SMART BLIND STICK

MINI PROJECT REPORT

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DEPARTMENT OF ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

BONAFIDE CERTIFICATE

This is to certify that it is the bonafide work of **"Bhuvanika S 9517202109011, Raja Kumari S 9517202109042, Suji S 9517202109051"** for the Mini project titled **"Smart Blind Stick"** in 19AD752–Intelligent Systems for IOT Laboratory during the seventh semester July 2024–November 2024 under my supervision.

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ABSTRACT

The "Smart Blind Stick" project is an assistive device designed to enhance the mobility and safety of visually impaired individuals by using an Arduino Nano microcontroller. The smart stick incorporates sensors and feedback mechanisms to detect obstacles and alert the user through auditory and tactile feedback. A combination of a normal buzzer and a passive buzzer is used to generate different sound alerts, while a vibration motor provides haptic feedback, notifying the user about nearby obstacles. The stick is lightweight, portable, and user-friendly, aiming to improve the user's navigation experience in unfamiliar environments by providing timely and intuitive alerts for obstacles, thereby reducing the risk of accidents. The system's low power consumption and affordable components make it a practical and accessible solution for visually impaired users.

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CHAPTER 1
INTRODUCTION

1.1 Introduction

The "Smart Blind Stick" is an innovative assistive device aimed at improving the mobility and independence of visually impaired individuals. Navigating safely in both familiar and unfamiliar environments can be a significant challenge for those with visual impairments, as they often rely on traditional white canes, which offer limited feedback about the surroundings. To address these limitations, the Smart Blind Stick incorporates modern technology using an Arduino Nano microcontroller, sensors, and feedback mechanisms to provide enhanced guidance and safety.

This device uses proximity sensors to detect obstacles in the user's path, translating that information into sensory signals that can be easily interpreted by the user. Alerts are delivered through a normal buzzer and passive buzzer, providing auditory signals, while a vibration motor offers haptic feedback to indicate the distance and direction of obstacles. This combination of sound and vibration feedback allows the user to detect potential hazards in real-time, even in noisy environments where auditory cues alone may not be sufficient.

The Smart Blind Stick is designed to be lightweight, portable, and easy to use, making it a practical tool for everyday use. By integrating affordable and widely available components, the project seeks to create a low-cost, reliable solution to improve the quality of life for visually impaired individuals, offering them greater confidence and independence as they navigate their surroundings.

1.2 Objectives

- To design and develop a cost-effective, user-friendly assistive device that enhances the mobility and safety of visually impaired individuals.
- To implement a reliable system using sensors to detect obstacles in the user's path, providing early warnings to prevent collisions.
- To provide both auditory (using a normal and passive buzzer) and tactile (using a vibration motor) alerts, ensuring that the user is informed of obstacles in various environments, including noisy surroundings.
- To design a lightweight, portable, and ergonomically efficient device that can be easily handled by visually impaired users.
- To utilize readily available and affordable components, such as the Arduino Nano and basic sensors, to make the device accessible to a wide range of users.
- To Ensure the device is low-power and can operate for extended periods, minimizing the need for frequent charging or battery replacements.

1.3 Scope of the Project

The **Smart Blind Stick** project is focused on developing a practical and effective assistive tool for visually impaired individuals, enhancing their mobility and safety through advanced sensor technology. The project involves designing and implementing a stick that can detect obstacles in real time and provide immediate feedback to the user via auditory and tactile alerts. Using an **Arduino Nano** microcontroller, the system processes input from proximity sensors and drives **buzzers** and a **vibration motor** to notify users of nearby obstacles. The normal and passive buzzers provide distinct sound signals, while the vibration motor delivers haptic feedback, making the device suitable for various environments, including noisy areas where sound alone may be insufficient.

A key objective of the project is to ensure that the stick responds instantly to obstacles, giving users timely alerts that allow them to navigate their surroundings with greater confidence and independence. The device is designed with user comfort in mind, ensuring it is **lightweight, portable**, and **easy to handle**. The combination of affordable components and energy-efficient design makes the Smart Blind Stick an **accessible solution** for those in need, aiming to improve daily life without being prohibitively expensive.

The scope of the project also includes potential future improvements, such as integrating features like **GPS for navigation**, **voice assistance**, or **Bluetooth connectivity** to further enhance usability. With ongoing testing and feedback from users, the Smart Blind Stick could be refined to offer even more accurate obstacle detection and smoother feedback mechanisms, continuously improving the user experience and expanding its capabilities.

CHAPTER 2
PROPOSED SOLUTION
2.1 Block Diagram

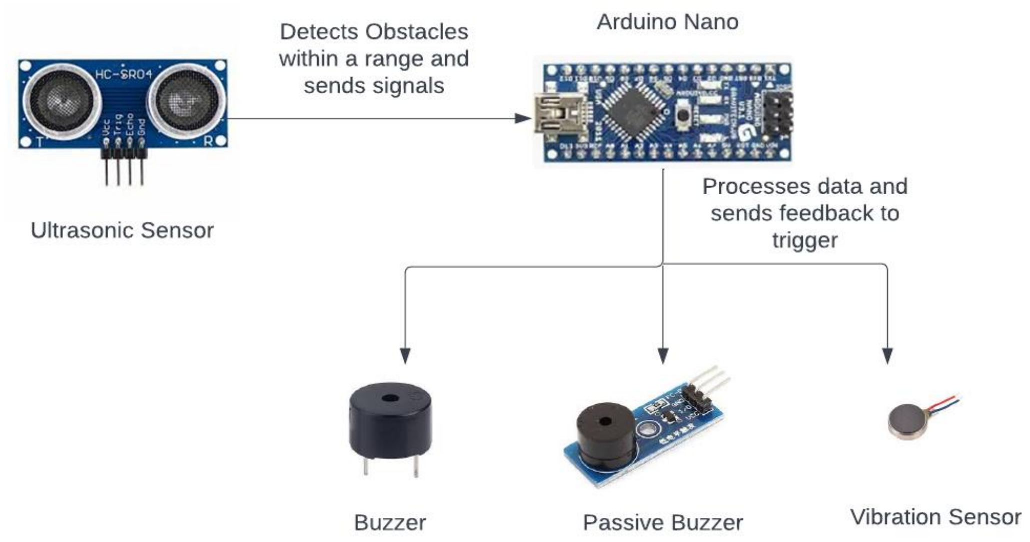

Fig 2.1.1 Block Diagram

The diagram illustrates the working mechanism of the Smart Blind Stick, designed to assist visually impaired individuals in detecting and avoiding obstacles. The process begins with the Ultrasonic Sensor detecting obstacles by emitting sound waves and measuring the time it takes for the echo to return. This sensor calculates the distance to the object and sends the information to the Arduino Nano, which serves as the system's microcontroller. Once the Arduino detects an obstacle within a certain range, it sends signals to alert the user through multiple feedback mechanisms. The buzzer emits sound, providing an auditory warning. Similarly, the passive buzzer offers a varied sound alert depending on how close the obstacle is. In parallel, the vibration motor provides tactile feedback by vibrating when obstacles are nearby. This combination ensures that the user receives timely alerts, enabling them to navigate safely and confidently.

2.2 Modules Description

2.2.1 Ultrasonic Sensors (Obstacle Detection)

The smart blind stick starts with ultrasonic sensors as the primary input devices for detecting obstacles in the user's surroundings. These sensors emit ultrasonic waves and measure the time it takes for the waves to bounce back after hitting an object. By calculating the time difference, the sensor determines the distance to the obstacle. Multiple ultrasonic sensors can be placed at different angles or heights on the stick to cover a wide area of detection. The sensors continuously scan the environment in real-time, alerting the user to any obstacles within a predefined range. This ensures that the user can navigate safely by avoiding potential hazards in their path.

2.2.2 Microcontroller (Arduino Nano)

The microcontroller serves as the central processing unit of the system, managing input from the ultrasonic sensors and other connected components. It processes the distance data collected by the sensors and determines if an obstacle is within the danger range. Based on predefined thresholds, the microcontroller sends signals to the vibration motor and buzzer to alert the user. The microcontroller also integrates other features, such as GPS tracking or emergency assistance buttons, if present. It ensures smooth coordination between all sensors and feedback mechanisms, enabling real-time response to environmental changes.

2.2.3 Buzzer (Auditory Feedback)

The buzzer is responsible for providing auditory feedback to the user when an obstacle is detected. When the microcontroller detects an obstacle within the specified range based on sensor input, it sends a signal to activate the buzzer. The frequency or intensity of the buzzer can vary depending on the proximity of the obstacle — a closer object could trigger faster or louder beeps.

The buzzer acts as an immediate alert system, helping the visually impaired person identify obstacles and change their course to avoid collisions.

2.2.4 Vibration Motor (Haptic Feedback)

The vibration motor offers haptic feedback to the user as an additional form of alert. When the ultrasonic sensors detect an obstacle, the microcontroller sends a signal to the vibration motor, which starts vibrating to inform the user about the presence and distance of nearby objects. The intensity of the vibrations can vary depending on how close the object is, giving the user a sense of proximity through touch. This haptic feedback is especially helpful in noisy environments where auditory alerts may not be as effective.

2.3 Software Requirements

- Arduino IDE Software

2.4 Hardware Requirements

- Ultrasonic Sensors (HC-SR04)
- Passive Buzzer (KY-006)
- Active Buzzer
- Vibration Motor
- Regulator 7805
- Battery (e.g., 9V or 12V)
- Switch

2.5 Circuit Diagram and Pin Connections

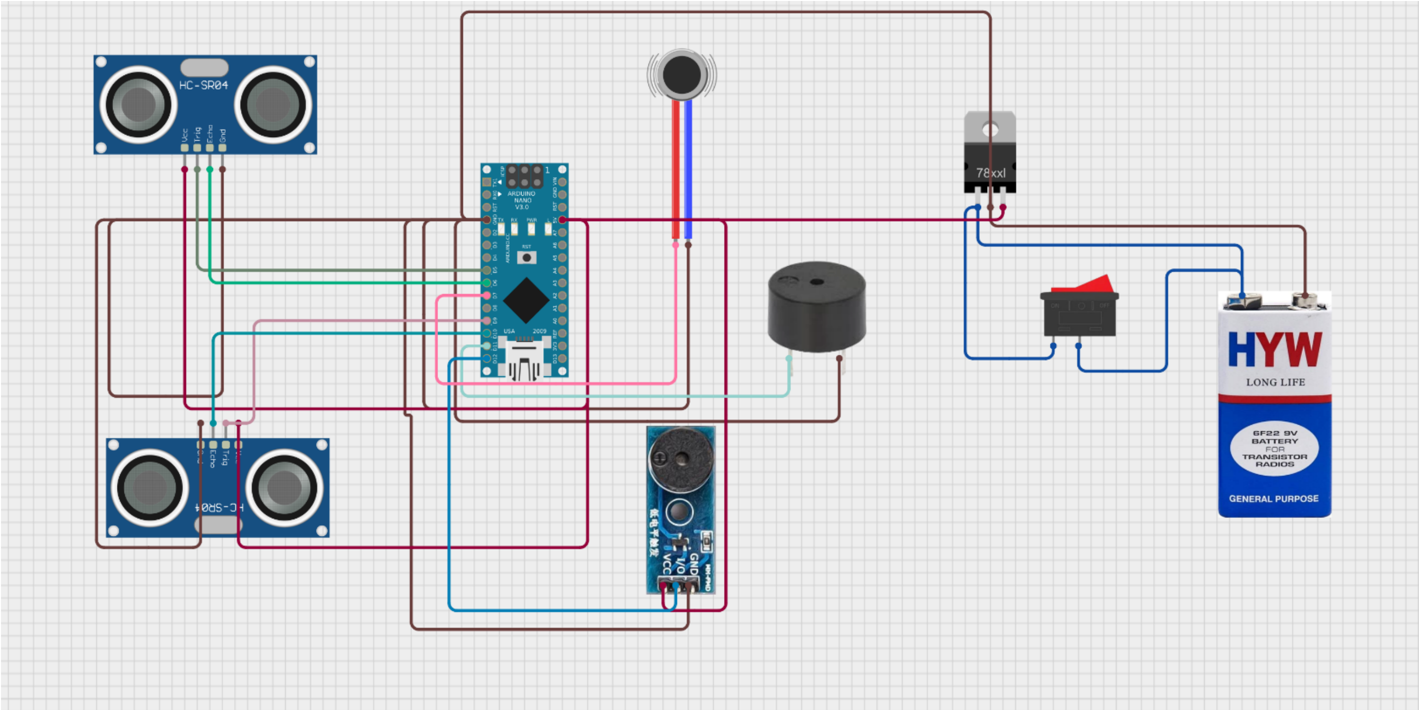

Fig 2.5.1 Circuit Diagram

2.5.1 Ultrasonic Sensors (HC-SR04) to Arduino Nano:

Ultrasonic Sensor 1:

- VCC (Power): Connect the VCC pin of the sensor to the 5V pin of the Arduino Nano.
- GND (Ground): Connect the GND pin of the sensor to the GND pin of the Arduino.
- Trigger (Trig): Connect the Trig pin of the sensor to digital pin D9 on the Arduino.
- Echo: Connect the Echo pin of the sensor to digital pin D10 on the Arduino.

Ultrasonic Sensor 2:

- VCC (Power): Connect the VCC pin of the sensor to the 5V pin of the Arduino Nano.
- GND (Ground): Connect the GND pin of the sensor to the GND pin of the Arduino.
- Trigger (Trig): Connect the Trig pin of the sensor to digital pin D5 on the Arduino.
- Echo: Connect the Echo pin of the sensor to digital pin D6 on the Arduino.

2.5.2 Buzzer to Arduino Nano:

- VCC (Power): Connect the VCC pin of the buzzer to the 5V pin of the Arduino.
- GND (Ground): Connect the GND pin of the buzzer to the GND of the Arduino.

- Signal: Connect the signal pin of the buzzer to digital pin D11 on the Arduino.

2.5.3 Passive Buzzer to Arduino Nano:

- VCC (Power): Connect the VCC pin of the passive buzzer to the 5V pin of the Arduino.
- GND (Ground): Connect the GND pin of the passive buzzer to the GND pin of the Arduino.
- Signal: Connect the signal pin of the passive buzzer to digital pin D12 on the Arduino.

2.5.4 Vibration Sensor to Arduino Nano:

- VCC (Power): Connect the VCC pin of the vibration sensor to the 5V pin of the Arduino.
- GND (Ground): Connect the GND pin of the vibration sensor to the GND pin of the Arduino.
- Signal: Connect the signal pin of the vibration sensor to digital pin D7 on the Arduino.

2.5.5 Power Supply and Voltage Regulator (7805):

- Battery (9V): Connect the positive terminal of the 9V battery to the input of the voltage regulator (7805) and the negative terminal to the GND.
- Regulator Output (5V): Connect the 5V output of the voltage regulator to the 5V pin on the Arduino Nano for regulated power.
- Switch: Place a switch between the positive terminal of the battery and the input of the voltage regulator to control the power supply.

2.6 Ultrasonic Sensor

An **ultrasonic sensor** is a device that uses sound waves to measure the distance to an object or detect its presence. These sensors are widely used in various applications, including robotics, automation, automotive systems, and industrial processes, due to their ability to provide accurate distance measurements without physical contact.

Fig 2.6.1 Ultrasonic Sensor

The ultrasonic sensor operates based on the principle of **echo**. It uses **ultrasound**—sound waves with frequencies higher than the human hearing range (typically above 20 kHz)—to detect objects. The sensor emits an ultrasonic pulse (sound wave), which travels through the air. When this pulse encounters an object, it is reflected back toward the sensor. The time taken for the pulse to travel to the object and back is measured, and this time is then used to calculate the distance to the object. Ultrasonic sensors are commonly used in robots and autonomous vehicles to detect nearby obstacles and avoid collisions. Ultrasonic sensors are commonly used in robots and autonomous vehicles to detect nearby obstacles and avoid collisions.

2.6.1 Working of an Ultrasonic Sensor

An ultrasonic sensor works by,

- **Transmitter Sends Pulse:** The ultrasonic sensor has two main components—a transmitter and a receiver. The transmitter emits short bursts of ultrasonic sound waves (typically 40 kHz).
- **Sound Wave Travels:** These sound waves propagate through the air at a speed of approximately 343 meters per second (at room temperature). The waves continue traveling until they hit an object in their path.
- **Reflection:** When the sound waves hit an object, they are reflected back toward the sensor. This phenomenon is called an echo. The time taken for the echo to return is proportional to the distance between the sensor and the object.
- **Receiver Detects Echo:** The ultrasonic sensor's receiver detects the reflected sound waves. It calculates the time difference between when the pulse was sent and when the echo was received.
- **Distance Calculation:** Using the formula:

$$\text{Distance} = \text{Time taken} \times \text{Speed of sound} / 2$$

The time is divided by two because the sound wave travels to the object and back to the sensor. This calculated distance is the distance between the sensor and the object.

Ultrasonic sensors offer high accuracy and can measure distances within millimeter precision in controlled environments.

2.7 Buzzer

A **buzzer** is an electronic device that produces sound when powered by an electrical signal. It is commonly used in various electronic circuits and applications where an audible alert or alarm is required. Buzzers are compact, simple to operate, and efficient, making them widely used in everyday devices such as alarm systems, timers, and indicators.

Fig 2.7.1 Buzzer

2.7.1 Working of Buzzer:

Servo motors Input Signal: The buzzer is powered by an electrical signal, usually a low-voltage DC current (3V, 5V, or 12V). This signal can come from a battery, a microcontroller (like Arduino), or any electronic control system.

Vibration: When a voltage is applied to the buzzer, the piezoelectric element or electromagnet inside the buzzer begins to vibrate. These vibrations occur at high frequencies, typically in the range of 1 kHz to 10 kHz (depending on the type of buzzer).

Sound Production: The vibrations of the piezo element or metal diaphragm create sound waves, which we perceive as a beep, tone, or alarm sound. The frequency of these sound waves determines the pitch of the sound produced by the buzzer.

2.8 Passive Buzzer

A passive buzzer is a type of sound-producing device that generates sound through the application of an alternating current (AC) signal. Unlike active buzzers, which contain a built-in oscillator and can produce sound when connected directly to a power source, passive buzzers require an external audio signal to produce sound. Passive buzzers typically have two terminals (positive and negative) and can be connected directly to a microcontroller or an audio output circuit.

Fig 2.8.1 Passive Buzzer

2.9 Vibration Motor

A vibration sensor is an electronic device used to detect and measure vibrations in a particular environment or system. These sensors convert mechanical vibrations into an electrical signal, which can then be processed and analyzed**.**

Fig 2.9.1 Vibration Motor

2.9.1 Working of Vibration Motor

- Vibration sensors typically consist of a sensing element (like a piezoelectric crystal or an accelerometer) that responds to vibrations.

- When the sensor vibrates, it produces an electrical signal proportional to the magnitude and frequency of the vibration.
- This signal can be processed to analyze the vibration characteristics, such as amplitude, frequency, and duration.

2.10 Arduino NANO Board

The Arduino Nano is a compact and versatile microcontroller board based on the ATmega328P (or ATmega168). It is part of the Arduino family, designed for building electronic projects. Its small size makes it ideal for applications where space is limited, while its powerful features allow for a wide range of uses. It operates at 5V with a clock speed of 16 MHz, making it fast enough to handle a variety of tasks, from reading sensor data to controlling motors, such as in robotics or prosthetic systems. It has a dimension of approximately 18 mm x 45 mm.

Fig 2.10.1 Arduino NANO Board

One of the key strengths of the Arduino Nano is the small form factor allows it to fit into tight spaces, making it suitable for portable and embedded projects. It is compatible with the Arduino IDE, which provides a simple programming environment and extensive libraries. It is generally more affordable than larger Arduino boards, making it accessible for beginners and educational purposes. It can be used with various shields and modules available in the Arduino ecosystem. It is commonly used in small robots or automated systems due to its compact size and sufficient I/O options.

CHAPTER 3

IMPLEMENTATION

3.1 Source Code

```
// Defines pins numbers for Sensor 1

const int trigPin1 = 9;

const int echoPin1 = 10;

// Defines pins numbers for Sensor 2

const int trigPin2 = 5;

const int echoPin2 = 6;

// Pin definitions for the Buzzers, LED, and Vibration
Motor

const int passiveBuzzer = 12; // KY-006 Passive Buzzer
connected to pin 12

const int activeBuzzer = 11; // Normal Active Buzzer
connected to pin 11

const int vibrationMotor = 7; // Vibration motor connected
to pin 7

// Defines variables for distance calculation

long duration1, duration2;

int distance1, distance2;

int safetyDistance1, safetyDistance2;
```

```
void setup() {
  // Sensor 1 setup
  pinMode(trigPin1, OUTPUT); // Sets the trigPin1 as an
Output
  pinMode(echoPin1, INPUT);  // Sets the echoPin1 as an
Input
  // Sensor 2 setup
  pinMode(trigPin2, OUTPUT); // Sets the trigPin2 as an
Output
  pinMode(echoPin2, INPUT);  // Sets the echoPin2 as an
Input
  // Buzzer and Vibration Motor setup
  pinMode(passiveBuzzer, OUTPUT);   // Sets passive buzzer
as output
  pinMode(activeBuzzer, OUTPUT);    // Sets active buzzer
as output
  pinMode(vibrationMotor, OUTPUT);  // Sets vibration
motor pin as an Output
  // Starts the serial communication for monitoring
  Serial.begin(9600);
}
```

```
void loop() {
  // Clears the trigPin1 and trigPin2
  digitalWrite(trigPin1, LOW);
  digitalWrite(trigPin2, LOW);
  delayMicroseconds(2);
  // Sends the pulse from trigPin1 for Sensor 1
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);
  // Reads the echoPin1, gets the time for sound wave to
return
  duration1 = pulseIn(echoPin1, HIGH);
  // Sends the pulse from trigPin2 for Sensor 2
  digitalWrite(trigPin2, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin2, LOW);
  // Reads the echoPin2, gets the time for sound wave to
return
  duration2 = pulseIn(echoPin2, HIGH);
  // Calculating the distance for both sensors
  distance1 = duration1 * 0.034 / 2; // Distance in cm for
```

```
Sensor 1
  distance2 = duration2 * 0.034 / 2; // Distance in cm for Sensor 2
  // Setting the safety distance to trigger alarms
  safetyDistance1 = distance1;
  safetyDistance2 = distance2;
  // Check safety distance for both sensors
  if (safetyDistance1 <= 5 || safetyDistance2 <= 5) {
    // If either sensor detects an object closer than 5 cm, activate alarms
    digitalWrite(vibrationMotor, HIGH);   // Turn on the vibration motor
    // Activate both Passive and Active Buzzers
    tone(passiveBuzzer, 1000);  // Generates a tone at 1000 Hz for the passive buzzer
    digitalWrite(activeBuzzer, HIGH);  // Turns on the active buzzer
  } else {
    // Otherwise, deactivate all alarms
    digitalWrite(vibrationMotor, LOW);     // Turn off the vibration motor
```

```
    // Deactivate both Passive and Active Buzzers

    noTone(passiveBuzzer); // Stops the tone for the
passive buzzer

    digitalWrite(activeBuzzer,LOW);  // Turns off the
active buzzer

  }

  // Prints the distances from both sensors to the Serial
Monitor

  Serial.print("Distance from Sensor 1: ");

  Serial.println(distance1);

  Serial.print("Distance from Sensor 2: ");

  Serial.println(distance2);

  delay(100);  // Delay between readings

}
```

This Arduino code is designed to control two ultrasonic sensors (Sensor 1 and Sensor 2), buzzers (active and passive) and a vibration motor based on the proximity of objects detected by the sensors. The trigPin1 and echoPin1 are assigned for Sensor 1, while trigPin2 and echoPin2 are assigned for Sensor 2. Additionally, the code defines pins for a passive buzzer, active buzzer, LED, and vibration motor. In the setup() function, the pinMode() function is used to configure the pins as either input or output. Serial communication is also initialized to monitor sensor data. In the loop(), the ultrasonic sensors send out pulses, and the time it takes for the echo to return is measured to calculate the distance to nearby objects. Distances from both sensors are calculated in centimeters. If either sensor detects an object closer than 5 cm, the system activates all alarms, buzzing both buzzers, and triggering the vibration motor. If the distance is greater than 5 cm, the alarms are deactivated. The code outputs real-time distance measurements for both sensors to the serial monitor for monitoring. The delay between each cycle is set to 100 milliseconds. This setup is useful for creating a basic proximity alert system using multiple sensors and feedback mechanisms.

3.2 Flowchart

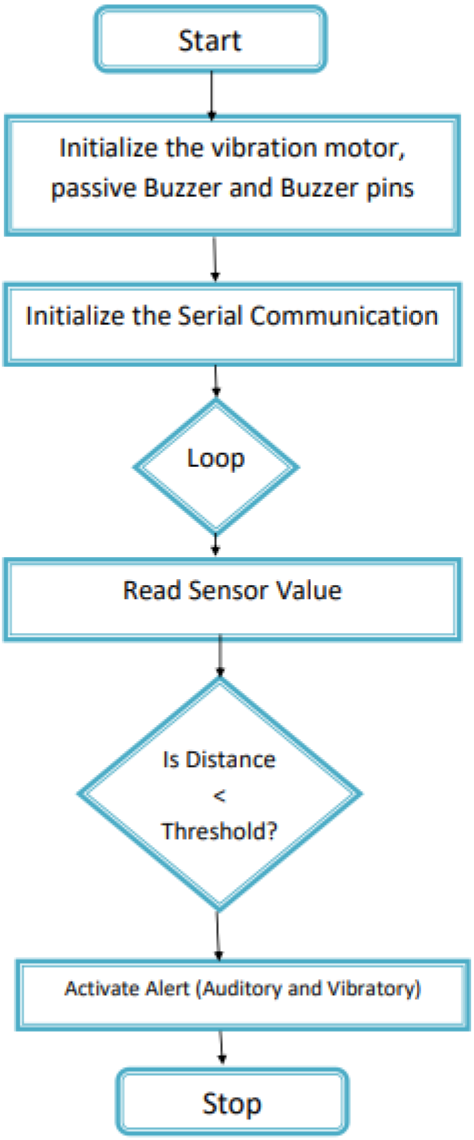

Fig 3.2.1 Flowchart

The flowchart visually represents the process of the Arduino program that controls buzzer, passive buzzer and vibration motor based on ultrasonic signals. It outlines the sequence of actions, from initializing the system to reading the Ultrasonic input, mapping the values to threshold, and sending commands to the nano, while also indicating the loop for continuous operation.

3.3 Experimental Results

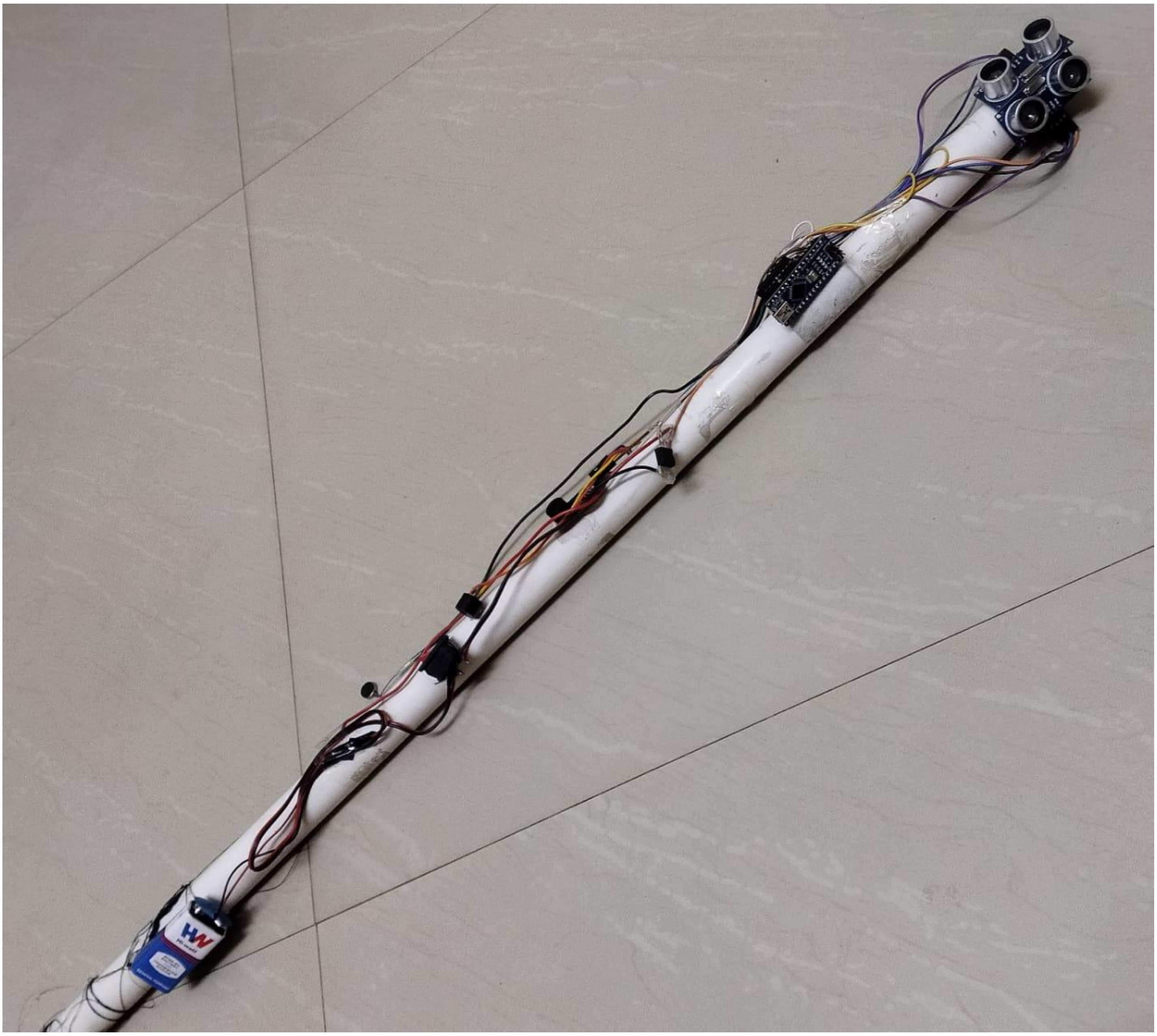

Fig 3.3.1 Project Prototype

```
Distance from Sensor 2: 570
Distance from Sensor 1: 247
Distance from Sensor 2: 570
Distance from Sensor 1: 247
Distance from Sensor 2: 511
Distance from Sensor 1: 246
Distance from Sensor 2: 512
Distance from Sensor 1: 246
Distance from Sensor 2: 569
Distance from Sensor 1: 246
Distance from Sensor 2: 570
```

Fig 3.3.2 Sensor values

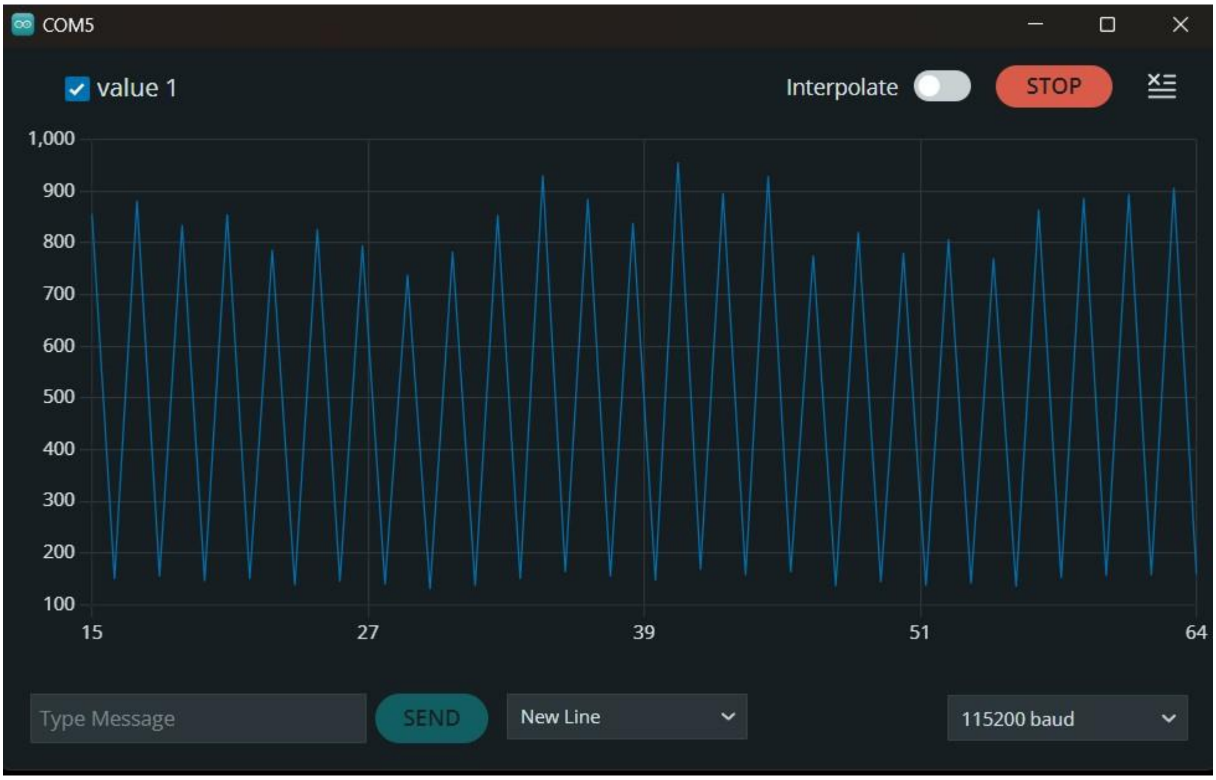

Fig 3.3.3 Plotted Sensor read values

CHAPTER 4
CONCLUSION

The Smart Blind Stick IoT project has successfully demonstrated a practical and innovative solution to enhance the mobility and independence of visually impaired individuals. By integrating advanced technologies such as ultrasonic sensors and IoT connectivity, the smart blind stick provides real-time obstacle detection and navigation assistance. The implementation of features like vibration alerts not only ensures safety but also empowers users to navigate their environment with greater confidence.

Throughout the development of this project, we explored various hardware and software components, resulting in a robust and user-friendly device. Future work may involve refining the design for portability, enhancing the battery life, and incorporating additional features such as emergency alert systems and integration with mobile applications for user-friendly interactions. The impact of this project extends beyond technology; it represents a step towards greater accessibility and inclusivity for individuals with visual impairments, contributing to a society that values equal opportunities for all.

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