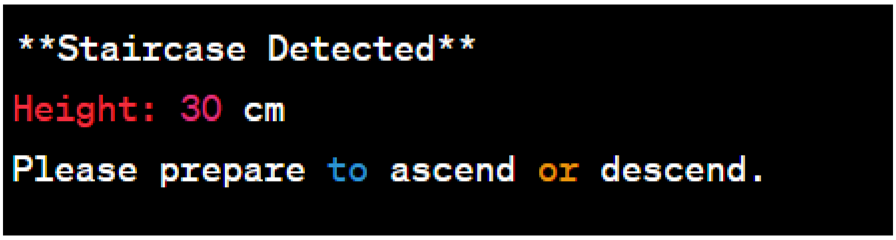

Figure 12: Real Time output of Ultrasonic staircase Sensor.

The ultrasonic sensor on the Blind Navigation Stick employs sound wave emission and reflection measurements to detect staircases. It calculates the distance to objects, comparing it to a pre-set height threshold, typically set at 30 centimeters as shown in fig 12. When the measured distance falls within this range, indicating a potential staircase step, the sensor triggers an alert. This alert is researched to the user through tactile and auditory feedback mechanisms, such as vibrations or distinct sound patterns. It instructs the visually impaired user to prepare for ascending or descending the staircase, facilitating safer and more independent navigation. This technological process enhances the stick's utility in helping users navigate complex environments effectively.

Table 1: List of Sensors trails and output accuracy.

S.No	System Parameter Under Test	No. of Trails	Performance Rate
1	GPS Coordinates	20	100%
2	SMS Warning	15	100%
3	Ultrasonic Object Detection	15	95%
4	Ultrasonic Staircase Detection	15	95%
6	Wet Surface Detector	15	95%
7	Telegram Notification	15	100%
8	PIR Sensor	15	95%
9	IR Flame Detector	15	95%
10	RF Transmitter/Reciever	15	100%
11	Emergency Button	15	100%
12	Vibration Output	15	100%
13	Sound Alert	15	100%

V. CONCLUSION

The primary purpose of this system is to serve as a protective barrier and provide assistance to those who are blind in becoming more aware of their surroundings. The work that will be done in the future involves the installation of a GPS system, the construction of an application, and facial recognition so that they can identify the individuals who came before them. The addition of a GPS system makes it possible to pinpoint the precise location of a blind person, which not only enables their caretakers to locate them but also serves as an excellent guide. In order for visually impaired persons to be able to live their lives in a pleasant manner, it is essential for them to have access to an item that is both effective and comfortable. In a growing nation like India, there is a pressing need for a solution that is both cost-effective and efficient, so that the greatest number of people may benefit from the effective product that is the subject of this study. The goal of the research titled "Smart Stick for Blind Using

Arduino" is to develop a system for visually impaired persons that makes use of ultrasonic sensors, a GPS module, and provides voice commands to those individuals through headphones. It would make it easier for someone who is blind or visually handicapped to walk freely through public spaces.

In conclusion, our walking smart stick for the blind is an impressive accomplishment that has the potential to make a huge difference in the lives of those who are visually impaired. It has the ability to considerably enhance the independence and safety of blind individuals when they are traversing unknown places by offering a dependable mode of navigation and integrating with the caretaker's phone for active updates. Our work is a demonstration of the potential of modern technology to improve the quality of life for individuals and communities.

VI. FUTURE OF VISION SENTRY STICK

Vision Sentry is a smart stick designed to aid visually impaired individuals in walking and navigating their environment safely. This research is extremely cost-effective and reasonably priced, making it accessible to a greater number of individuals. The stick is equipped with a number of sensors that detect obstacles and vibrates or emits a sound to alert the user. Additionally, the stick can be linked to a smartphone application that provides additional information, such as GPS location and destination guidance. As the creators of the Vision Sentry, we intend to integrate body implants that will send notifications to the user. Body implants are small electronic devices that can transmit signals wirelessly and can be inserted into the body of the user. By incorporating this technology into the stick, the user could receive traffic alerts or location-based reminders on a smartwatch or other wearable device. Vision Sentry's use of body implants is a promising innovation that could significantly enhance the stick's usability for the visually impaired. By receiving notifications directly on a wearable device, users would no longer have to rely solely on audible or tactile cues from the stick, which can be difficult to detect in noisy or crowded environments. The implementation of body implants could also enable more personalised and individualised notifications based on the user's particular needs and preferences. For instance, users could receive alerts regarding upcoming appointments or events, medication reminders, or environmental factors such as weather or air quality changes. Nonetheless, the Vision Sentry's implementation of body implants must also address a number of obstacles and factors. First is the question of user consent and privacy. The insertion of a body implant is a medical procedure requiring the patient's informed consent. In addition, users must be informed of how their personal information will be used and protected.

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