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Indoor Navigation System for Visually Impaired

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Abstract: Visually impaired individuals face significant challenges in navigating their surroundings safely and independently. Traditional mobility aids such as canes provide limited assistance and lack real-time hazard detection. This paper presents an indoor navigation system for visually impaired and designed to enhance mobility, safety, and emergency response. The system integrates two ultrasonic sensors—one for depth detection and another for obstacle avoidance. An LM393 Comparator IC sensor detects water on the road, warning users of wet surfaces. The device also includes a GPS module for real-time location tracking and a GSM module to send emergency SMS alerts. A panic button allows users to instantly send their location to predefined contacts in distress situations. The system is built around an Arduino Nano, ensuring efficient processing and communication. This assistive technology enhances the independence of visually impaired individuals by offering real-time alerts and automated emergency assistance. This innovation contributes to improving accessibility, safety, and overall quality of life for visually impaired users.

Keywords: Assistive Technology, Indoor Navigation, Blind Assistance Device.

I. INTRODUCTION

Navigating indoor and outdoor environments can be a significant challenge for visually impaired individuals, especially in unfamiliar or complex spaces. With the advancement of embedded systems and smart technologies, it is now possible to enhance their mobility and safety through assistive devices. This paper focuses on developing a Smart Indoor Navigation System for the Visually Impaired, combining multiple sensors and communication modules to provide real-time assistance and hazard alerts.

The system is equipped with two ultrasonic sensors — one dedicated to depth detection and another for obstacle detection, activating a vibrator to alert the user when an obstacle is encountered. A GSM module is used to send emergency SMS notifications, while a GPS module provides location tracking. A panic button is included to send an alert message along with the user's location in emergencies. Additionally, an LM393-based wet sensor is integrated to detect the presence of water on the path, triggering a buzzer to warn the user. This comprehensive design ensures enhanced situational awareness, safety, and independence for visually impaired users in both indoor and outdoor environments.

II. LITERATURE REVIEW

1. Dr. C K Gomathy, This research aims to assess students' knowledge of the Ge loT topic covered by the Internet of Things. IOT initiatives that address design, development, and other requirements are relevant to our field of study. The Smart Stick Assistant For Visually Impaired People Using Al Image Recognition is the paper I've chosen to work on as a result. A blind assistance app called "The Smart Stick Assistant For Visually Challenged People Using All Image Recognition" basically came from the conventional white or blue cane and improved into the present day technology. It's a paper to improve accessibility for blind individuals so they may receive assistance when travelling. A contemporary automation of utilizing cutting-edge technological components, such as the Blynk app and ESP shield, would lessen the challenges faced by the community of visually impaired persons in getting better responses from their surroundings.

2. Prof. Poonam Pawar, Person(s) with vision impairment find it challenging to communicate and perceive my surroundings. For someone who is visually impaired, moving around might be difficult because it can be difficult to tell where he is and how to get from one area to another. The development of an intelligent and smart stick to help and an alert system to warn visually impaired people about obstacles and provide information about their whereabouts has taken decades of research. In this essay, we'll talk about developing a smart kit system to help the blind. The smart gear is provided as people struggle to recognize the world and obstacles in front of them while walking. The apparatus is intended to function as an artificial eyesight and the visually impaired person through beeps which is assigned to a particular action. The designed system consists of hardware and software .part; hardware detects the slippery area, potholes on the road or path where the user is walking and the objects that comes in contact with the stick through ultrasonic sensor, infrared sensor and water sensor; software uses various algorithms to processes images for face recognition, to detect the text through image processing.

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3. N.Loganathan, When travelling from one spot to another, a blind person finds it challenging to identify the presence of any impediments in their path, and it is quite challenging to locate the stick's exact location if it has been misplaced. Therefore, the smart stick is presented as a suggested remedy to assist the visually impaired in their day-to-day living without the assistance of others. Using an ultrasonic sensor in the blind stick, we suggested a solution for the blind in this research. He is able to detect impediments at a distance of four metres, while infrared technology is utilised to detect closer obstacles in front of blind persons. In this way, the radio frequency transmitter and receiver enable the user to precisely locate the smart stick using a buzzer. When an obstacle is recognised, the smart stick's vibration motor, which is housed there, activates and vibrates. The Arduino UNO serves as the controller in this suggested manner. The branch is capable of detecting every challenge in front of the user. The user-friendly, quick-response, and extremely low power consumption of the smart stick lighter weight, and it is simple for the user to grip and fold.

4. Priyanka Abhang,People who are blind or partially sighted have difficulty moving securely from one location to another. They find it more and more difficult to complete simple activities without substantially relying on others. Our suggested system seeks to offer a simple solution to this problem. In this system, we employ infrared sensors to help detect raised surfaces like staircases and ultrasonic sensors to help detect obstructions. Additionally, we employ ISD1820 to provide speech warnings in the event that a barrier is encountered. The user can send panic messages to the predefined emergency contacts by using facilities for a panic button. The message informs the emergency contact of the user's GPS coordinates. Our smart blind stick seeks to offer a cheap, effective, quick, and light alternative.

5. Rajath V, This report will present a n order to help the visually challenged people, we design smart sticks. One of the many problems that people have little control over is blindness. It steals away from a person's life the intense visual beauty of the world. However, as they must overcome countless obstacles in order to carry out even the most basic duties in their daily lives, missing out on the beauty of nature becomes one of their least concerning problems. One of their biggest issues is transportation, whether it be using the roads, railroads, or other public spaces. It is known as the "Smart Stick." It is a tool that directs the user by detecting obstructions in the user's line of sight. With the aid of numerous mounted sensors, it will identify all obstructions in the way.

6. Vanitha Charitha, The proposed system consists of Arduino Nano, in which Jumper wires are used to link these parts to the Arduino's digital and analogue pins. When using the suggested approach, an input voltage of It has the following characteristics: 9V/12V. It can check for a setting with a range of obstacles of varied sizes and appropriate vibratory and auditory alarms are raised. It can be recognized. Surfaces that are moist or wet might warn the user. And it is able to communicate the user's location to friends via SMS can be used in the event of an emergency or crisis RF remote control-based locator when lost. An Arduinobased algorithm checks for input from each of the sensors.

7. T. S Aravinth, When a blind person gripping this as they cross the street walking cane When a barrier is present, it is being photographed with a camera and that picture is sent to the object identification microcontroller that issues a warning of that item through the ear pad. Raspbian is a walking stick inserted at which the Pins are used to interconnect an ultrasonic sensor. The camera should be attached at the same time. where both should face in Raspberry Pi the same way on the highway. Moreover, the device features a connection between the RF receiver and the walking stick. When a blind person presses button 1 on the RF transmitter, a beep sound emanating from their walking stick will be heard, allowing them to locate their walking stick in case they misplace it or it falls. In a similar vein, pressing button 2 will cause it to instantly read our present position. Each command is transmitted by depressing a button on the RF transmitter that they are holding.

8. Elsonbaty, Amira A., The presented system functions similarly to a white cane in that it assists blind people in scanning their surroundings for obstacles or orientation marks. This system will be mounted on a white cane with an ultrasonic sensor, and a water sensor to detect changes in the environment. Ultrasonic sensors detect obstacles in front of it using ultrasonic wave reflection, water detection sensors detect whether there is a puddle.

9. Riehle, Timothy H., et al., This paper describes the construction of such a device which utilizes a commercial Ultra-Wideband (UWB) asset tracking system to support real-time location and navigation information. Human trials were conducted to assess the efficacy of the system by comparing target-finding performance between blindfolded subjects using the navigation system for real-time guidance, and blindfolded subjects who only received speech information about their local surrounds but no route guidance information (similar to that available from a long cane or guide dog). A normal vision control condition was also run.

10. Grover, Sameer, et al., Smart Blind Stick is a system device which incorporates several features namely- obstacle detection, navigation, panic button and moisture detector. The main objective of the device is to help blind people to walk

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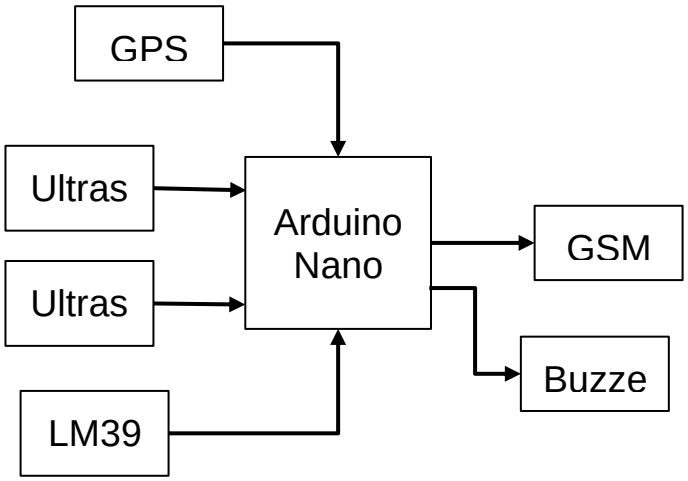
with complete relieve and self-dependency. The blind stick is integrated with three ultrasonic sensors, panic switch, navigation switch, and Bluetooth and soil moisture detector along with Arduino UNO. The Smart Blind Stick automatically detects the obstacle in front of the person by use of sensors present in the systems, it also incorporates moisture detection at its bottom in order to detect the moisture of the soil or ground so that the person will be aware if it's feasible to walk on that particular ground.

III. METHODOLOGY

The proposed system incorporates two ultrasonic sensors — one for depth measurement and the other for obstacle detection. At the core of the system, an Arduino Nano functions as the primary microcontroller, coordinating inputs and outputs across all components. A GSM module is integrated to send SMS alerts in emergency situations, while the GPS module provides real-time location tracking. A dedicated panic button enables the user to instantly alert caregivers by sending both an emergency message and current location. To ensure environmental awareness, an LM393-based wet sensor detects the presence of water on roads or floors, activating a buzzer to notify the user of slippery or unsafe surfaces. The device offers a reliable, responsive, and user-friendly solution that empowers visually impaired users to navigate independently and safely in various environments.

IV. BLOCK DIAGRAM



V. DESCRIPTION

1. **Ultrasonic Sensor 1 (Depth Detection)** – This sensor measures the depth of any terrain or steps ahead, helping visually impaired users navigate elevation changes. The data is processed by the Arduino, which provides feedback to the user.

2. **Ultrasonic Sensor 2 (Obstacle Detection)** – This sensor detects obstacles in the user's path and triggers a vibrating motor as a tactile alert, warning the user of an obstruction.

3. **LM393 Comparator IC Sensor (Wet Surface Detection)** – It detects wet or slippery surfaces, ensuring users are alerted to hazardous conditions through an audio signal.

4. **GPS Module (Location Tracking)** – Continuously tracks the real-time location of the user. If an emergency occurs, this module sends the user's coordinates via SMS.

5. **GSM Module (SMS Alert System)** – Facilitates emergency communication. When the panic button is pressed, it sends an SMS containing the user's real-time location to predefined contacts, ensuring quick assistance.

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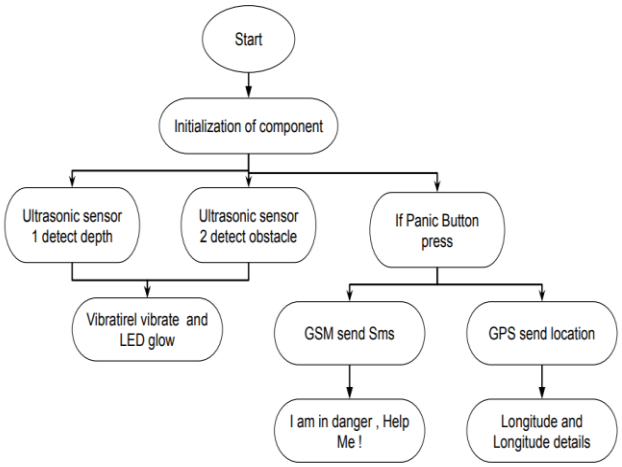
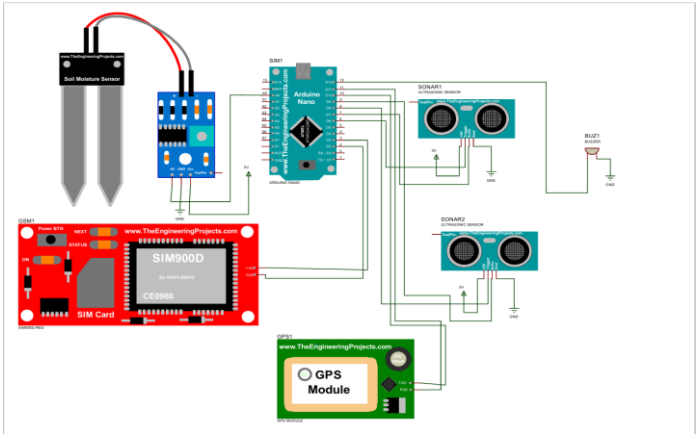
6. **Panic Button (Emergency Alert)** – When activated, it triggers the GSM module to send a distress message along with GPS location details, alerting caregivers or emergency services.

7. **Buzzer (Audio Alert System)** - It serves as an audio warning system for the visually impaired. When the LM393 wet sensor detects the presence of water or moisture on the road, it sends a signal to the Arduino Nano, which then activates the buzzer.

VI. FLOW CHART



CIRCUIT DIAGRAM



VII. WORKING

1) Power ON & Initialization

- The system is powered on, and all sensors, GSM, GPS, and the microcontroller (Arduino/ESP32) initialize.

2) Ultrasonic Sensor for Depth Measurement

- The first ultrasonic sensor continuously measures depth (e.g., well, pit, or water level).
- If the depth exceeds a critical limit, an alert can be triggered.

3) Ultrasonic Sensor for Obstacle Detection

- The second ultrasonic sensor detects obstacles in the surroundings.
- If an obstacle is detected within a predefined distance, the vibrator motor activates to alert the user.

4) GPS Module for Location Tracking

- The GPS module continuously fetches the current location coordinates (latitude & longitude).
- The location data is stored and used when sending alerts.

5) GSM Module for SMS Alerts

- The GSM module is set up to send alert messages when triggered.

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6) Panic Button Operation

- If the user presses the panic button, the system immediately:
  - Fetches the current location from the GPS module.
  - Sends an SMS alert with location details to pre-configured emergency contacts using the GSM module.

7) Wet Surface Detection using LM393 Comparator IC Sensor

- The LM393 comparator processes this signal and sends a digital output to the Arduino.
- If water is detected, the Arduino activates a buzzer to alert the user about slippery or unsafe conditions ahead.

VIII. SYSTEM REQUIREMENT

HARDWARE REQUIREMENT

- Arduino Nano
- Ultrasonic Sensor
- GSM
- GPS
- Button
- LM393 IC
- Buzzer

SOFTWARE REQUIREMENT

- Arduino IDE
- Proteus

IX. EXPERIMENTAL SETUP & RESULT

EXPERIMENTAL SETUP

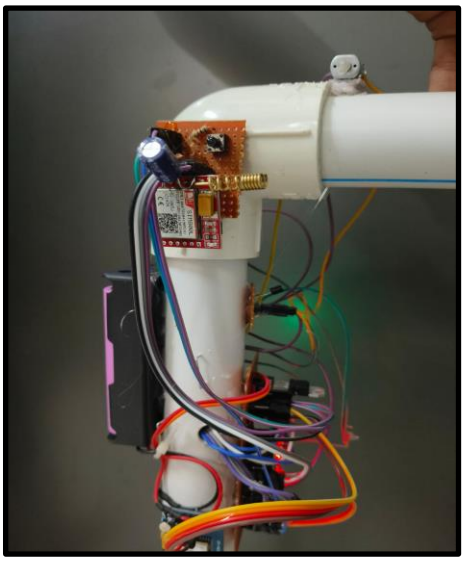

FIG I) SHOWS THE EXPERIMENTAL SETUP OF COMPONENT

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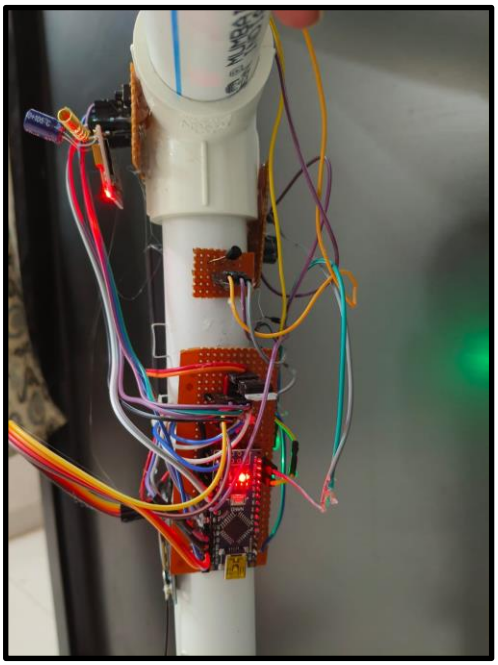

FIG II) SHOWS THE EXPERIMENTAL SETUP OF COMPONENT

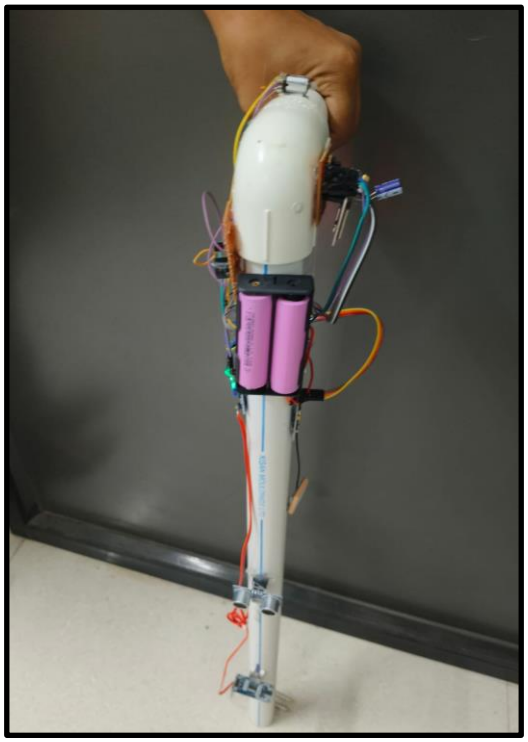

FIG III) SHOWS THE EXPERIMENTAL SETUP OF THE SYSTEM

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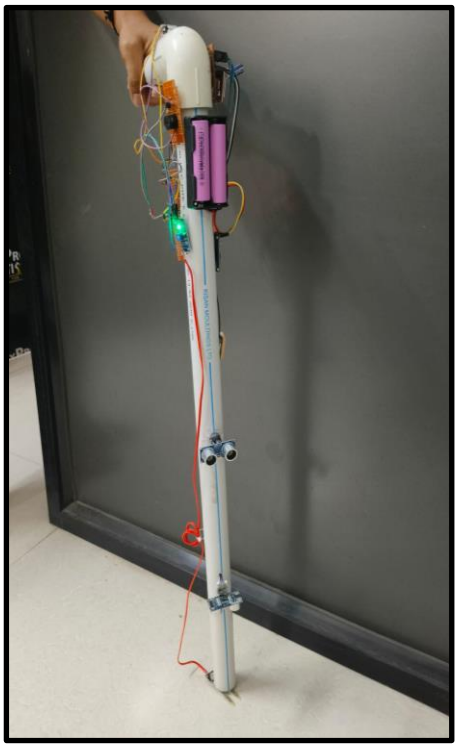

FIG IV) SHOWS THE EXPERIMENTAL SETUP OF THE SYSTEM

X. RESULT

The paper successfully integrates multiple sensors and communication modules to enhance safety and real-time monitoring. The ultrasonic sensors effectively measure depth and detect obstacles, triggering the vibrator motor for immediate user alert. The GPS module accurately fetches location coordinates, displaying longitude and latitude in real-time, while the GSM module successfully sends an emergency SMS with the message: "I AM IN DANGER, Help Me!" along with the location details.

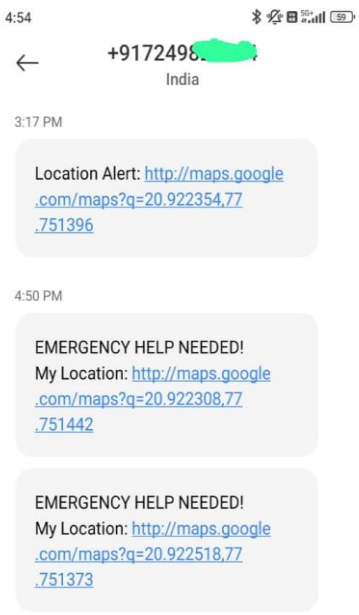

Fig Shows the GSM output

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XI. CONCLUSION

The smart assistive device offers a comprehensive solution for visually impaired individuals, integrating multiple sensing and communication technologies to improve navigation, safety, and emergency response. By providing real-time alerts and location tracking, it significantly enhances the independence of users. Powered by an Arduino Nano and designed for low power consumption, this system offers a budget-friendly and efficient assistive solution, greatly enhancing the independence and quality of life for visually impaired individuals in diverse indoor environments.

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