Tactile Navigation Support for Blind Individuals

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(Autonomous)

2023 - 2024

Contents

Abstract

Sighted individuals possess the ability to navigate their surroundings with ease and utilize their visual facility to promptly identify potential hazards. Conversely, individuals who are visually impaired are unable to perceive the external environment, traverse independently, or discern danger. Moreover, they may occasionally feel distressed and wish to notify their family or friends of their location via text. So, the primary challenge faced by visually impaired individuals is their reliance on others, as even their closest relatives may not always be able to provide adequate care. To address this issue, a "***Smart Stick***" would be developed utilizing the "*Internet of Things*". Using a variety of sensors, including ultrasonic, soil moisture, RF, GPS-GSM modules and using Arduino UNO, the Smart Stick empowers blind people to be independent and gives them a sense of normalcy.

Keywords: Smart Stick, Ultrasonic Sensor, Soil Moisture, Solar Panel, Infrared Sensor, GPS-GMS Module, Relay Module, RF Module, User setup Notification.

Introduction

- Blind persons always struggle with their daily tasks since they are unable to see even a single thing.
- When using a standard blind stick, blind persons have trouble recognizing stairs and obstacles surrounded by them.
- By making the use of smart blind stick, we can hear alert noises to identify stairs and obstacles.
- The problem can be minimized using IoT technology.
- The Internet of Things (IoT) describes the network of physical object that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.
- Sensors play an important role in creating solutions using IoT.
- Sensors are devices that detect external information, replacing it with a signal that humans and machines can distinguish.
- IoT = Sensing + Communicating + Computing

Literature survey

- This paper outlines the creation of a walking stick for a person who is vision impaired utilizing an ultrasonic sensor.
- The blind person is alerted by a buzzer, and obstructions in their path are detected by the ultrasonic sensor module.
- The main component in this system is the PIC microcontroller.
- The blind can travel safely with the aid of this walking stick. It is capable of detecting obstructions between 5 and 35 cm away.
- However, this technology was unable to identify stairs and damp surfaces.[1]

Literature survey

- The authors of this study also presented a novel walking assistance for the blind that enables blind people to travel.
- Along with object and water sensors, the blind stick also has an ultrasonic sensor and voice module. The sensor sends information to the Arduino UNO while detecting impediments.
- The Arduino UNO decides whether the obstruction is close enough after processing the data.
- If the barrier is not closing the circuit, nothing will happen. If the obstruction is nearby, the Arduino UNO will send out a voice alarm. However, this system only provides a single voice notification when it detects movement of the barrier at a distance of 50 cm.[2]

Literature survey

- This paper outlines about GPS, which is a satellite navigation system used to determine the ground position of an object.
- It will update the location of stick to main board. But this system, cannot work indoors because no signal can be received from the GPS navigation system.
- It has less accuracy of the signals within a range of 5m.[3]

Literature survey

- If the stick is misplaced from its intended location, visually challenged people can be informed of its whereabouts by activating RF remote control device. The remote control may send signals to the stick thanks to the RF modules, which enable wireless communication [4].
- By providing a concrete method of directing visually impaired individuals back to the proper location of the stick, this communication increases their independence and reduces the possibility of misplacing [5].

Existing System

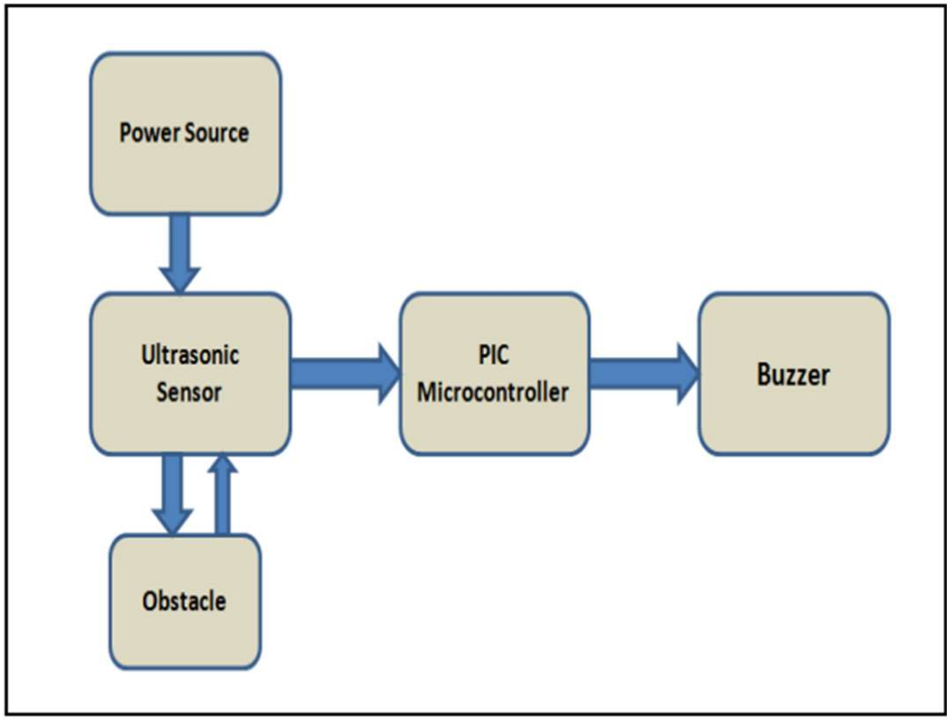
- The existing system is capable of detecting the objects giving single sound.
- Three ultrasonic sensors are incorporated- to sense objects on the right, left and in front respectively.
- The PIC microcontroller has to be programmed in order to calculate the distance of any object from the sensor.
- The programming of the microcontroller is done in C language.
- On detection of an obstacle, a buzzer is sounded.

Existing System

- Drawbacks of the existing system:
    - The maximum ranging accuracy can be extended upto 3mm.
    - Single sound is produced for all the sensors.
    - It is capable of detecting obstructions between 5 and 35 cm away.
    - This technology was unable to identify stairs and damp surfaces.

Existing System

- **Architecture of the Existing System**



Existing System

- **SOFTWARE AND HARDWARE USED:**
- **Software:**
  - MPLAB IDE
- **Hardware:**
  - PIC Microcontroller
  - Ultrasonic sensors
  - Power supply (+5V power supply)

Proposed System

- The proposed system is capable of detecting the surroundings for various barriers of different sizes and producing the required auditory using the ultrasonic sensor in the presence of buzzer. When damp surfaces are detected using sensors, it might alert the user by vibratory sounds and also enable to send SMS based on the user's location in an emergency or when they are having trouble. When the stick is misplaced, the user can find the stick by using an RF remote control.

Planning

➢Objective

- To develop a model that will enable blind persons to navigate both familiar and unfamiliar places without the use of guides. To alarm the user through vibration to determine the obstacles direction sources.
- To create a user-friendly interface that makes use of tactile feedback and sensations that are simple for blind users to grasp and interpret, enabling them to make independent.

➢Scope

- Alert the blind people by giving buzzer when obstacle is detected.
- Notify the blind people by giving vibration motor when wet surfaces are detected.
- Alert the blind people by giving speaker when stairs are detected.

Planning

- **HARDWARE AND SOFTWARE REQUIREMENTS:**
- **Hardware:**
  - Arduino Uno
  - Ultrasonic Sensor
  - Moisture Sensor
  - Infrared Sensor
  - GSM Module
  - GPS Module
  - RF Module
  - Battery
  - Relay Module
  - Speaker
  - Buzzer
  - Vibration Motor
  - Push Button
  - Solar Panels

Planning

- **Software**:
  - Arduino IDE
  - RAM: 4GB and Above
  - Memory: 8GB and Above
  - Processor: I3 and Above

Planning

- **Functional Requirements**
  - To develop a prototype hardware for modern blind stick.
  - To help the blind people navigate the route at their best.
  - To reduce the risk of injuries and lost for the visually impaired person.
- **Non Functional Requirements**
  - ✓ **Reliability:**
    - The smart blind stick should be ensuring that it operates consistently and accurately in various environments and conditions.
  - ✓ **Portability:**
    - The device should be easy to carry, ensuring that it is practical for daily use and travel.
  - ✓ **Usability:**
    - The smart blind stick should be user-friendly, with an intuitive interface and easy-to-understand controls.

Planning

- **Methodology**
  - To implement this project Iterative model is used. It involves continuous cycle of Planning, Analysis, Implementation and Evaluation.
  - Each cycle produces a segment of development that forms the basis for the next cycle of iterative development.

- **Advantages:**
  - It is easily acceptable to ever-changing needs of the project.
  - Testing and debugging during smaller iteration is easy.
  - A parallel development can plan.

Planning

➢Cost Estimation

S.No	Component	Cost (Rs)	No of Pieces Required	Total Cost (Rs)
1	Arduino Uno	1500	1	1500
2	Solar Panels	500	1	500
3	Ultrasonic Sensor	200	1	200
4	IR sensors	250	1	250
5	Moisture Sensor	150	1	150
6	GSM Module	600	1	600
7	GPS Module	700	1	700
8	RF Module	350	1	350
9	Relay Module	100	2	200
10	Regulators	150	1	150

Planning

➢Cost Estimation

S.No	Component	Cost (Rs)	No of Pieces Required	Total Cost (Rs)
11	Buzzer	100	1	100
12	Speaker	200	1	200
13	Vibration Motor	250	1	250
14	Push Button	150	1	150
15	Adapter	400	1	400
16	Jumper Wires	10	10	100
17	Shipping	400	-	400
	Total Cost			**6200**

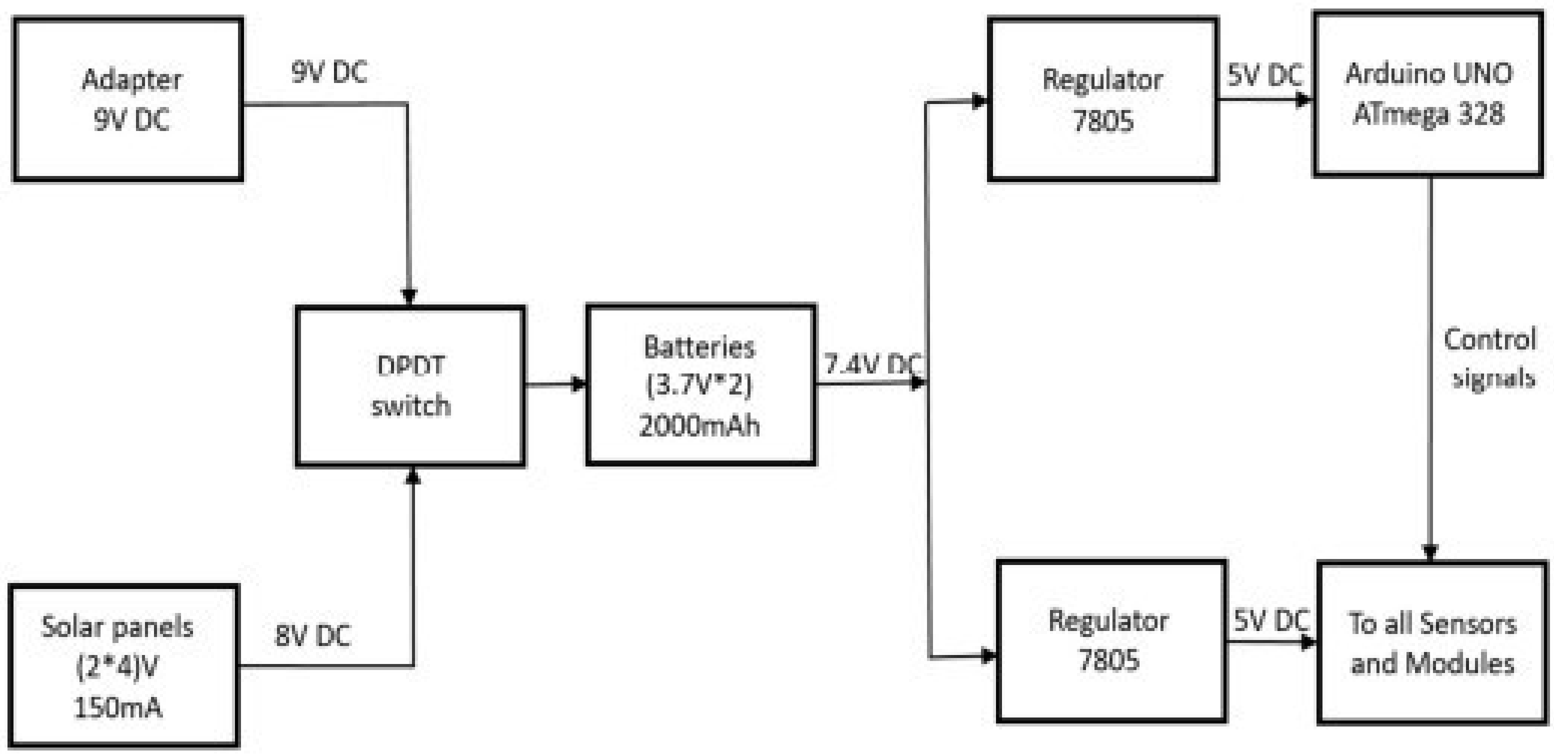
Planning

➢Time Estimation

S. N0	Activity	Duration
1	Gathering all the Components	1 Week
2	Detecting the objects, water surfaces, Stairs(Module 1)	3 Weeks
3	Developing Remote Control, SMS Notification(Module 2 & 3)	4 Weeks
4	Implementing the System	1 Week
5	Rectifying the drawbacks and Finalizing the System	1 Week

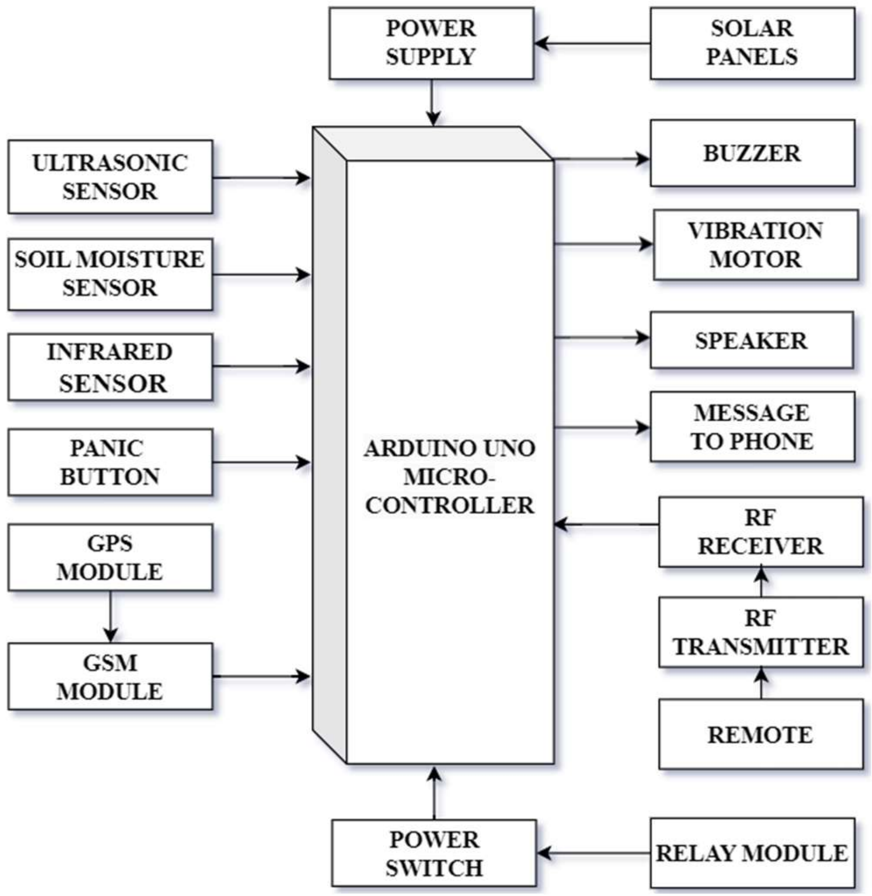
Design

➢System Architecture



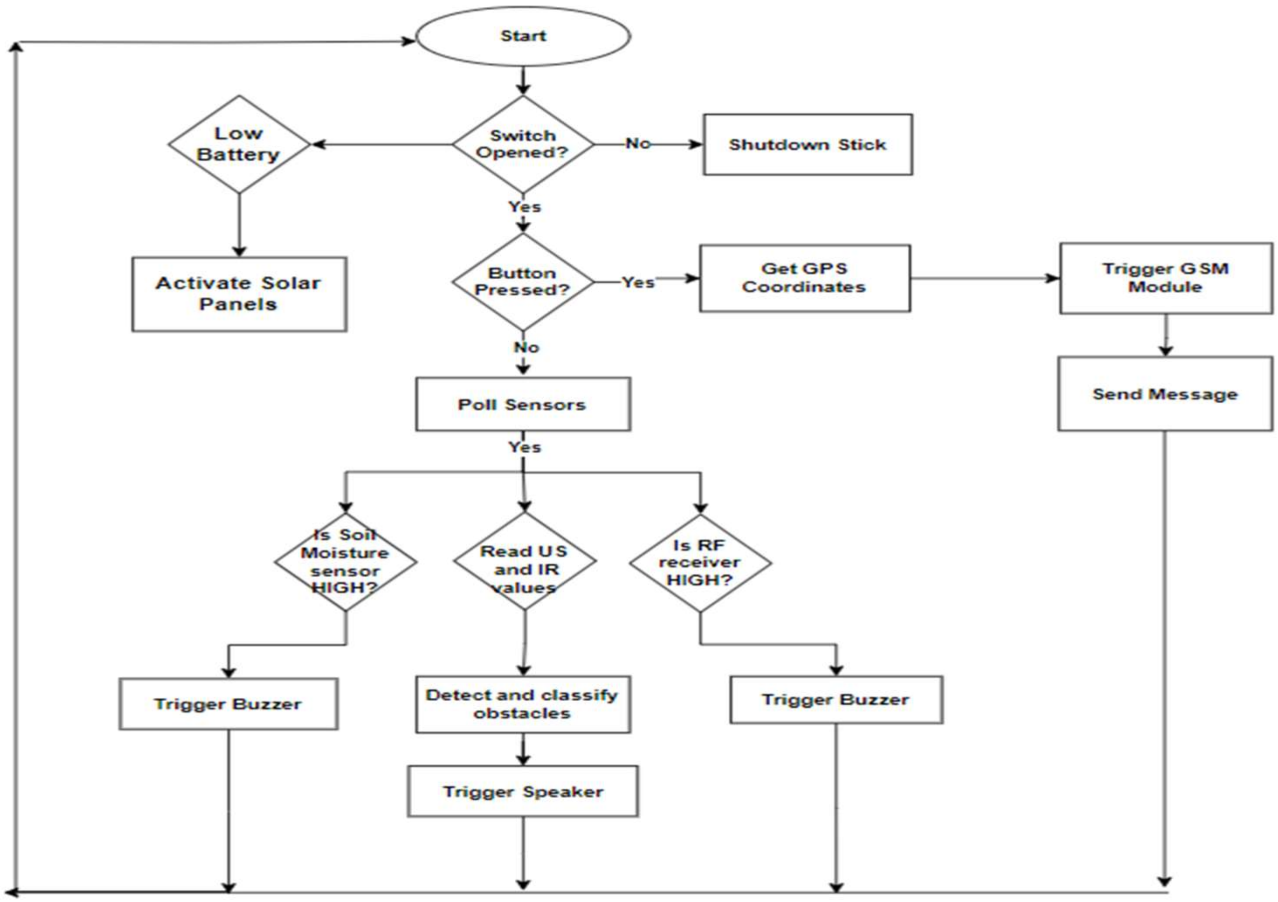
Design

➢Block Diagram



Design

➢Flow Chart



Implementation

Module 1: Object and Wet Surface Detection

- The first module utilizes ultrasonic for object detection and soil moisture for wet surface. Alerts the user through a dual-alert mechanism, comprising a buzzer for auditory signals and a vibration mechanism for tactile feedback.

```
a = pulseIn(echoPin, HIGH);
d=(a/2)/29.1;
if d < 20
if (d > 50 && d < 100)
Alerts voice1
if d < 35
if d < 150
if (d > 150 && d < 200)
Alerts voice2
Else
No Alert
where Voice1 - Speaker
Voice2 – Buzzer
```

Implementation

If value > 50 -- Vibration Motor On

Else -- Vibration Motor Off

Type of Obstacle	Type of alert	Sensors (Proximity & Distance readings)	
		IR sensor	Ultrasonic sensor
Stairs	Voice 1	< 20 cm	> 50 cm & < 100 cm
Near Obstacles	Voice 2	< 35 cm	< 150 cm
Far Obstacles	Voice 2	< 35 cm	> 150 cm & < 200 cm

Table-1 Classification of obstacles based on sensor readings

Implementation

Module 2: GSM and GPS Location Notification System

- The second module incorporates GPS and GSM modules for accurate communication and position tracking. Actual-time location notifications are transmitted via push notifications to pre-specified mobile devices when user-initiated push button is pressed. Combines location-based communication with sophisticated environmental awareness to create absolute Smart Stick solution.

```
If pushbutton ==1 -- Activate the GPS Module
    If GPS == 1 -- Activate the GSM Module
        If GSM ==1 -- Send Location to coordinates
        Else – No Location sent
    Else – No Activation of GSM Module
Else – No Activation of GPS Module
```

Implementation

Module 3: Remote Control

- The third module designed with an RF module and a dedicated remotecontrol unit, this module introduces remote control capabilities for locating the stick. Users can remotely activate location alerts, adding a layer of convenience to the Smart Stick. Auditory feedback through a buzzer enhances the user experience during remote control interactions, making the system more user-friendly and accessible.

If remote == 1 -- Find the position of stick
Else Can't find the position of stick

Implementation

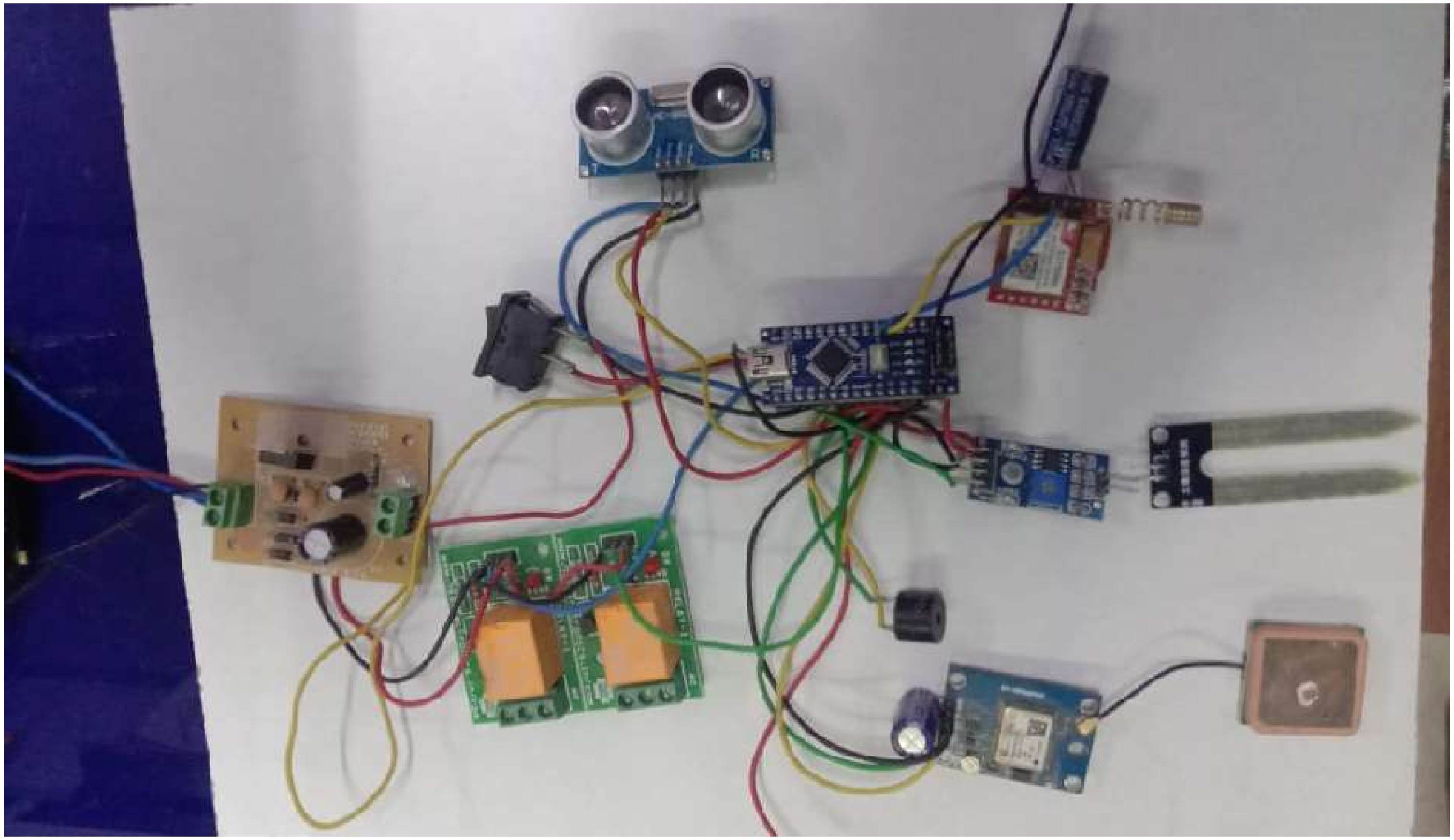


Fig 1 Circuit Diagram

Results

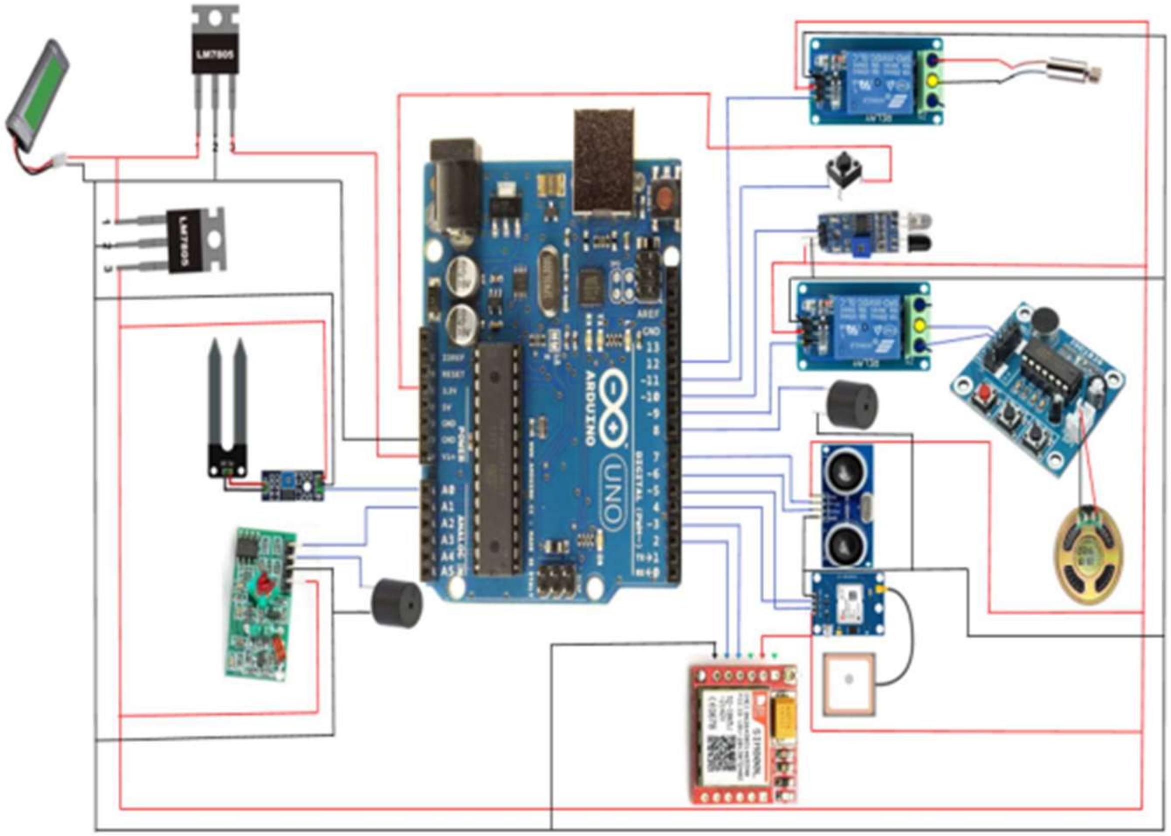


Fig-2 Experimental Setup

Results

Fig-3 Smart Blind Stick

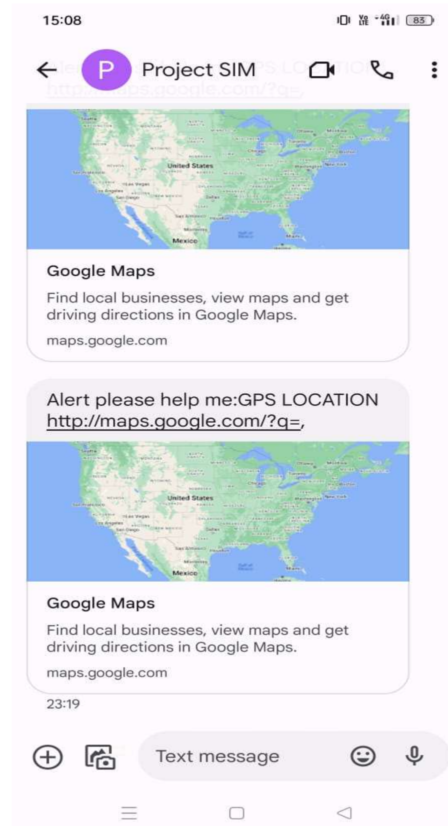


Fig-4 Alert Messages to the Coordinates of the Blind Person

Results

Devices	Number of tests	Measured	Number of Succeeded tests	Percentage of succeed tests
Obstacles	20	65.5 cm	20	100%
Stairs	20	75.5 cm	18	90%
Heat	15	25.5 cm	13	86.6%
Water	15	45 cm	14	93.3%
Average percentage of succeed of the tested device				92.5%

Table-2 Tests of Smart Blind Stick

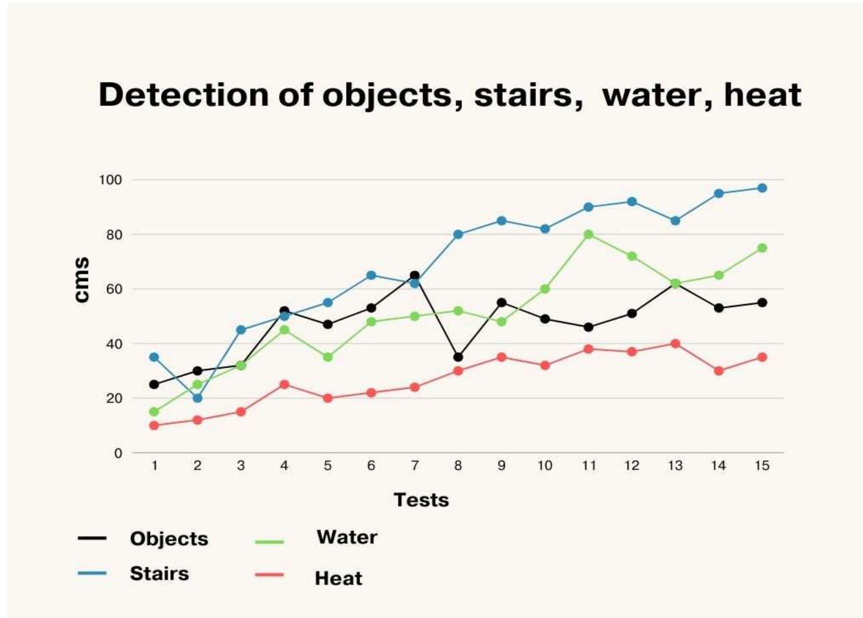


Fig-5 Detection of Objects, stairs, water, heat

Results

Obstacle Position	Accuracy
0 - 20 cm	95%
20 - 40 cm	92%
40 - 60 cm	94%
60 - 80 cm	93%
80 - 100 cm	95%
100 - 120 cm	92%
120 - 140 cm	91%

Table-3 Reliability for obstacle position

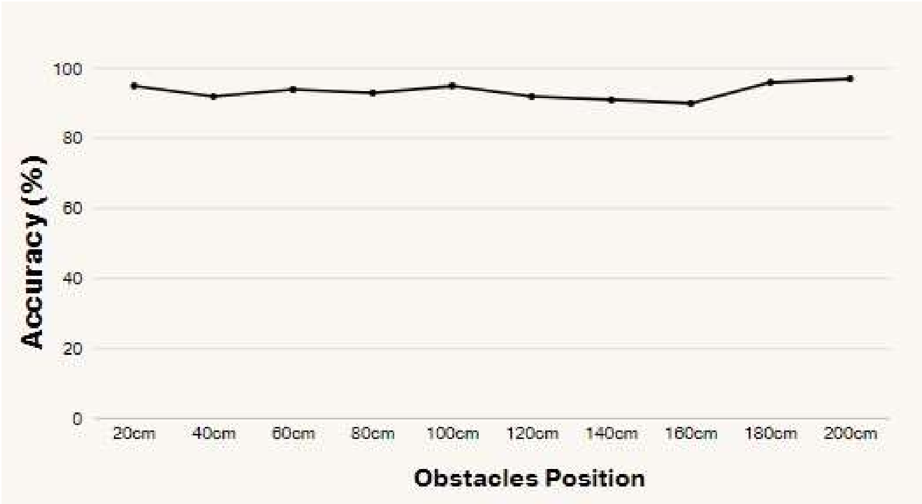


Fig-6 Reliability for obstacle position

Results

Moisture Content	Accuracy
40 - 60 cm	95%
60 - 80 cm	92%
80 - 100 cm	97%
100 - 120 cm	94%
120 - 140 cm	96%

Table-4 Reliability for moisture content

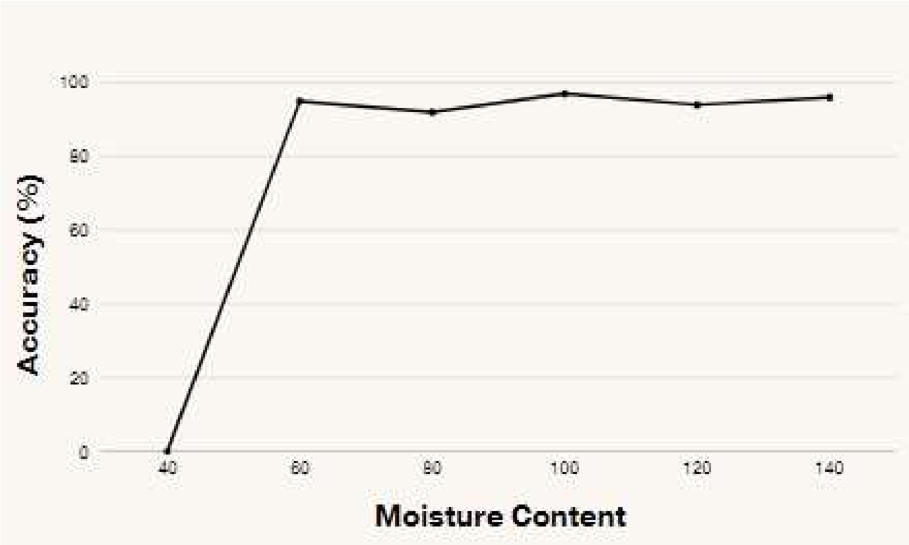


Fig-7 Reliability for moisture content

Conclusion

- Finally, the proposed system effectively detects barriers using the ultrasonic sensor with auditory alerts and provides safety features such as vibratory alerts for damp surfaces and emergency SMS based on user location. The inclusion of an RF remote control for stick retrieval enhances user autonomy. The system offers a comprehensive solution for obstacle detection, emergency response, and stick location retrieval, making it valuable tool for individuals with visual impairment.

Research Paper

- [Research Paper]

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Thank You!!!