BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

# EEE 416 (January 2023)

Microprocessor and Embedded Systems Laboratory

# Final Project Report

## Section: C1 Group: 03

# IOT based Smart Stick for Blind People

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**Signature of Instructor:** ______________________________________________

## Academic Honesty Statement:

**IMPORTANT! Please carefully read and sign the Academic Honesty Statement, below. <u>Type the student ID and name, and put your signature</u>.** ***You will not receive credit for this project experiment unless this statement is signed in the presence of your lab instructor.***

*"In signing this statement, We hereby certify that the work on this project is our own and that we have not copied the work of any other students (past or present), and cited all relevant sources while completing this project. We understand that if we fail to honor this agreement, We will each receive a score of ZERO for this project and be subject to failure of this course."*

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# 1 Abstract

Technology is rapidly evolving to help people improve their day-to-day life. The standard of living can be significantly impacted if a person is visually impaired. It hampers normal day to day activities and decreases workforce participation and productivity level causing depression and anxiety. It is very unfortunate that visually impaired people cannot enjoy their regular life without help from someone else, which can be frustrating. This report presents the design, development, and testing of a cost-effective smart stick for visually impaired people to navigate in the outside environment with the ability to detect and warn about obstacles and casualties like fire and water holes. The proposed design improves the regular assistive stick of a blind person by employing sensors. We have used ultrasonic sensors are used for obstacle detection, a water sensor for sensing the puddles and wet surfaces in the user's path, a flame sensor for detecting fire accidents. Furthermore, the user is signaled about various hindrances and objects using different buzzer sounds after accurately detecting and identifying objects. All these sensors are mounted on a PCB. A GPS and NODEMCU is interfaced to send the user's location to his close contacts in case of an emergency. Such a low cost and low powered device would be a blessing to blind people.

# 2 Introduction

Visually impaired people have acuity 6/60 or the horizontal extent of this visual field with both eyes open less< 200 , which means they cannot or face difficulty in identifying objects around them. There are around 2.2 billion people, at least, that have a near or far vision impairment and it has been found that around 10% of blind people have no usable eyesight at all to help them move around independently and safely. In the era of technological advancement and innovation, our project presents a "Smart Stick" designed to empower blind individuals by enhancing their mobility and safety. In this project we have built an Arduino based smart stick for people with vision impairment or low vision to assist them in their everyday life. Normal white cane used by blind people is not helpful enough to overcome the challenges that they experience while travelling. Therefore, we thought of a stick that will ensure better opportunities to be liberated from most of their pressures concerning their movements. In this project we have used active sensors like three ultrasonic sensors, a water sensor and flame sensor for sensing any kind of obstacle or harm in the user's path quickly. However, the user can encounter different hindrances where he needs the assistance of a person. Emergency situation may also occur that we don't know yet. In that case, the smart stick can track the location of the user with the help of NODEMCU ESP board and send texts/alerts to user's close contacts in case of emergency. This entire device is cost efficient making it affordable to any person. It also uses low power, and the batteries can be replaced easily. Overall, this Smart blind stick will aid blind people to confidently walk in their everyday life.

# 3 Design

## 3.1 Problem Formulation

### 3.1.1 Literature Review

The smart stick, developed by [1] Wahab in **Smart cane: Assistive cane for visually-impaired people**, uses ultrasonic sensor for the detection of the objects or obstacles that come in front of the user**.** Two authors proposed an innovative blind stick technique called **Smart ultrasonic walking stick for visually impaired people [2].** The group built up a stick for outwardly hindered people that helped the individual by providing an alert. But it could not send notifications like navigation or voice message alerts. Muhammad Siddique Farooq , Imran Shafi described an Smart stick model where the location of the user tracked using GPS and send the location with GSM in **IoT Enabled Intelligent Stick for Visually Impaired People for Obstacle Recognition[3]** paper**.**

### 3.1.2 Formulation of Problem

It is not unknown that blind people face a lot of trouble while travelling outside. A normal stick or white cane is used by blind people which can not ensure safety. If there is any obstruction in the pathway, a visually impaired person can not detect it quickly from a safe distance with just a cane and that may lead to some accidental events which can cause physical injury.  Also another aspect of hindrance is water holes which is very common in the streets of our city. For that reason, Headlines are often found with the accident news. This also can’t be detected using a traditional blind stick nor can it warn a blind person if a fire breaks out. Besides, in case of an emergency there is no existing method to inform a visually impaired person’s close contacts within shortest amount of time. These problems might seem minor, but they are really troubling to a blind person. Hence the necessity of a new Smart gadget arises.

### 3.1.3 Analysis

Above mentioned problems made us think of such a stick that will be easier to use but at the same time will guarantee a better experience while walking or just strolling around. We used Ultrasonic sensors for detecting obstacles, water sensor for detecting water holes on the road and flame sensor to aware the user of any fire outbreak through buzzer. We also added a GPS location tracking system using NODEMCU.

## 3.2 Design Method

We used 3 ultrasonic sensors to sense any obstacle within 1ft along with a water level detecting sensor and IR flame sensor are connected to the Arduino Mega 2560. We designed a PCB to attach it to the stick and reduce using wire. The location tracking was done by using ESP8266 NODEMCU board with GPS module and Google's Geolocation service to get live coordinates.

## 3.3 Components

a) Arduino Mega 2560

b) Ultrasonic sensor – 3

c) Water sensor – 1

d) Flame Sensor – 1

e) Buzzer

f) NODEMCU

g) GPS module

h) Battery – 2

i) Wires

Water Sensor

Flame sensor

Ublox neo-6m GPS module


Ultrasonic Sensor (HC-SR04)

Buzzer

Arduino Mega

ESP8266 NodeMCU

## 3.4 Circuit Diagram

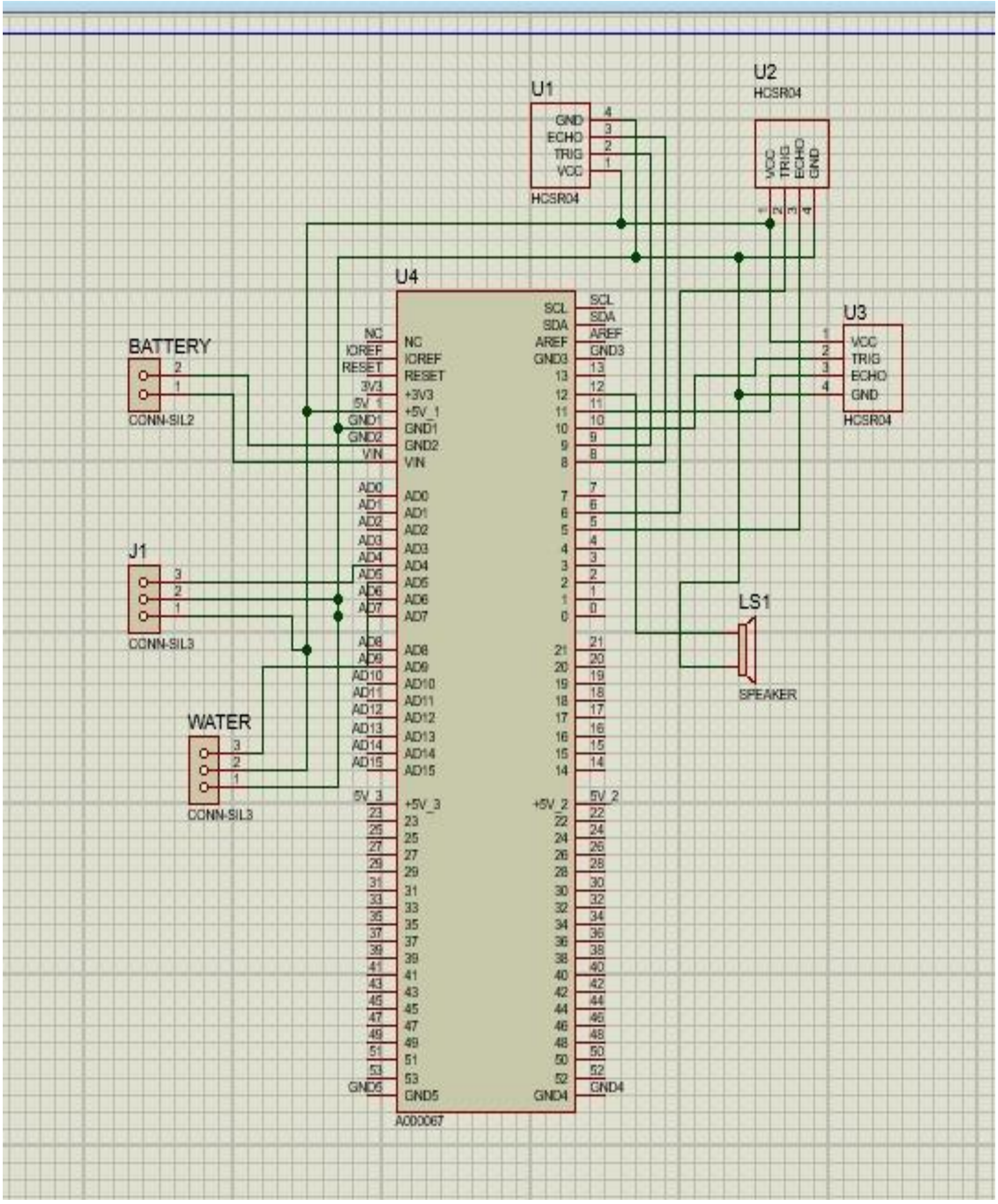



Fig: Schematic diagram of the sensors connected to Arduino

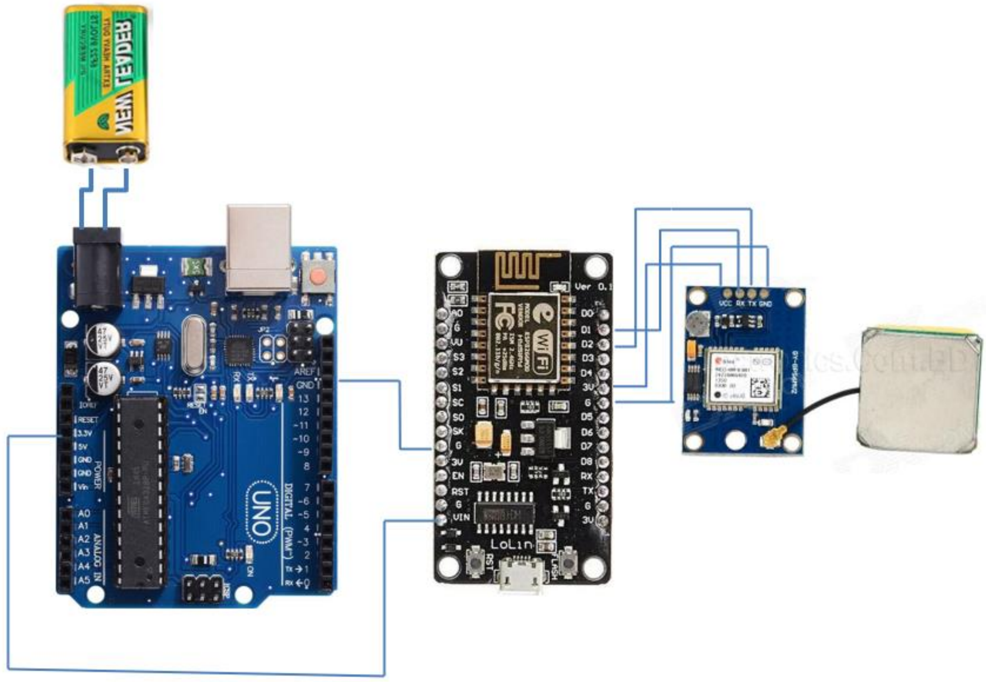


Fig: Schematic diagram of GPS location tracking

## 3.5Hardware Design

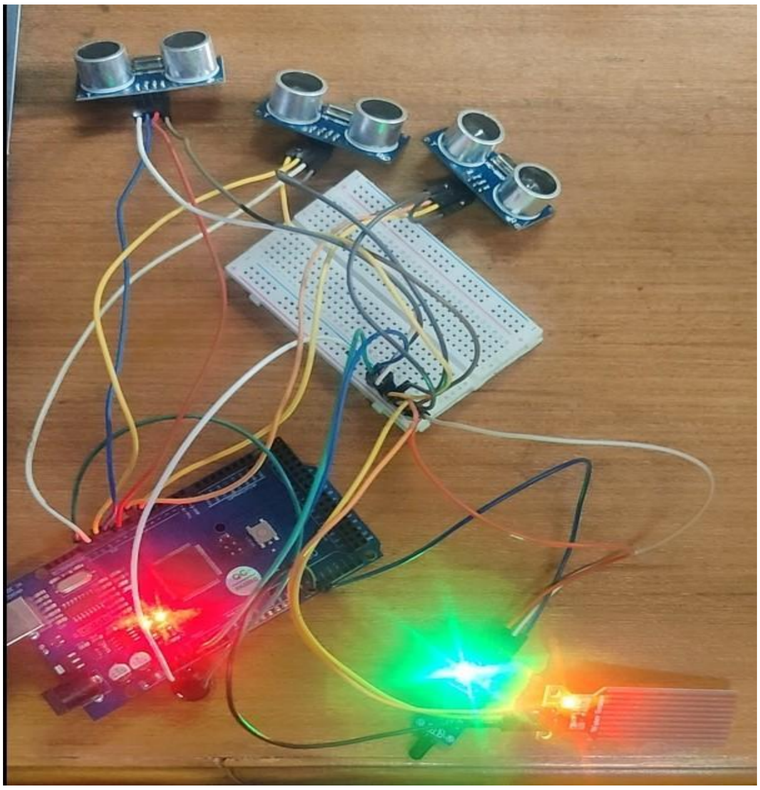
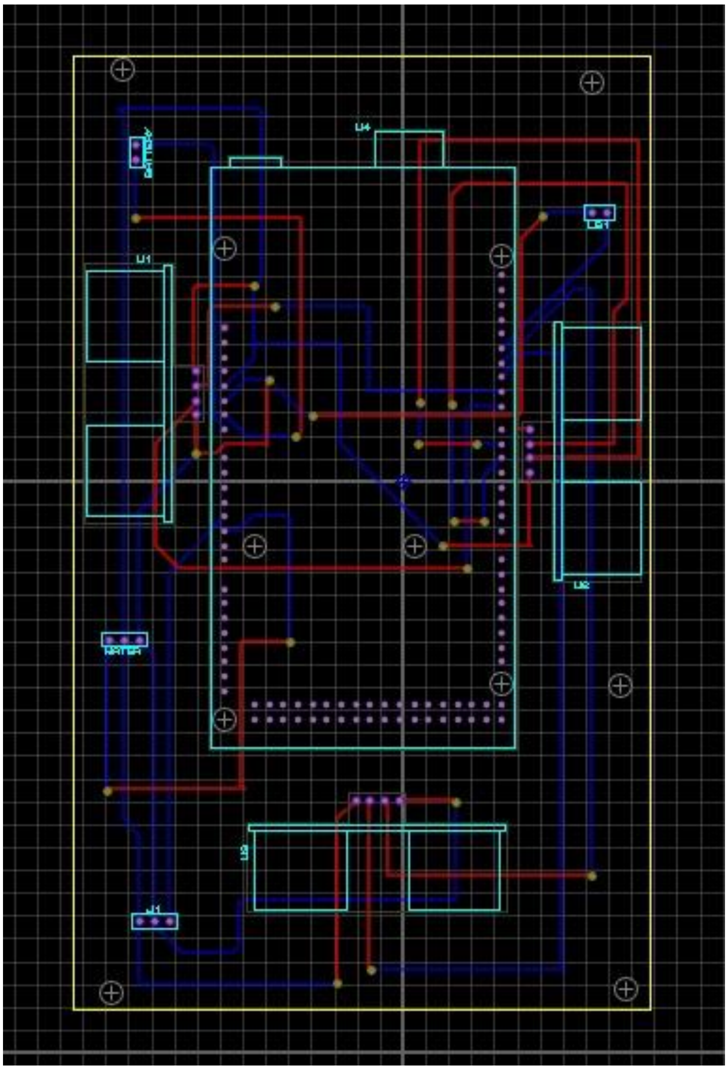


Fig: Sensors hardware connection

## 3.6 PCB Design



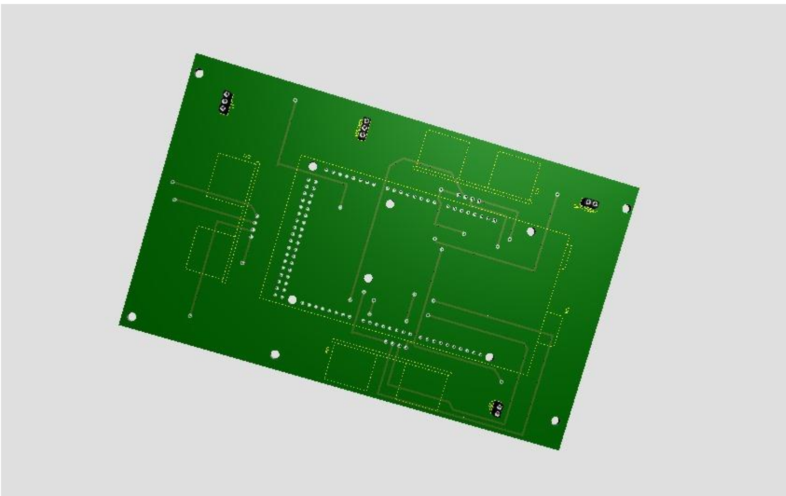


Fig: PCB designed for Sensors

## 3.7Full Source Code

**Code for GPS location tracking**

```
#include <SoftwareSerial.h>

//Install the following Libraries
#include <TinyGPS++.h> //https://github.com/mikalhart/TinyGPSPlus
#include <ESP8266WiFi.h>

//GPS Module RX pin to NodeMCU D1
//GPS Module TX pin to NodeMCU D2
const int RXPin = 4, TXPin = 5;
SoftwareSerial neo6m(RXPin, TXPin);

TinyGPSPlus gps;

const char *ssid = "JaemGem";
const char *password = "12445678nafisa";

String GMAP_API_KEY = "AIzaSyBAJQtiu2uAw6HEJ0BXPsHctoLk0yIMkNs";

WiFiServer server(80);

String html;

void setup()
{
  Serial.begin(115200);
  Serial.println();
  neo6m.begin(9600);

    Serial.print("Connecting to ");
    Serial.println(ssid);

    WiFi.begin(ssid, password);
    while (WiFi.status() != WL_CONNECTED) {
        delay(500);
        Serial.print(".");
    }
    Serial.println("");
    Serial.println("WiFi connected");
    Serial.println("IP address: ");    // this is the address to use for viewing the map
    Serial.println(WiFi.localIP());
    server.begin();

}

void loop()
{
  smartdelay_gps(1000);

  if (gps.location.isValid())
  {
    //Storing the Latitude. and Longitude
    String latitude = String(gps.location.lat(), 6);
    String longitude = String(gps.location.lng(), 6);

    //Send to Serial Monitor for Debugging
    //Serial.print("LAT:  ");
    //Serial.println(latitude);  // float to x decimal places
    //Serial.print("LONG: ");
    //Serial.println(longitude);

    // listen for incoming clients
    WiFiClient client = server.available();
    if(client) {
    Serial.println("new client");
    String currentLine = "";                // make a String to hold incoming data from the client
    while (client.connected()) {
      if (client.available()) {             // if there's client data
        char c = client.read();          // read a byte
          if (c == '\n') {                      // check for newline character,
          if (currentLine.length() == 0) {  // if line is blank it means its the end of the client HTTP request

    //MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
    html="<!DOCTYPE html>";
    html+="<html lang='en'>";
    html+="<head>";
    html+="<meta charset='UTF-8'>";
    html+="<meta name='viewport' content='width=device-width, initial-scale=1.0'>";
    html+="<meta http-equiv='X-UA-Compatible' content='ie=edge'>";
```

```
html+="<title>My Google Map</title>";
html+="<style>#map{height:400px;width:100%;}</style>";
html+="</head>";
html+="<body>";
html+="<h1>My Google Map</h1>";
html+="<div id='map'></div>";
html+="<script>";
//MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM

html+="var map;";
html+="var marker;";

//5000ms means 5000/1000 = 5 Seconds
//20000ms means 20000/1000 = 20 Seconds
html+="var INTERVAL = 5000;";

//MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
html+="function initMap(){";
  //NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
  html+="var options = {";
      html+="zoom:16,";
      html+="center:{lat:"+latitude+",lng:"+longitude+"},";
      html+="mapTypeId: google.maps.MapTypeId.ROADMAP,";
  html+="};";
  //NNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNNN
  html+="map = new google.maps.Map(document.getElementById('map'), options);";
html+="}";
//MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM

//MMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMMM
html+="function getMarkers() {";
  //html+="console.log("+latitude+");";
  //html+="console.log("+longitude+");";

  html+="var newLatLng = new google.maps.LatLng("+latitude+", "+longitude+");";
  //NN…
```

## Code for Sensors:

```
#define trigPin1 9

#define echoPin1 8

#define trigPin2 6

#define echoPin2  5

#define trigPin3 10

#define echoPin3 11

//#define POWER_PIN  7

#define SIGNAL_PIN A5 //water

#define FLAME_PIN A4  //flame



#define buzz_pin  12
```

```
long distance1;

long duration1;



long distance2;

long duration2;



long distance3;

long duration3;



int value = 0;

int flame_detected = 0;



// Maximum distance we want to ping for (in centimeters).

//#define MAX_DISTANCE 400



// NewPing setup of pins and maximum distance.

//NewPing sonar(TRIGGER_PIN, ECHO_PIN, MAX_DISTANCE);



void setup() {

  Serial.begin(9600);

  pinMode(trigPin1, OUTPUT);

  pinMode(echoPin1, INPUT);

  pinMode(trigPin2, OUTPUT);

  pinMode(echoPin2, INPUT);

  pinMode(trigPin3, OUTPUT);
```

```
  pinMode(echoPin3, INPUT);

  pinMode(SIGNAL_PIN, INPUT);

  pinMode(FLAME_PIN, INPUT);



  pinMode(buzz_pin, OUTPUT);

}



void loop() {

 // Serial.print("Distance = ");

  //Serial.print(sonar.ping_cm());

 // Serial.println(" cm");

 delay(500);



digitalWrite(trigPin1, LOW);

delayMicroseconds(2);

digitalWrite(trigPin1, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin1, LOW);

duration1 = pulseIn(echoPin1, HIGH);

distance1 = duration1/58.2;

Serial.print("distance_1 ");

Serial.print(distance1);

Serial.println("cm");
```

```
digitalWrite(trigPin2, LOW);

delayMicroseconds(2);

digitalWrite(trigPin2, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin2, LOW);

duration2 = pulseIn(echoPin2, HIGH);

distance2 = duration2/58.2;

Serial.print("distance_2 ");

Serial.print(distance2);

Serial.println("cm");



digitalWrite(trigPin3, LOW);

delayMicroseconds(2);

digitalWrite(trigPin3, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin3, LOW);

duration3 = pulseIn(echoPin3, HIGH);

distance3 = duration3/58.2;

Serial.print("distance_3 ");

Serial.print(distance3);

Serial.println("cm");




delay(1000);

//water
```

```
delay(10);                      // wait 10 milliseconds

value = analogRead(SIGNAL_PIN); // read the analog value from sensor

//digitalWrite(POWER_PIN, LOW);   // turn the sensor OFF



Serial.print("Water Sensor value: ");

Serial.println(value);



//flame

flame_detected = analogRead(FLAME_PIN);

Serial.print("Fire Sensor value: ");

Serial.println(flame_detected);

 if ((distance1<36 || distance2<36 || distance3<36)  && (value>400) && (flame_detected<100)){

    digitalWrite(buzz_pin, HIGH);

 }

 else if ((distance1<36 || distance2<36 || distance3<36)  && (value>400))

 {

    digitalWrite(buzz_pin,HIGH);

    delay(100);

    digitalWrite(buzz_pin, LOW);

    delay(10);

 }

 else if(distance1<36 || distance2<36 || distance3<36)

 {

    digitalWrite(buzz_pin,HIGH);

    delay(100);
```

```
  digitalWrite(buzz_pin, LOW);

  delay(3000);

  digitalWrite(buzz_pin, HIGH);

  delay(3000);

  digitalWrite(buzz_pin, LOW);

  delay(100);

}

else if ((value>400) && (flame_detected<100)){

  digitalWrite(buzz_pin, HIGH);

}

else if (value>400)

{

  digitalWrite(buzz_pin,HIGH);

  delay(100);

  digitalWrite(buzz_pin, LOW);

  delay(10);

}

else if (flame_detected<100)

{

  digitalWrite(buzz_pin, HIGH);

}

else

{

digitalWrite(buzz_pin,LOW);

delay(1000);
```

```
    }

    delay(1000);

  }
```

# 4 Implementation

## 4.1 Description

We used a total of 5 sensors. Three of them are ultrasonic sensors, and the other two are a flame sensor and a water sensor. The trigger pins and the echo pins of the sonars are connected to the digital pins of the Arduino whereas the flame sensor and the water sensor are connected to the analog pins of the Arduino. To avoid complexities, we designed a pcb to accommodate all of these. Lastly, we installed the whole project on an actual walking stick using threads and binding tapes.

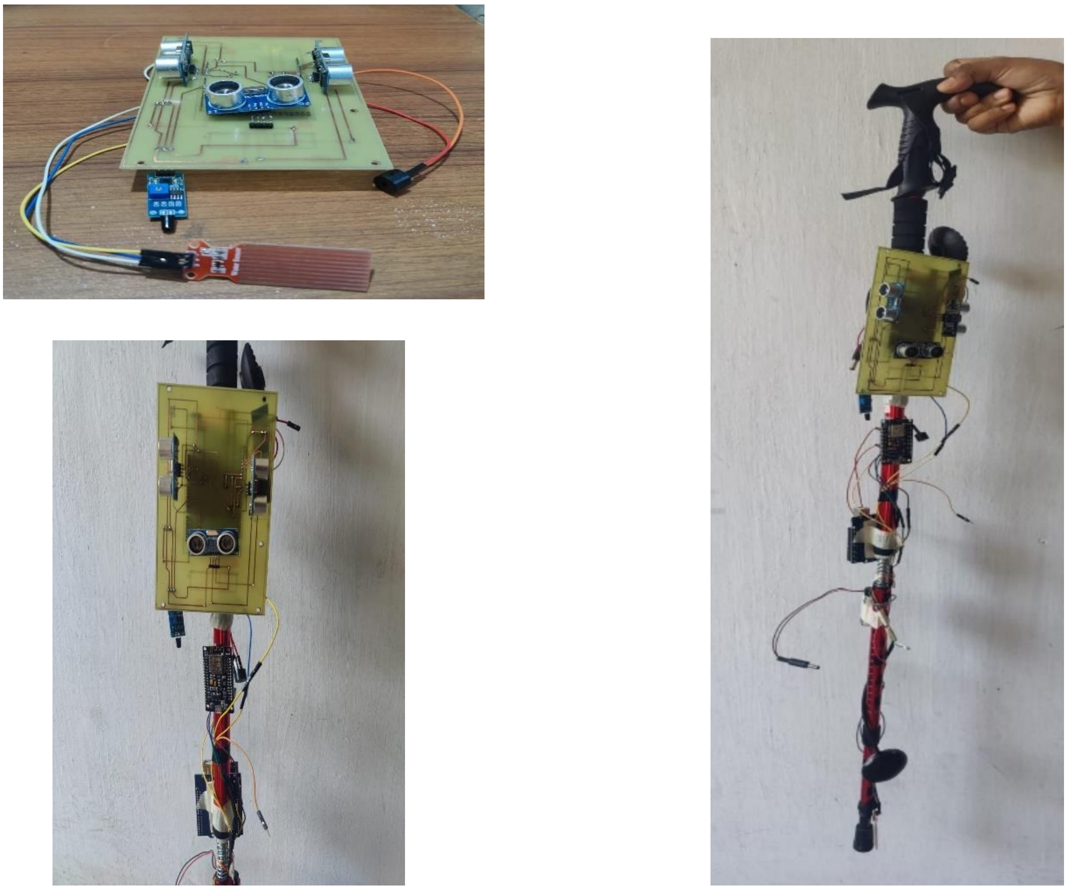


*Figure: Implementation of Design*

## 4.2 Data Analysis & Results

We have set different threshold values for different sensors , as tabulated below:

| Sensor name | Threshold value |
|---|---|
| Ultrasonic sensor | <36 cm |
| Water sensor | >400 |
| Flame sensor | <100 |

As soon as the threshold value is crossed for each sensor, the buzzer will buzz in different patterns to warn the user about the presence of various hindrances.

# 5 Design Analysis and Evaluation

## 5.1 Novelty

Aside from different patterns for different situations, we also incorporated the possibilities of overlapping more than one concern by setting proper priorities. In this project fire was prioritized followed by water and lastly obstacles. We also included a live location tracking facility for rescuing purposes in case of danger.

## 5.2 Design Considerations

### 5.2.1 Considerations to public health and safety

It is needless to say that our project makes a blind person's daily routine much easier and secure. It will reduce any kind of unwanted situation while walking on the road and ensure a safer experience.

### 5.2.2 Considerations to environment

This project is a low power consuming, low waste model. As long as the sensors work fine, this stick is a self-sufficient tool which will leave no negative effect on the environment.

### 5.2.3 Considerations to societal needs

Visually impaired people have to depend on others on a regular basis, which can come in the way of their productivity and talent. If they can be more self reliant, it will boost their confidence which will lead our society to a more enriched manpower.

## 5.3 Investigations

### 5.3.1 Literature Review

### 5.3.2 Experiment Design

We tried to make the design as simple as it can be. So instead of using breadboards, we designed a pcb which was mounted on the stick easily. For live location tracking, we avoided using a gps module as it would have needed a separate arduino board for effective serial communication.

## 5.4 Limitations of Tools

Our GPS sensor doesn't work inside the house and sending location information is troubling. Also our PCB soldering got disconnected from the board several times. A lot of newly bought sensors were damaged too.

## 5.5 Impact Assessment

### 5.5.1 Assessment of Societal and Cultural Issues

Investigate the cultural sensitivity of smart stick deployment, considering local customs, beliefs, and values that may impact public perception.

### 5.5.2 Assessment of Health and Safety Issues

Assess the presence of emergency location sending mechanisms and fail-safe protocols to ensure the safety of people and property

## 5.6Sustainability and Environmental Impact Evaluation

- We performed an analysis of the environmental aspects, aiming to pinpoint any potential adverse effects on ecosystems, wildlife, or natural habitats from the robot's presence or actions.

- We assessed the overall expenses across the entire lifespan, taking into account maintenance, energy consumption, and operational costs.

- We carried out an ethical assessment, seeking to uncover any ethical issues concerning data privacy or the robot's actions in sensitive areas.

- Our commitment includes continuous research and development efforts aimed at improving the sustainability of the robot, by integrating technological advancements.

## 5.7Ethical Issues

During testing we carried out an ethical assessment, seeking to uncover any ethical issues concerning the data privacy or the robot's actions in sensitive areas.

# 6 Reflection on Individual and Team work

## 6.1 Individual Contribution of Each Member

Mayesha and Afroza contributed mostly in PCB designing whereas Eva and Nafisa worked on the microcontroller codes.

## 6.2 Mode of TeamWork

We regularly attended meetings and also worked together in person to turn our ideas into the well-functioning project.

## 6.3 Diversity Statement of Team

Two of us are in Electronics major, and one each are in CSP and Power major.

## 6.4 Log Book of Project Implementation

| Date | Milestone achieved | Individual Role | Team Role | Comments |
|---|---|---|---|---|
| 1.8.23- 12.9.23 | Entire project is complete | Everyone contributed equally | 2 person designed PCB and two person designed arduino codes | Project is done |

# 7 Project Management and Cost Analysis

## 7.1 Bill of Materials

| Name of Equipment | Price (Taka) |
|---|---|
| Arduino Mega 2560 | 1450 |
| Ultrasonic Sensor | 270 |
| Flame Sensor | 50 |
| Water Sensor | 70 |
| ESP module | 420 |
| GPS module | 410 |
| Miscellaneous | 300 |
| TOTAL | 2970 |

# 8 Future Work

We plan to use camera and Machine learning in future for better object detection and alert the user by voice messages

# 9 References


[1] . Wahab, M.H.A.; Talib, A.A.; Kadir, H.A.; Johari, A.; Noraziah, A.; Sidek, R.M.; Mutalib, A.A. Smart cane: Assistive cane for visually-impaired people. arXiv 2011, arXiv:1110.5156.

[2] Gend M, Pathan S, Shedge C, Potdar PDP (2021) Smart ultrasonic walking stick for visually impaired people. Int J Adv Res Sci Commun Technol 680–687

[3] : Farooq , M.S.; Shafi, I.; Khan, H.; Díez, I.D.L.T.; Breñosa, J.; Espinosa, J.C.M.; Ashraf, I. IoT Enabled Intelligent Stick for Visually Impaired People for Obstacle Recognition. Sensors 2022, 22, 8914. https://doi.org/10.3390/s22228914