AN IOT BASED SMART STICK FOR BLIND AND VISUALLY IMPAIRED PERSON

by

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A Project submitted to the Department of Computer Science and Engineering
in partial fulfillment of the requirements for the degree of
M.Engg. in Computer Science and Engineering

Department of Computer Science and Engineering
Brac University
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Declaration

It is hereby declared that

1. The project submitted is my own original work while completing degree at Brac University.
2. The project does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.
3. The project does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.
4. We have acknowledged all main sources of help.

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Approval

The Project titled "AN IOT BASED SMART STICK FOR BLIND AND VISUALLY IMPAIRED PERSON" submitted by Nigar Sultana (16266003) Of Spring, 2021 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of M.Engg. in Computer Science and Engineering on September, 2021.

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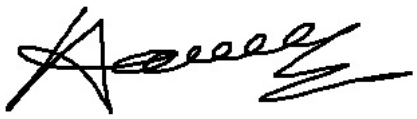

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Abstract

Vision loss has a devastating effect on the lives of those who experience it. It affects as well as on their family, friends and society. Completely loosing or deterioration of eyesight is frightening and unbearable which leaves those affected to question their ability to maintain their independence, remain employed, and provide for themselves and their families. Loss of vision can affect one's standard of life, his independence and mobility as well as it also has been linked to falling down, being injured, mental health issue, social function, cognition and educational attainment. In our society visually impaired or blind people is not very uncommon. At least 2.2 billion people have a near or distance vision impairment globally according to the World Health Organization (WHO). People with vision impairment have lower rates of productivity and workforce participation. They also have high rates of anxiety and depression. The deterioration of vision that they have to suffer from not only matter but also the overall quality of their lives deteriorates too. Vision impairment causes social isolation, a higher risk of falls and fractures. The biggest challenge for a blind person is to navigate around places. Without a human guide he or she cannot navigate around places, especially in a new terrain. Vision impairment is associated with an increased risk of fractures which has been shown in multiple studies. This problem can be life threatening as well.To make life easier for someone with vision loss, SMART STICK has been developed. By detecting obstacles and identify the current position of the blind and visually impaired person IoT based SMART STICK can solve many challenges. Basic requirements of the blind and visually impaired person can be met through this Stick. This IoT based Smart Stick can make a visually impaired person to walk more confidently. The study hypothesizes with the concept of a Smart Stick which allows a visually impaired person to navigate over obstacles and have less incidents.The development work of this Stick involves coding and physical installation of various types of components. The aim of this project is to build a smart stick that could communicate with its users helps him to move freely and overcome his disability.

Acknowledgement

Firstly, all praise to the Almighty Allah for whom my project have been completed without any major interruption.
I would like to express my sincere thanks to my advisor Dr. Amitabha Chakrabarty, Associate Professor of Computer Science and Engineering at Brac University for his kind support and valuable advice in my work. He helped and guided me with great dedication and knowledge in the process of this project.
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Chapter 1

Introduction

1.1 Motivation:

The primary goal of this project is to outline a smart stick to extend the portability of a visually impaired person. Around 80% information human being receive from the environment via sight[12]. A lot of people who lost their eyesight or are suffering from blindness or partial blindness, have to go through severe hardship. Even many children are born with blindness. They have a long life ahead but they will have to be dependent on others. Mobility of the people who are visually impaired is restricted to recognize their surroundings due to their incapability. Their life can be significantly improved and their hardship could be reduced if mobility can be improved by reducing their dependency on others. This plays an important role to come up with this decision.

Visual Impairment: The term "blindness" has a broad spectrum of visual disability from when one's eye sight is impaired enough to interfere with daily activities up to total blindness. Physiological or neurological causes create a state of lacking the visual perception. Each person's experience of blindness is unique and it has many causes which affects eyesight differently. Blindness is commonly stated as the state of being totally sightless in both eyes. A completely blind individual is not capable to see at all. The word blindness is commonly used as a relative term for signifying visual impairment or low vision which means that even with the help of eyeglasses, contact lenses, medicine or surgery, a person would not be able to see well. Vision impairment can be ranged from mild to severe. There are some causes of vision impairment. The significant causes are[17]:

1. cataract
2. trachoma
3. glaucoma
4. diabetic retinopathy
5. age-related macular degeneration
6. uncorrected refractive errors

7. corneal opacity

Recent data provided by the World Health Organization (WHO) shows us that globally minimum of 2.2 billion people have been suffering from a near/distance vision impairment.Among them approximately 50 million people are totally blind. [6] Partial blindness is caused due to the lack of integration in the growth of the optic nerve or visual center of the eye. According to WHO statistics 246 million people have low vision[5]. They need help mostly to carry out their daily lives' routine. According to the The International Classification of Diseases 11 (2018) there are two types of vision impairment i)distance vision impairment ii) near vision impairment [7].

Distance vision impairment:

- Mild – if the visual acuity is worse than 6/12 to 6/18
- Moderate – when the visual acuity is worse than 6/18 to 6/60
- Severe – if the visual acuity is worse than 6/60 to 3/60
- Blindness – when visual acuity is worse than 3/60

Near vision impairment:

- if the acuity is worse than N6 or M.08 at 40cm.

Usually blind or visually impaired people use conventional white stick for navigation.The main white stick for blind is composed after War World I. White cane or Blind Stick is a long (generally white colored) stick that is utilized by visually impaired individuals to know surroundings of them. It is used to identify openings, staircase, pit and slant of the ground or any item around them. When utilizing the white stick, one end of the stick is held by the person and the bottom portion of it touches the ground. A visually impaired individual will swing and tap the stick as he walks forward. There are four types of white stick[18].

1) The first kind of white stick is a long stick. The length of this stick is the longest. It is the most essential, alterable and lesser maintenance is required. Therefore it is the most ordinarily utilized. Essential training is required to habituate this sort of white stick for blind individuals. By using this stick they can move freely.

2) The second type of white cane is Guide cane. This stick is considerably shorter than long stick which is just to the abdomen of the person. Therefore, it has bring down portability work. It can be used to recognize gaps, stones, and check.

3) The third type of white stick is identification stick. It is also called symbol stick. It is not intended for portability reason. However, it is intended to remind people around is that the client is visually impaired. The purpose of this white stick is for general society for providing helping hand to visually impaired person.

4) The last type of white stick is a kids' stick. This sort of white stick is for kids' utilization. It has similar properties like long stick.

1.2 Problematic description

Customary white stick is not able to enhance everyday comforts of visually impaired individuals[18]. Visually impaired individual needs to be trained by experts to use the white stick to do their day by day tasks. White stick is able to find an obstruction up to one meter. It can't aware the client when there is a deterrent in front of them until the client has touched it at the certain point. As visually impaired person would not be able to detect the presence of a hitch, any instance might occur because of that. Severe damage on visually impaired individual might occur due to the instances. Besides, visually impaired individual may get lost as well as face some hazard or even be threatened when they need to travel. Therefore, they have to rely on others for everyday life.

1.3 Aims and Objective

There are many limitations as touching or tapping on the object/obstacle with the conventional blind stick is necessary. There can be possibilities of accidents due to this process. Frequent occurrence of stumbling or shattering objects is very common for the people who uses conventional blind stick. Although guidance of dogs as well as humans as a guide can be helpful but this procedure is not only expensive but also very difficult to maintain.Smart Stick can be an alternative to dogs and human guides as it can detect surrounding objects without any prior information.

Figure 1.1: Foldable white cane that is usually used worldwide

To reduce the hardship and struggle of the visually impaired individual, Intelligent IoT based Smart Stick is designed that could guide the visually impaired to move freely without worrying about road obstacles or water ahead. The inbuilt Global Positioning System (GPS) is a key factor that will help family members to know the location of the visually impaired person through SMS. Therefore, he can be tracked by his caregiver. Also in case of emergency SMS can be sent by the visually impaired person by pressing emergency button in the stick to the already stored contacts.

Figure 1.2: The Smart stick helps to walk more comfortably

Due to the reliability and outstanding versatility of the ultrasonic sensor it has been applied to the smart walking stick. The device is very robust. Therefore,it can operate in the most adverse situation. Integrating the ultrasonic sensor to the smart stick is the most suitable option because it serves as a traveling aid. Water sensor has been used to detect water in front of visually impaired individual. Buzzer has been used to inform the visually impaired individual if there is water or obstacle ahead. This proposed system comes with a remote control as well which is used to locate stick in case the stick get misplaced. IR remote receiver system is used for this purpose. Buzzer has been used for detection.

1.4 Organization of the report

The project report is divided into seven chapters and organized in the following way-
Chapter 1- Overview of the project is briefly described in this chapter.
Chapter 2- In this chapter, previous papers in this area has been discussed.
Chapter 3- This chapter describes about various types of required equipment for the project.
Chapter 4- Methodology and process of the venture and the techniques to actualize the venture.
Chapter 5- The way this project has been implemented has been described in this chapter.
Chapter 6- Experimental result has been discussed.
Chapter 7- Contains conclusion and future work.

Chapter 2

Background Study

2.1 Literature Review:

"Smart Walking Stick for Visually Impaired People Using Ultrasonic Sensors and Arduino" was proposed by Dada Emmanuel Gbenga, Arhyel Ibrahim Shanti, et [4] al which was an amalgamation of individual electronic components. Some other electronics sensors and components were also used to build this modified cane along with the ability to solve many issues faced by visually impaired individuals. To detect all kinds of obstacles Ultrasonic Sensor is used and to detect water in the pathway of the user water sensor is used. This cane is made to identify and detect the obstacles as well as humidity in the pathway.

"IoT Based Smart Walking Cane for for Typhotic with Voice Assistance" was proposed by Sathya Narayanan, Gokul Deepan D, Nithin B P. Vidhyasagar[2]. They have designed a system that can solve the challenges of visually impaired individual easily. It can detect obstacles anywhere along with level crossing guidance and identifying live location of the blind person. Ultrasonic Sensors detect the obstacles and Global Positioning System (GPS) has been used to identify live location of the blind person. Reflective Infra Red (RIR) sensor implements the Level Crossing Guidance. Through Wi-Fi module live location of the blind person is uploaded to cloud. Stereophonic Headphone converts Text-to-speech to give the smart stick user navigation information along with instructions. In noisy environments buzzer and vibratory circuit helps to find the distance.

Shah Md Mostofa, et al. Proposed "A Cost Effective Smart walking Stick for Visually Impaired Pepole"[16]. For visually disabled citizens Smart Stick guidance model has been developed. An Arduino based controlling system is in it where an Ultrasonic Sensor has been used for object detection around the user to prevent collusion. To monitor the light strength around surroundings a light sensor is used and also there are LED lights to give signal. A buzzer is here to detect obstacles around the stick which is fitted in a controlling system powered by DC source. This system is being created to help the users who are visually disabled as well as to help them to navigate around them which will help to prevent physical injuries.

N. Rama Murthy, N. Sudha proposed "Smart Navigation System for Visually Challenged People"[3]. They provided a system architecture of waist belt and shoe that could detect obstacles by the visual impaired individual. For this purpose they used 2 sensors at spectacles and 3 sensors at waist belt. They are separated by 12cm from each other. The two sensors in the shoe of which one is facing the front and the other one facing is the down.

Sharma, Himanshu, et al. proposed "Embedded Assistive stick for visually impaired Persons"[9]. Crater or hole identification and avoidance system is implemented when designing the stick. The basic idea is to set the ultrasonic sensor at 30 degree angle on the smart stick which will detect hole or staircase which is at 30 cm distance in front. Accidental falling or getting injured can be avoided by it. Secondly, there is a moisture detection sensor at the bottom of the stick which will detect moisture level of the land or soil and notify him if the moisture level exceeds in a point that might wet the users foot. Thirdly, to detect the obstacles which are above knee level an additional ultrasonic sensor has been used on top of the stick. There is an alarm and vibration system integrated with it. If there is people, object or any kind of obstacle within 50cm ahead the alarm and vibration system will alert the user. Fourthly, at 20cm height of the stick there is another ultrasonic sensor which will detect the obstacles which are below knee level and which can detect the obstacle at a distance of 70cm. A wireless RF remote module (Transmitter & Receiver) is included if the blind person drops the stick or forgets it somewhere. When the remote is pressed, integrated alarm and vibrator will turn on. By this process the user will find it. An arduino microcontroller, three ultrasonic sensors, RF modules, two buzzers and two vibration motors are used to build this system.

Loganathan, N., et al. created the idea "Smart Stick for Blind People"[14]. They proposed a solution for the blind people where they have used an ultrasonic sensor in the blind Stick which can identify any obstacle at the distance of four meters. To perceive unidentified obstacles ahead infrared instrument is used. To help the user finding the stick, radio frequency transmitter and receiver would help. After detecting any obstacle ahead the vibration motor gets activated and through vibration it signals its user. Arduino UNO is being used as microcontroller in this proposed method. According to Loganathan, N. this smart stick is user friendly, low power consumer, quick responsive and easy to hold and fold by the user.

Chen, Liang-Bi, et al. have given the idea of "An implementation of an intelligent assistance system for visually impaired/blind people."[11] In their paper they submitted the theory of an assistance system which is intelligent enough to replace guided dog or human assistance. This assistance system is composed of intelligent smart stick, wearable smart glasses, mobile application and online information platform. When a blind person wears the smart glasses and holds the smart stick, object or obstacle in front is detected. If the blind person happens to fall in a hole or be on an accident, this information (through GPS) will be recorded and uploaded in the online server. By using the mobile application most of the related information can be seen remotely.

Chapter 3

Hardware Description

3.1 Hardware Description

The total system is developed to offer the visually impaired person to give comfort and independence to some extent. Depending on several factors the appropriate hardware selection process has been done. For example- depending on the atmospheric condition making the system affordable and reliable, desired precision of measurements, low cost with better accuracy, , types of obstacle that needs to be detected, the range of the detection etc. This system has been designed considering the above mentioned parameters. It is an integration of both software and hardware. In order to achieve this, suitable hardware and components have been chosen. There are various prototyping boards available in the market that has different features and usage such as Arduino, Raspberry Pi, NodeMcu etc. In this project Arduino Uno has been used as the control kernel. The Hardware that have been used in this project are as follows-

3.1.1 Arduino UNO:

In this system, Arduino Uno has been used as microcontroller which is mainly based on ATmega328. There are many features of ATmega32 for which it is selected as microcontroller in this project. For, example, It can be connected to the computer through USB port easily. ATmega328 board possesses regular innovation. It also has a bug fix in the design which makes the board compatible for this project's use. The microcontroller ATMega328 is easily available and convenience to use. There are other components like PWM pins, timers, other types of sleep modes, external interrupts or internal interrupts etc. The board has got open source tool that has some advantages. It has several hardware components and has the capability to interact with those devices. It is also included of internet, Bluetooth, motor control and many more. This board is flexible which supports the chip of the controller to be replaced from the board in case it got damaged. The power supply can be done using a USB cable, an AC to DC adapter or a battery otherwise. Analyzing the input it can detect its surroundings. With the help of IDE (Integrated Development Environment) and Arduino programming language and the ATmega328 microcontroller can be programmed[19].

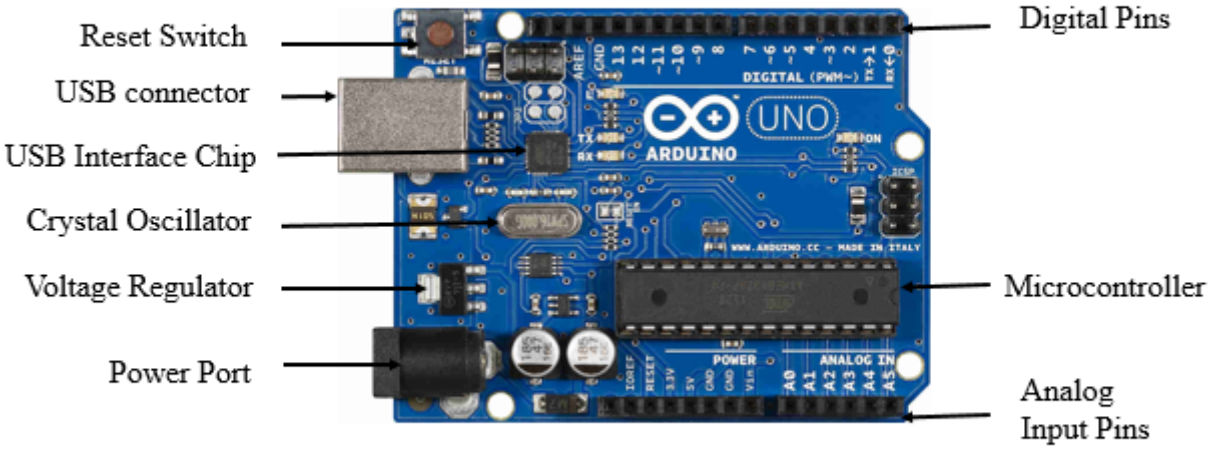

Figure 3.1: Diagram of Arduino Uno

Features of Arduino Uno:

- There are 14 Digital I/O pins
- There are 6 Analog I/O pins
- The operating voltage : 5V
- The input voltage ranges: 6v-20V
- For each I/O pin, DC Current : 40 mA
- Flash Memory : 32 KB
- SRAM: 2 KB
- EEPROM: 1 KB
- CLK Speed: 16 MHz

Arduino Uno PIN diagram: Brief description of the PIN diagram of Arduino UNO board is as follows-

- **Power Supply:** There are two ways of for power supply. It can either be done using a USB cable or using an external power source. The external power supplies can be done using AC to DC adapter otherwise a battery. For AC to DC

adapter power supply, the adapter need to be plugged in into the power jack of the board. On the other hand, If it is done by the battery, the Vin pin and the GND pin should be connected to the battery leads. It is suggested that the voltage range is to be around 7 volts to 12 volts.

- **Input and Output:** There are 14 digital pins on the board which will be used as input and output. The function will be helpful for this purpose are like pinMode(), digitalWrite(), digitalRead() etc.

- **Pin 0 (RX) and Pin 1 (TX) (Serial):** For transmitting and receiving TTL serial data these pins are used. These are mainly connected to TTL Serial chip equivalent pins to the ATmega328 USB.
- **Pin 2 and Pin 3 (External Interrupts):** For activation an interruption over a low value or to change in value these external pins can be used.
- **Pins 3, 5, 6, 9, 10, and 11 (PWM):** This pin is given 8-bit PWM output with the help of analogWrite() function .
- **SPI Pins (Pin-10 (SS), Pin-11 (MOSI), Pin-12 (MISO), Pin-13 (SCK):** For maintaining SPI-communication these pins are used.
- **Pin-13(LED):** As the value of the pin is HIGH, the light emitting diode is activated. Whenever the pin is LOW, the light emitting diode is deactivated.
- **Pin-4 (SDA) and Pin-5 (SCL) (I2C):** These pins support TWI-communication with the help of the Wire library.
- **AREF (Reference Voltage):** It is used for analog input.The function analogReference() is used for this purpose.
- **Reset Pin:** To reset the microcontroller this RST pin is used.
- **Memory:** It has flash memory-32 KB to store code along with 2 KB of SRAM and 1 KB of EEPROM.
- **Communication**:This board uses UART TTL-serial communication. It is accessible using digital pins like TX (1) and RX (0). The serial monitor of the software permits easy data. Two LEDs on the board RX and TX will blink whenever data is being broadcasted through the USB. Software Serial library permits for serial communication. The ATmega328 supports SPI-communication as well as TWI (I2C).Arduino software has a wired library. It helps to facilitate the utilization of the I2C bus.

3.1.2 Ultrasonic Sensor:

As Ultrasonic sensor, HC-SR04 has been used in this system for obstacle detection. This device uses sonar to detect obstacle and determine the distance to an object. It can detect from 2cm to 400cm and the accuracy is approximately around 0.3cm, which is good for most prototype[1]. It could emits ultrasound which travels through the air.

Figure 3.2: Ultrasonic Sensor that has been used for obstacle detection

This electronic device measures the distance of an object which is the target object by emitting ultrasonic sound waves of 40,000Hz (40kHz). If there is any obstacle on its traveling way through the air, it will be bounced back to the module and converts the reflected sound into an electrical signal. The distance can be calculated considering travel time and speed of the sound.Usually, Ultrasonic waves travel very fast. It is faster than the speed of audible sound. There are two main components of this device. 1)The transmitter - emits the sound through piezoelectric crystals 2) The receiver- encounters the sound after it has traveled from the target.The distance between the sensor and the object should be measured by calculating the time between the emissions of the sound by the transmitter to its contact with the receiver. The formula for this calculation is D = $\frac{1}{2}$ T x C (where, D=the distance, T=the time, and C=the speed of sound 343 meters/second)[20].

Feature of HC-SR04: The features of HC-SR04 are mentioned bellow-

- Operating Voltage :5V
- Quiescent Current : <l2mA
- Operating Current: 15mA
- Effective Measuring Angle: <15°
- Detection range : 2cm – 400 cm
- Resolution : 0.3 mm

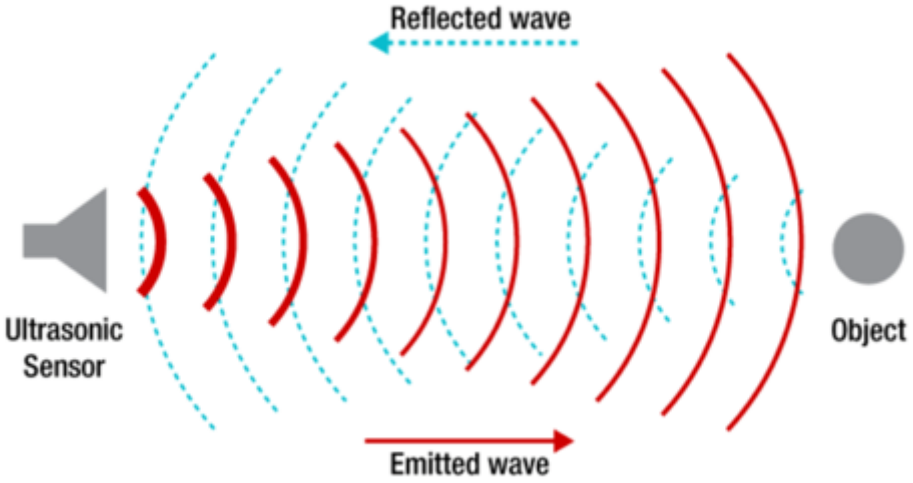

Figure 3.3: How does ultrasonic sensor work

- Dimension: 45mm x 20mm x 15mm

The configuration of HC-SR04 Pinout is-

1. VCC
2. TRIG
3. ECHO
4. GND

This device can be used in various purpose like medical ultrasonography, humidifiers, wireless charging, depth measurement,burglar alarm etc. In this project, ultrasonic sensor is connected to the Arduino UNO .If any obstacle is close enough and less than 50 cm, buzzer will let the blind or visually impaired know that there is obstacle ahead.

3.1.3 Water Sensor:

The water sensor is designed and used to detect the presence of water on the surface. This sensor is widely used in detection of rainfall, water level and even liquid leakage. It is also applicable for detection of the presence of water, the volume of water, the level of water etc.

How does it work: There is a Power LED on the sensor. The LED will light up when the sensor is powered ON.There is an array of ten exposed copper traces on the sensor.This array of exposed parallel conductors act together as a variable resistor which is similar to a potentiometer and its resistance changes according to the level of water. These traces are not connected with each other rather the traces are interlaced between each other. Among them five are sense traces and five are power traces. Therefore, between every two power traces there is one sense trace. However, when they are submerged in water, they are bridged by water. These

Figure 3.4: Water Sensor

traces having a weak pull-up resistor is 1MΩ. While a drop of water shorts the sense trace to the power trace, then the resistor will pull the sensor trace value low. The height of the water is inversely proportional to the resistance of sensor. If the sensor is immersed in more water, results is better conductivity and this will result a resistance is lower.On the other hand, If the the sensor is immersed in less water,then it will result poor conductivity and resistance is higher[21].
However, There is a common issue of the sensor. The sensor has got a short lifespan while it is exposed to a moist in the environment. Constantly powering the probe rush the rate of corrosion significantly. Therefore, to overcome this problem, it should be powered only when the reading is being taken.
In this project when the water is detected, the buzzer will buzz and make sound. Therefore, the user of the stick will be able to know that there is water or puddle in front of him.

3.1.4 Buzzer:

In this project, three piezo buzzers have been used. One buzzer is the output of ultrasonic sensor, second one is the output of water sensor and the third sensor is for IR remote receiver system. An electric buzzer is basically a beeper with audio signaling. The frequency of the sound it produces is around 1KHz to 7KHz . However, at this range for frequency the hearing threshold of buzzer is maximum. Even in a highly noisy environment the sound of the buzzer is noticeable. It might be used in electric doorbells, alarm clock, and keypad feedback or sometimes in games etc.

Types of buzzer

There are different types of buzzer. like-

- Piezoelectric buzzer
- Magnetic buzzer
- Electromagnetic buzzer
- Mechanical buzzer
- Electromechanical Buzzer

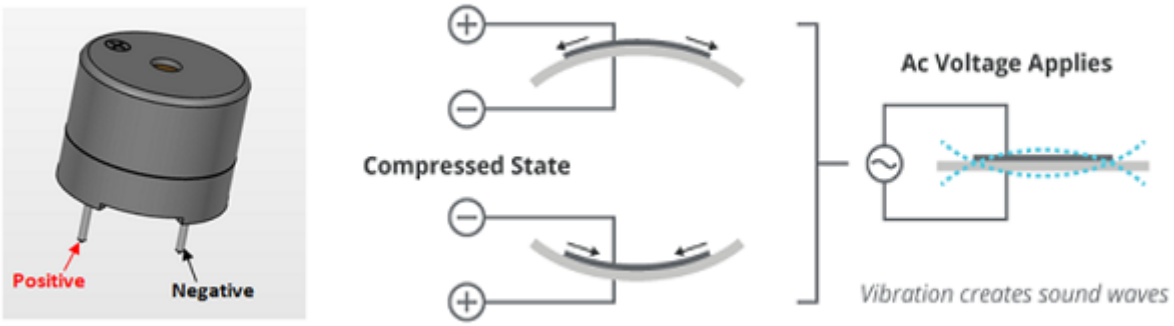

Figure 3.5: Piezo Buzzer and its Working Principal

Working principles: The core of the Piezoelectric buzzer is the piezoelectric effect. The main component is piezoelectric element in this buzzer. It is composed of two types of element. One is piezoelectric ceramic and another element is metal plate. The metal plate and piezoelectric disc are held together. When an alternating current passes through this device, the piezoelectric material will shrink and expand. It will produce a vibration which will cause creating sound waves that is shown in the diagram.

3.1.5 IR remote control (Infrared remote control) and Receiver:

IR remote control and receiver has been used to find out the stick when it get misplaced. IR communication is very common in wireless communication. It is also inexpensive and convenient to use. The wavelength of the IR light is longer than the visible light. Therefore, It is out of human vision range. Thus, it is a good option to use this technology in this project for wireless communication.

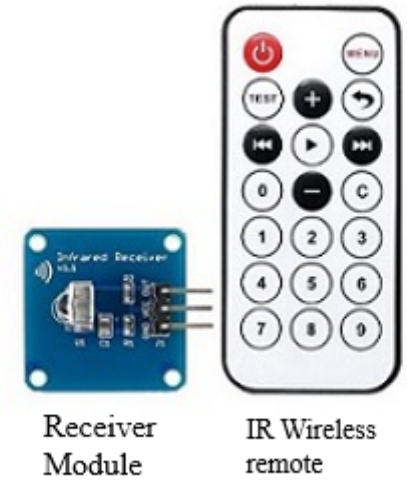

Figure 3.6: IR remote and Receiver

Working principle: IR radiation is simply light that can not be seen by human beings which makes it more suitable for communication. For example when we use television remote for transmitting information to the television, IR LED is applied. Modulated signal is used for this purpose. The IR receiver pick out the ambient IR signal using this method. Modulating a signal is similar to assign a pattern to the data.Therefore, the receiver will be able to listen and understand.

38 KHz modulation scheme is used for IR communication. Though it is very common, however other frequency can be applied as well. Small Number of natural sources posses the regularity of frequency 38KHz. Therefore, the transmitter sending data at 38 KHz frequency will be standing out among all the ambient Infrared. When a specific button of the remote is pressed,the IR light pulses create a unique pattern for that specific button and the IR LED will start transmitting. For a fraction of a second, it will quickly blink and encoded data will be transmitting and sending out to the appliance a modulated infrared signal. That unique pattern will be recognized by the receiver . The command will be executed after the signal is demodulated.

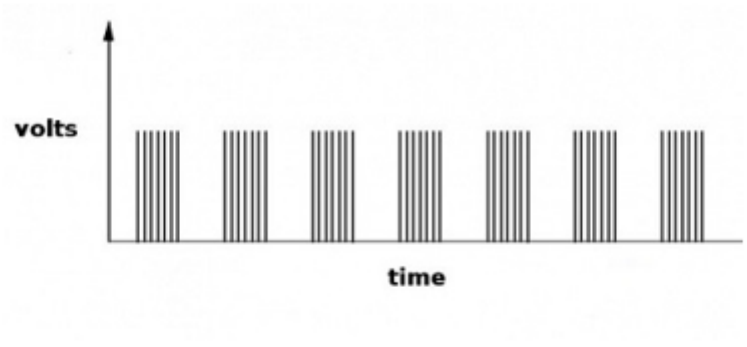

Fig: At frequency of 38kHz each pulse is turned on and off

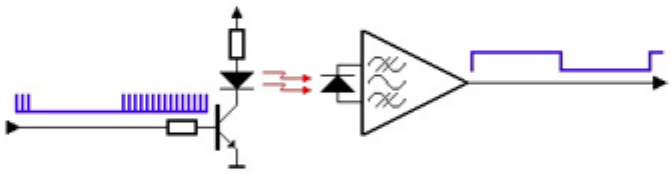

Fig: how an IR transmitter receiver pair works

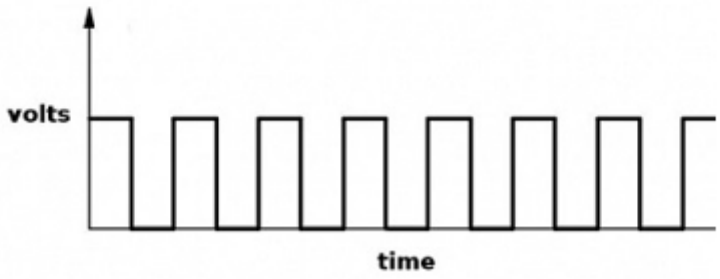

Fig: Output of the receiver

Figure 3.7: The conceptual view of how an IR transmitter receiver pair works

The signal is similar to the one in the picture above using oscilloscope. The receiver will see the modulated signal exactly as the above. The receiver will demodulate the signal. The output is a binary waveform. The binary waveform will be read by the microcontroller. In a microcontroller the binary waveform is read by an input pin and it is decoded as serial bit stream controlling the spacing between the modulated signal.

3.1.6 Push Button:

A push button is a type of switch that use simple air switch mechanism or a electric mechanism. It will trun something ON or OFF applying this mechanism. When it is pressed in a circuit, it only connects two points in that circuit. They could be operated depending on the model with the function momentary or latching action.

Push button has been used in this project for emergency communication. If the blind person needs help he can press the push button which will communicate with a selected person through IOT. When the button will be pressed an SMS will be sent to the saved numbers inside the microcontroller and thus the caregiver of the

Figure 3.8: Push Button

person can be notified that the person is in an emergency situation and as well as get the location of the person.

3.1.7 SIM 808 Module:

This smart stick supports to detect the current location of a blind person by their fellowships. It has an ultimate importance to know about the current position or location of a visually challenged person for their caregiver in case the visually challenged person is lost. In order to solve this challenge SIM808 GPS GSM GPRS shield has been used which is IOT Solution based. It is also suitable for IOT projects such as smart-home, outdoor monitoring, shared bicycle, etc.

This module is a Quad Band GSM/GPRS module that is combined with GPS technology. It is very much useful for satellite navigation. It is integrated with GPRS and GPS in a SMT (Surface Mount Technology) package. For developing GPS enabled applications, this module is helpful and will save time as well as cost significantly. It features a standard interface. At any location it allows to track seamlessly with signal coverage in anytime. A powerful GSM cellular module with integrated GPS is at the heart[22].

This module provides 68 SMT pads. Therefore, interfaces between the module and Arduino Uno can be established easily [22].

Features:

- It supports 4*4keypads by default
- There is a single full modem serial port (UART interface).
- It has Audio channels. It is included with a microphone input and a receiver output.
- There is SIM card interface.
- Charging interface.
- There is Programmable general purpose input and output (GPIO).

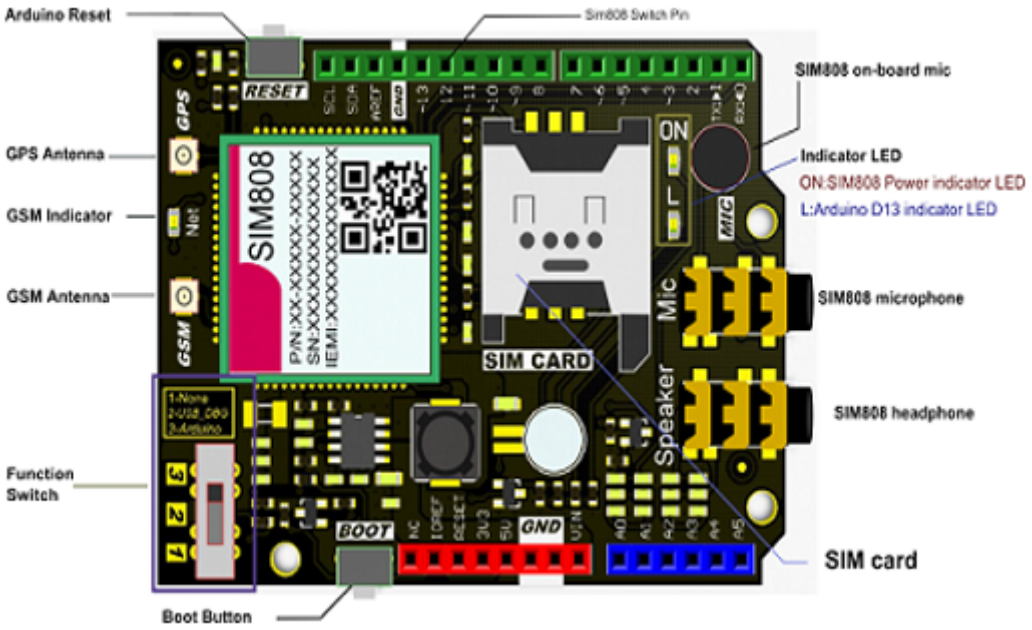

Figure 3.9: GPS GSM GPRS SIM808 Module and pin diagram

- It supports Bluetooth function.
- It has GPS function.
- There are two ADCs and two PWMs.
- PCM/SPI interface.

Interface function: SIM808 Connectors:

- Headset jack-There is TRRS 3.5mm of phone headset jack in this device which is a standard. It also includes mono microphone and stereo earphone. Android and IPhone is compatible for this however iPhone original is excluded.
- GSM and GPS connector-It is GSM and GPS Antenna connector.When GPS reading is required, an antenna is needed to be used connected in the SIM808 shield for more accurate data.
- SIM Connector: It is necessary to use a Mini SIM card in this module to run.
- Battery holder(VRTC)r: For RTC this is the Power supply.

SIM 808 LEDs :

1. PWR –This is the Power light.
2. 1PPS – This is called 'pulse per second' which is the output of GPS.
3. Status – When the module is being booted and running then status of Power will lit.

4. NetLight – It is Network status. Without sending an AT command the current state can be checked with this.

5. 64ms on, 800ms off - This means the module is running however it is not connected to the cellular network yet.

6. 64ms on,3 seconds off - It means the device is able to make contact with the cellular network and also it is able to send/receive SMS along with voice.

7. 64ms on, 300ms off - It means that the requested GPRS data connection is active.

Usage of PIN on Arduino:
D0 – Hardware serial port is selected for communication with SIM808.
D1 - Hardware serial port is selected for communication with SIM808.
D7 - Software serial port is selected for communication with SIM808.
D8 - Software serial port is selected for communication with SIM808.
D9 - Software control to Power ON or OFF of the module SIM808.

Hardware installation: This shield is unable do anything on its own.A microcontroller is required to drive this module. Some accessories is necessary to make SIM808 shield work as well.

- GSM and GPS antenna should be attached.
- A mini SIM card should be inserted into the sim slot. GPS is unable to operate without SIM card.
- When it is necessary to make a call,the headset should be connected to the headset jack.
- Arduino needs to be plugged in or the USB should be connected to the PC.
- Turning the power on of the device by the POWER KEY.

Specification:

- Quad-band 850/900/1800/1900MHz
- Standard Operating voltage: 5V
- Supply Voltage: 7V to 23V
- Operating environment: -40℃ - +85 ℃
- Support Micro SIM connector
- GPRS multi-slot class 12 connectivity
- GPRS mobile station class B
- Send and receive GPRS data (TCP/IP, HTTP, etc)

- Low power consumption: 100mA @ 7V-GSM mode
- Controlled by AT command (3GPP TS 27.007,27.005 and SIMCOM enhanced AT Commands)
- Support GPS satellite navigation technology
- Size: 69 * 54mm/2.71 * 2.12 inches
- Default baud rate: 115200

Chapter 4

Methodology

The Model and overall architecture of this project will be discussed in this chapter.

4.1 Outline of the project

This project mainly has two part- i)hardware part ii) software part. In the hardware part microcontroller Arduino Uno has been used as the brain of the system. This IOT based smart stick can detect two types of obstacle- water and solid object.To detect the solid object ultrasonic sensor has been used. If the obstacle is less than 50 cm which is defined in the code, sensor will detect the object. Then, the buzzer will turn on. On the other hand to detect any kind of liquid obstacle water sensor has been used. If obstacle in any liquid for detected, the buzzer will buzz and the user will be informed that way. SIM808 module has been used to track the blind or visually impaired person and provide the information of the person to his care giver through SMS. If the blind person is in danger he can also communicate with his care giver. He should press the push button of the stick and a notification will be sent to his care giver including his current location through SMS. Remote system has also been used to help to find the stick in case it get misplaced. For this purpose, IR remote and receiver have been used. All the above functionalities mainly controlled by microcontroller. The software part is controlled by using programming and Arduino Integrated Development (IDE) is used.

The modules that have been used in this system are as follows-

- Arduino UNO
- Ultrasonic sensor
- Water sensor
- SIM808 Module
- Switch
- Buzzer
- Speaker

- IR Remote and receiver

BLOCK DIAGRAM:

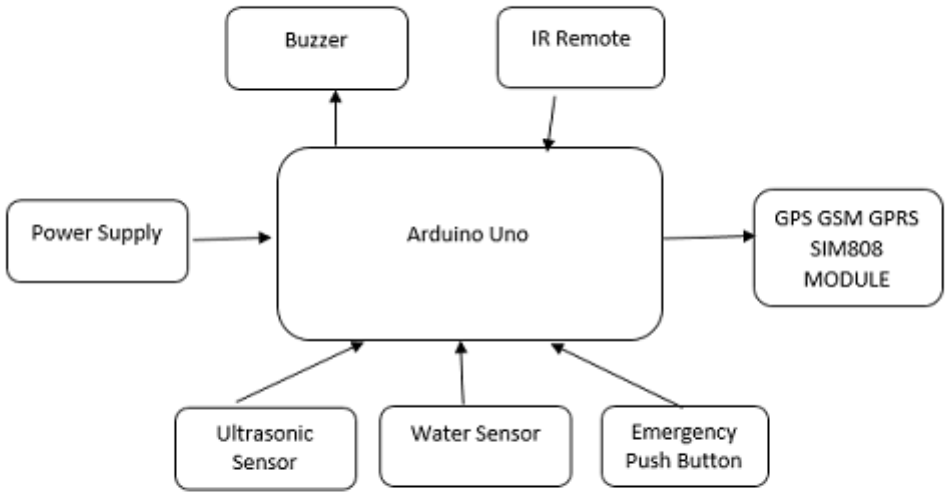

Figure 4.1: Block Diagram of the system

4.2 Flow Chart of the proposed system:

The flow chart of the system demonstrate the way that the proposed system will work. The ultrasonic sensor will recognize the obstacle up to 50cm using ultrasonic wave. Then the Arduino Uno process the data and determine whether the obstacle is close enough. If the obstacle is close enough buzzer 1 will be turned on. If it is more than 50cm away, nothing will happen. If the water sensor detect any liquid, it sends data to Arduino uno and it will process data and will turn on the buzzer 2 of the system. If the button of the IR remote is pressed, the receiver will receive the signal upto distance 2.2 metre and the 3rd buzzer will turn on. It will turned off after pressing the remote. However, this will not work from every angle. The location can be traced by sending sms to the GSM module or sms can be sent to a number from the Arduino Uno which will be mentioned in the code containing the latitude and longitude. While sim808 module that is a high performance GSM GPRS chip integrated with GPS engine is turned on, it will be initialized within 2 to 3 minutes. It will get the GPS signal with UART interface. Then it will report the related GPS into to microcontroller. A sim card has been inserted into the GSM module, when this sim card gets sms, microcontroller will text back with the latitude

and longitude information of the location of the module. Arduino Uno pushes data via HTTP.

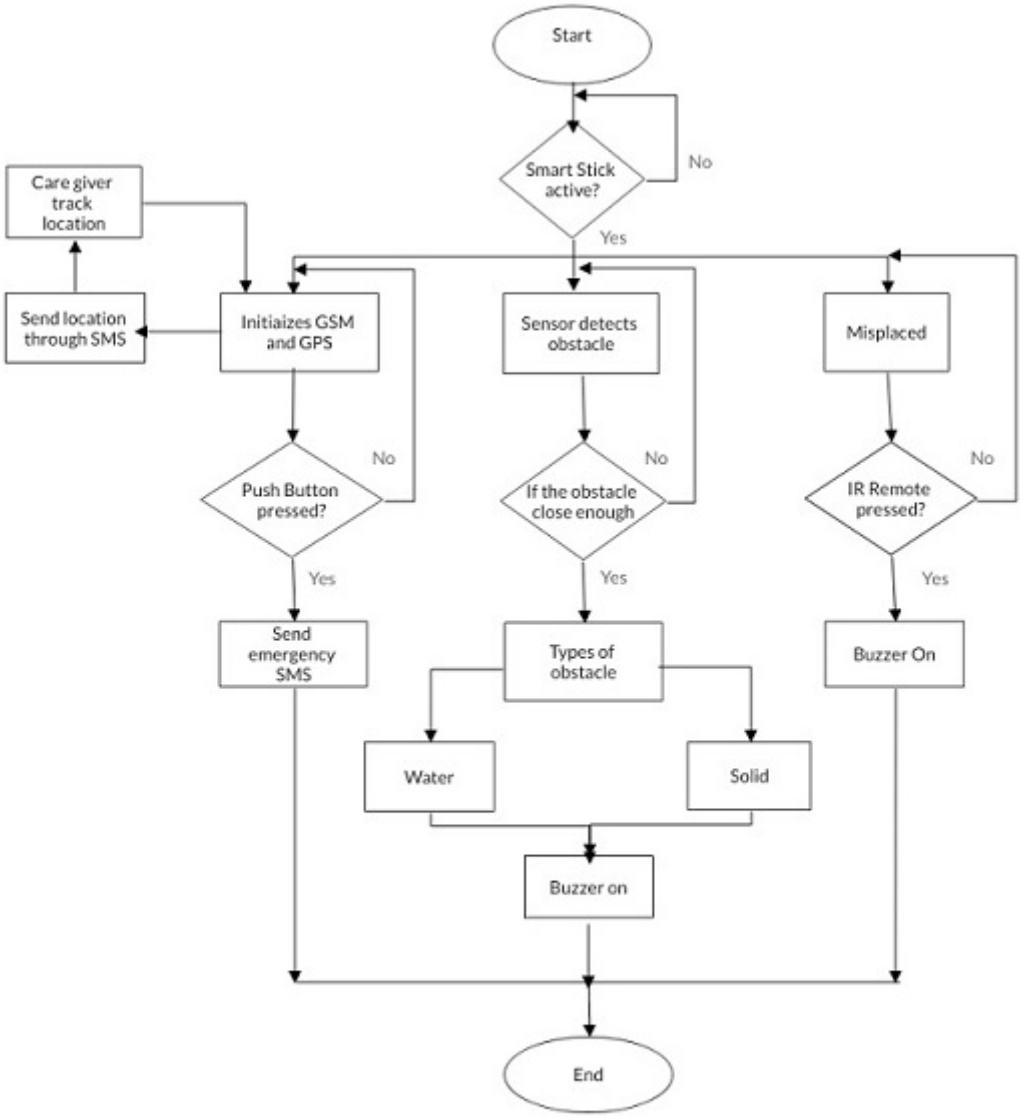

Figure 4.2: Flow Chart of the system

Chapter 5

Implementation

5.1 Software Implementation:

Program has been written using Arduino Integrated Development Environment (IDE). IT can be connected to the Arduino and hardware easily to upload programs and communicate with them. There are two .ino file. Code for running Water sensor, Ultrasonic sensor, IR remote control and sensor has been written in one .ino file. For GPS system .ino file is separate. First one is uploaded to one microcontroller and the second sketch is uploaded to the microcontroller that is connected with sim808 module. To control water sensor water() function has been used. when the digitalRead pin() is low, the output will be low. If the sensor detects water, digitalRead() pin goes HIGH. As a result, the buzzer will buzz. To control ultrasonic sensor, sound() function has been made.In that function distance will be calculated by (duration/2)/29.1 in centimeter as unit. The value of the variable "duration" is taken from echo pin. Then an condition has been applied using IF,Else condition statement. if the distance is between 1cm-50cm, the digitalWrite pin mode will be HIGH else it will be low. Remote() funtion is in the code for IR remote and receiver. All the button of the remote has a specific HEX value. It will be decoded when received.For example, buzzer will turn on if "1" is pressed on the remote and if "2" is pressed the buzzer will turn of. Therefore, It will receive the signal from remote and decode it by (irrecv.decode(&results).For "1" HEX value is 0xFF629D. When "result.value=0xFF629D", the digitalWrite() pin will go HIGH. There is loop() function that will read GPS data. SIM808 module will fetch GPS data in degree, minute and second. This function will calculate the latitude and longitude from degree,minute and second. When the push button will be pressed, the digitalRead() pin will go HIGH and an sms will be sent to the phone number saved in the code containing latitude and longitude.gps()function is used to detect unread sms.

```
void loop() {
  //*************** Get GPS data ********************

   if (sim808.getGPS())
   {
     la=sim808.GPSdata.lat;
     lo=sim808.GPSdata.lon;
     la=sim808.GPSdata.lat;
     lo=sim808.GPSdata.lon;
     ladegree=(int)la;
     lamin=(int)((la-(int)(la))*100);
     lasec=(((la-(int)(la))*100)-lamin)*100;
     latitude = ladegree+lamin*0.01666+lasec*0.00027-0.0101;

     lodegree=(int)lo;
     lomin=(int)((lo-(int)(lo))*100);
     losec=(((lo-(int)(lo))*100)-lomin)*100;
     longtitude = lodegree+lomin*0.01666+losec*0.00027-0.0101;
     dtostrf(latitude, 6, 6, lat); //put float value of la into char array of lat. 6 = number of digits before decimal
     dtostrf(longtitude, 6, 6, lon);
     if ( digitalRead(sw) == HIGH)
  {
    sprintf(MESSAGE, "Latitude : %s\nLongitude : %s\nThis is emergency. HELP.\nhttps://maps.google.com/maps/search/?api=
    Serial.println(phone1);
```

Figure 5.1: Converting degree,minutes and second to latitude and longitude

5.2 Hardware Implementation:

The basic frame of the project where all the component is placed is a UPVC pipe. It is one of the most famous polymer pipe. Two Arduino Uno microcontroller have been used in this project. IR remote and receiver, ultrasonic sensor and water sensor is attached to one Arduino Uno. On the other hand another Arduino Uno has been attached with GPS GSM GPRS SIM808 MODULE and with a push button that is used as emergency button. The system is wired with jumper cables.

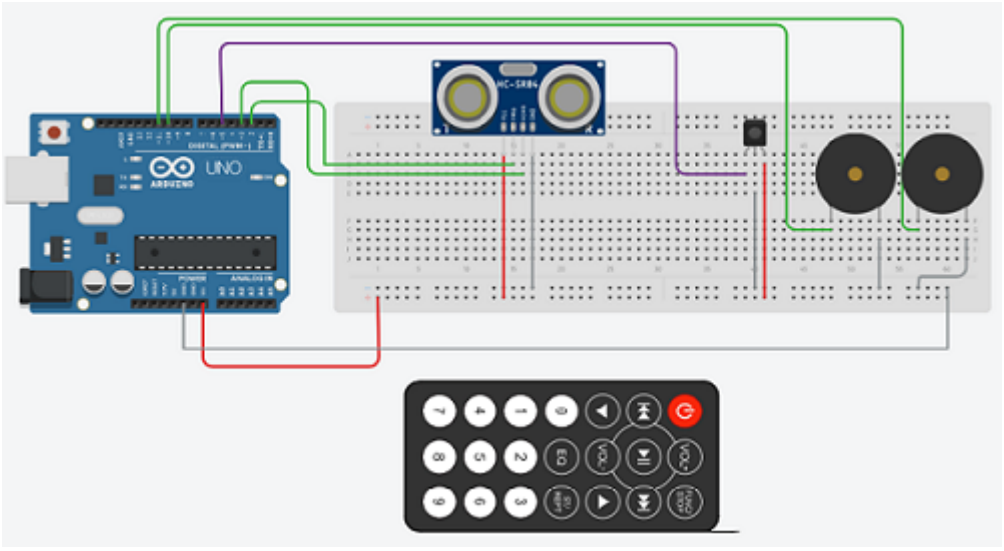

Figure 5.2: Circuit Diagram for obstacle detection and IR remote receiver

- The water sensor was set to the bottom of the stick. The water sensor has been

placed bellow the ultrasonic sensor and the receiver of IR remote sensor on the stick. Therefore the prototype should be handled very carefully otherwise circuit could be damaged. The prototype can be damaged by high level of water or rough surface.There are three terminals of water sensor- S, Vout and GND. Vout and GND is connected to +5V and GND of the Arduino board. S is connected to Digital pin number 6. Digital pin 9 is the output for water sensor where a buzzer is attached. When power is given, the power LED of the sensor will on,after that it will start to work. If the LED does not flash, that means there is any problem that is needed to be fixed.

- Ultrasonic sensor has been placed at 12.5cm height from the ground level just above the water sensor. The ultrasonic sensor has four pins. The GND pin is attached to 0v/GND and Vcc pin to 5V of Arduino. Trig pin is connected to the Arduino digital pin 3 and the Echo pin is connected to the Arduino digital pin 2. The output pin is attached to the digital pin 10. Output is connected to Buzzer.

- The receiver of the IR sensor has been set just above the ultrasonic sensor. Input of the IR remote receiver id connected to the digital pin number 5 and pin number 11 is the output of the IR remote receiver. Output is connected to a buzzer.

- Microcontroller ATmega328 along with the bread board is placed between the power supply and IR sensor receiver. This microcontroller is connected to water sensor, ultrasonic sensor, IR sensor receiver. Two 9v batteries have been used for power supply of the two microcontrollers.

- Sim808 module along with another ATmega328 has been placed on the top of the stick. sim808 has been interfaced with this ATmega328. Digital pin number 7, 8 is the transmitter and receiver respectively. An antenna is attached to the GPS connector for GPS signal and data.One mini sim card has been installed to the sim slot. Push button is connected to digital pin number 5 of 2nd Arduino Uno board where SIM808 module is attached.Then the USB is connected the PC and boot the device turning on the power button.Then I have waited some time while see the blinking light of status led. After that the code has been uploaded to the microcontroller. When the code has successfully loaded the usb can be disconnected.

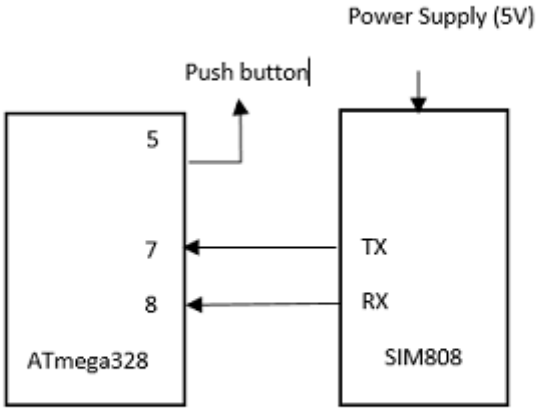

Figure 5.3: Interfacing ATmega328 with SIM808 module

Finally, after integrating and placing all the components, Working model of the prototype is as follows-

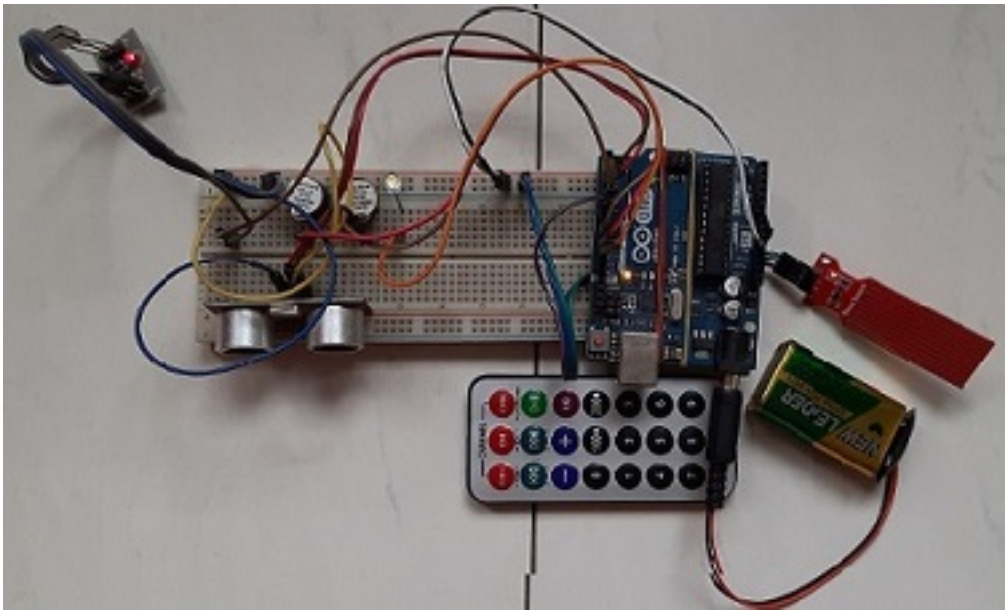

Figure 5.4: Circuit for obstacle detection, water detection and IR receiver

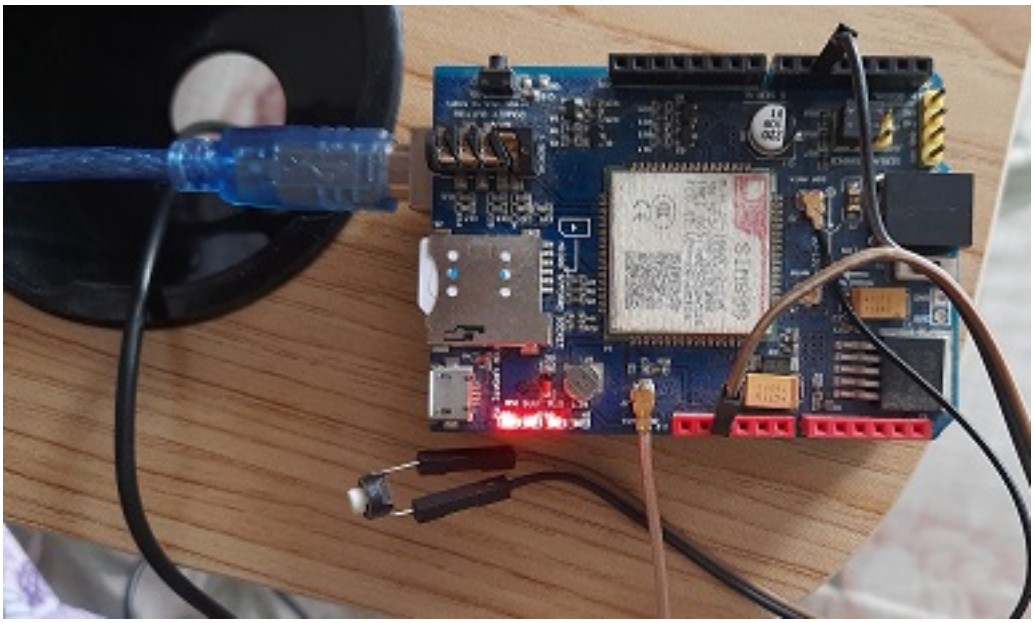

Figure 5.5: SIM808 module along with emergency push button is connected with ATmega328.

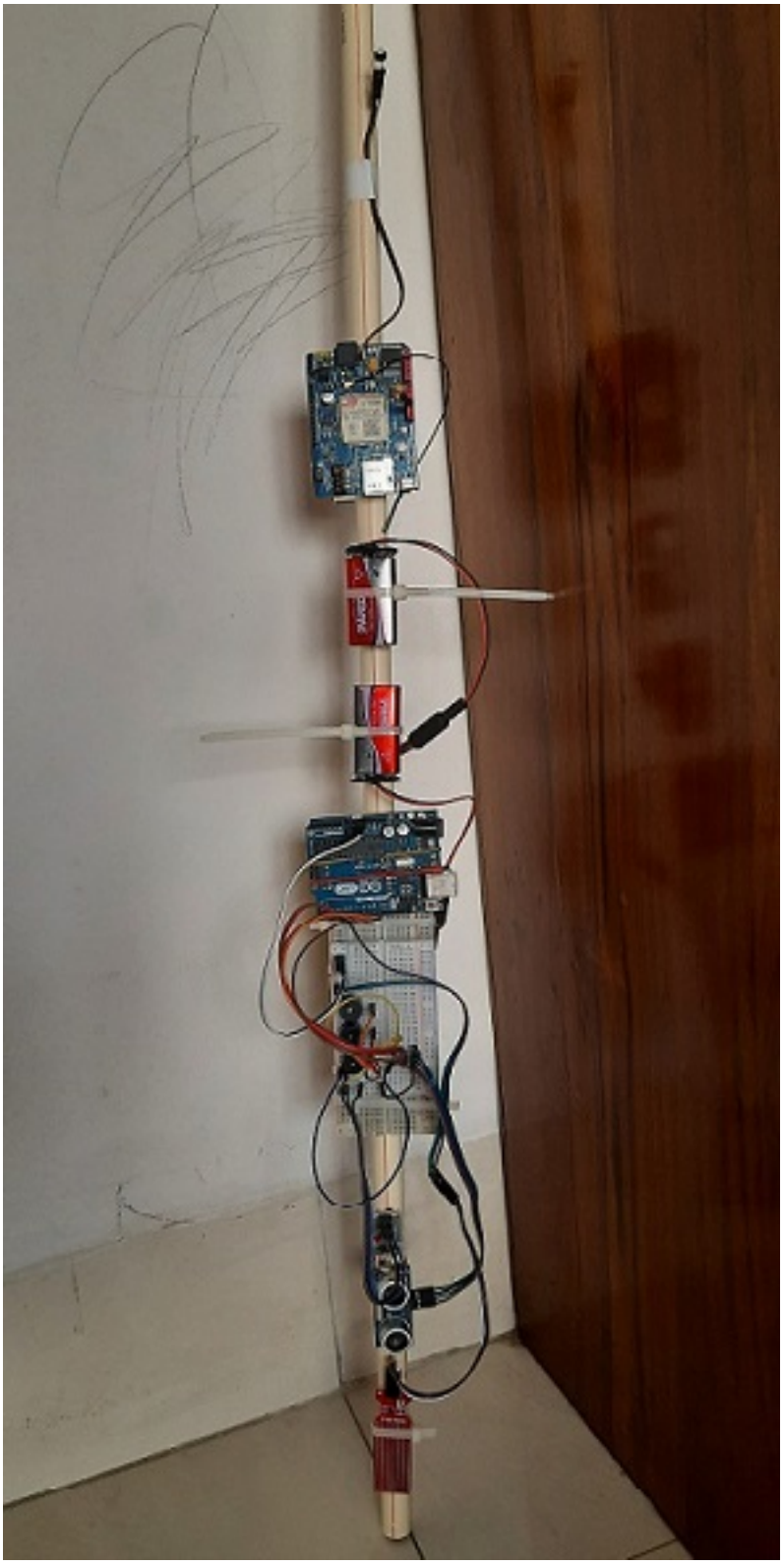

Figure 5.6: Working model of the prototype.

Chapter 6

Result And Discussion

6.1 Distance measurement test result:

The prototype of the smart stick has been implemented and the afterward effects have been discussed in this section. The outcome has been tried and the result are charted. The experiments were done both in indoor and outdoor.

Ultrasonic sensor HC-SR04 which is a standard does 1cm-50cm non-contact measurement here. Ultrasonic sensor has some drawbacks like-

1. It is very sensitive to variation in the temperature, airborne particles, weight, air turbulence.

2. Odd Formations will cause alignment issues for example small or curved object, rough surfaces etc. For the curved object a scanner having wheel-probe might be an excellent option. However, if the scanner is unable to read the second part of axes it could cause misalignment problem .

3. For probing test item surface needs to be accessible.Throughout the object for facilitating sound transfer in the surface coupling liquids needs to be applied.

4. Composition of the material is very important. Waves is unable to penetrate grainy materials or cast iron and which leads sound transmission to be diminished. For example,Attenuation can be caused by the larger grain that is found in austenitic steel and that causes to cover defects during ultrasonic testing.

The following table shows result of the accuracy test for distance measurement of different heights of the obstacle.

Distance	Readings	Error
10cm	no detection	0
20cm	16.5cm	3.5
30cm	22cm	8
40cm	37cm	3
50cm	44cm	6

Table 6.1: Distance measurement test result when obstcle height is 10cm

Distance	Readings	Error
10cm	7cm	3
20cm	14cm	6
30cm	21cm	9
40cm	31cm	9
50cm	41cm	9

Table 6.2: Distance measurement test result when obstcle height is 15cm

Distance	Readings	Error
10cm	9cm	3
20cm	16cm	4
30cm	27cm	3
40cm	36cm	4
50cm	41cm	9

Table 6.3: Distance measurement test result when obstcle height is 22cm

Average error is 13.6%, 24% and 14% respectively. Height, width, material, shape of the obstacles used are different. The graph between actual and detected distance for obstacle with height 10cm, 15cm and 22cm is given bellow-

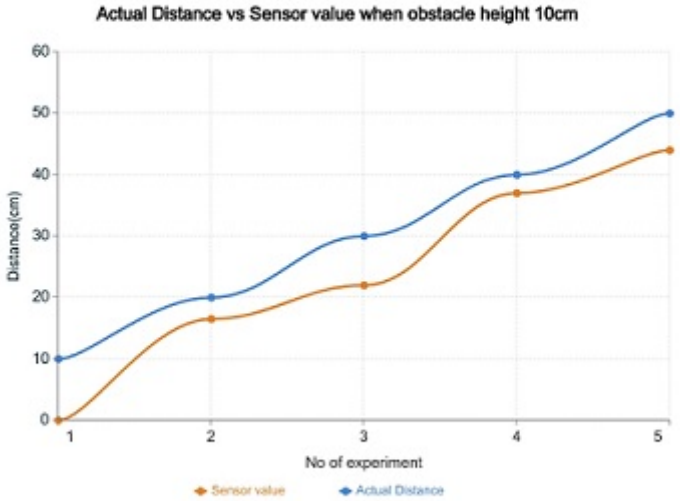

Figure 6.1: Graph between actual and detected distance for obstacle height 10cm

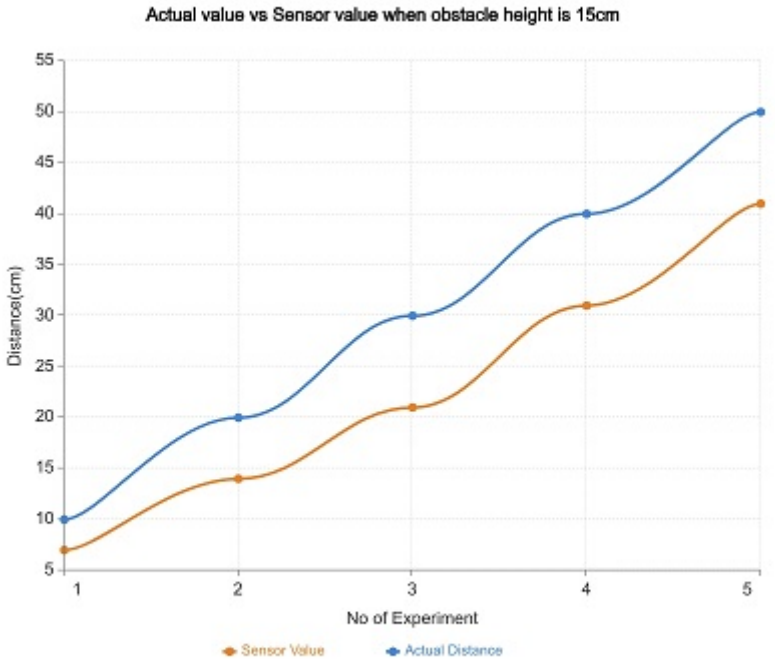

Figure 6.2: Graph between actual and detected distance for obstacle height 15cm

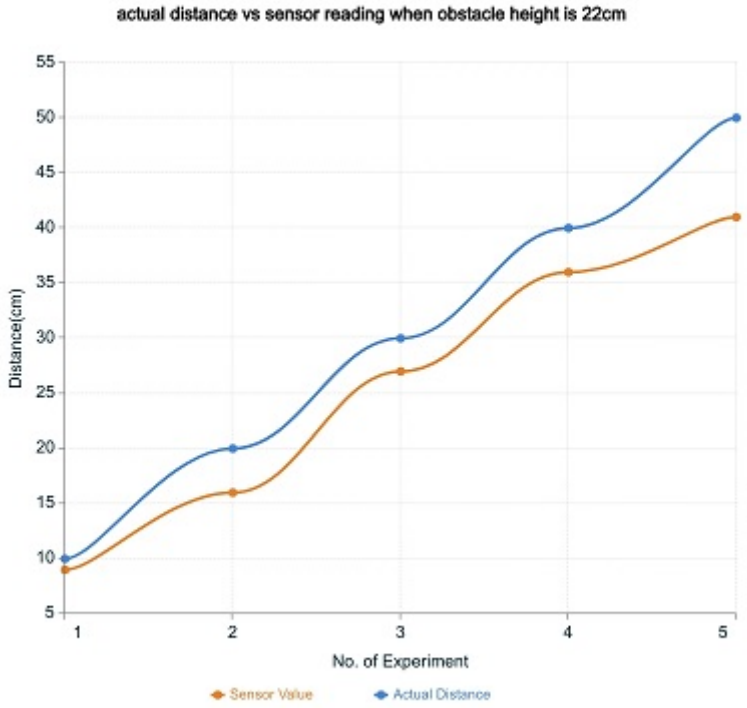

Figure 6.3: Graph between actual and detected distance for obstacle height 22cm

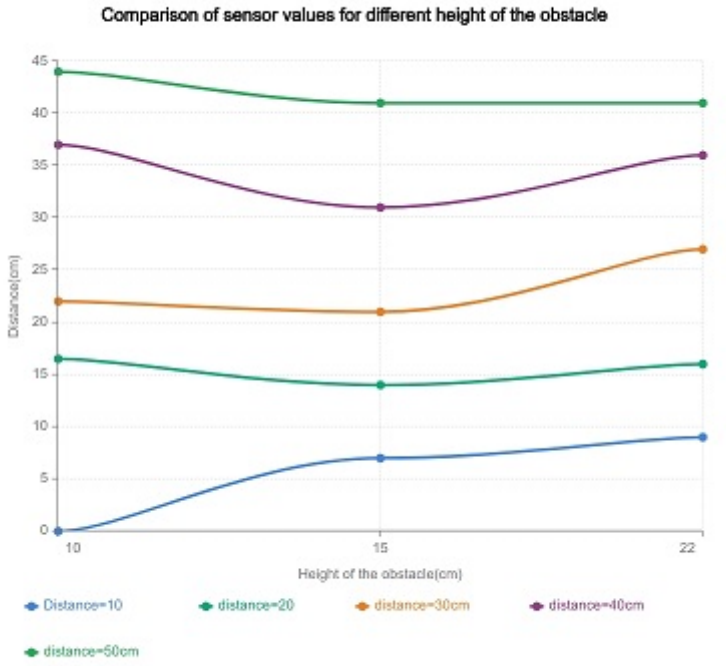

Figure 6.4: Detected value of the sensor changes slightly while height of the obstacle changes

6.2 Water detection test result:

The test for water sensor has been performed. Various types of liquid has been used for this experiments. In the presence of water,the sensor has reacted. There are some limitations of water sensor. Sometimes at the presence of water it is too sensitive. Therefore until the sensor is dry or no longer could detect presence of water the buzzer could sounds and it might be sometimes little longer.The following table shows the result of the test for water sensor for different types of liquid-

Liquid	No. of test	Result
Water	5	100%
Liquid soap	5	100%
Oil	5	0%
Urine	5	100%
70% alchohol+30% chlorhexibine gluconate	5	100%

Table 6.4: Water Sensor test result

6.3 GPS tracking test result:

SIM808 tracker get the GPS signal with UART interface, get the current location information and then the related GPS will be reported into to Atmega328. However, output of the result is greatly dependent on the network. The experiment has been done in indoor as well as outdoor. Data that is found in outdoor is more accurate than the data that is found in indoor.
Here, SIM808 get the sms from care giver, process this, report related GPS containing latitude and longitude to the ATmega328.Then the microcontroller push sms back to that number.

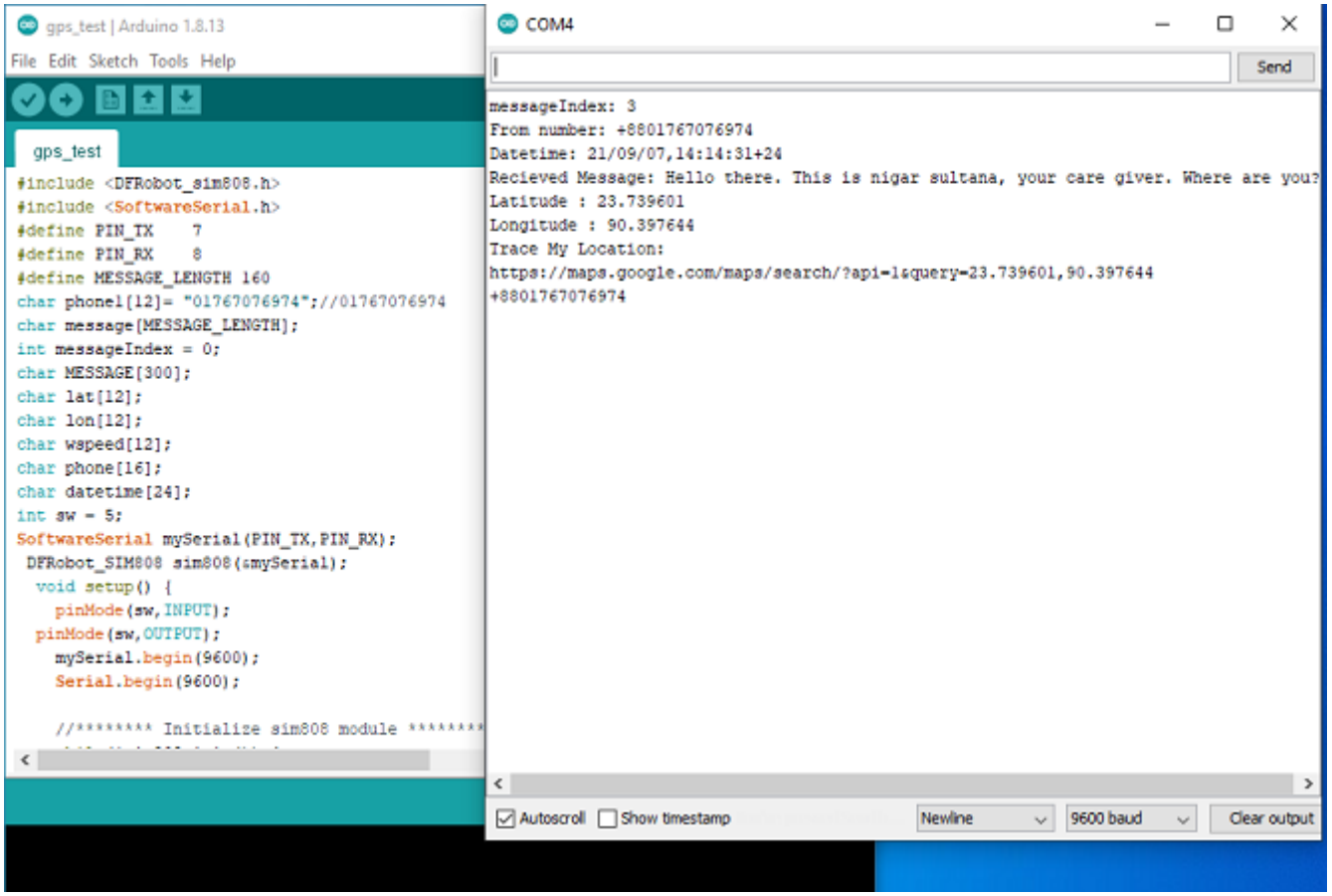

Figure 6.5: Terminal window displaying after sending sms to track location

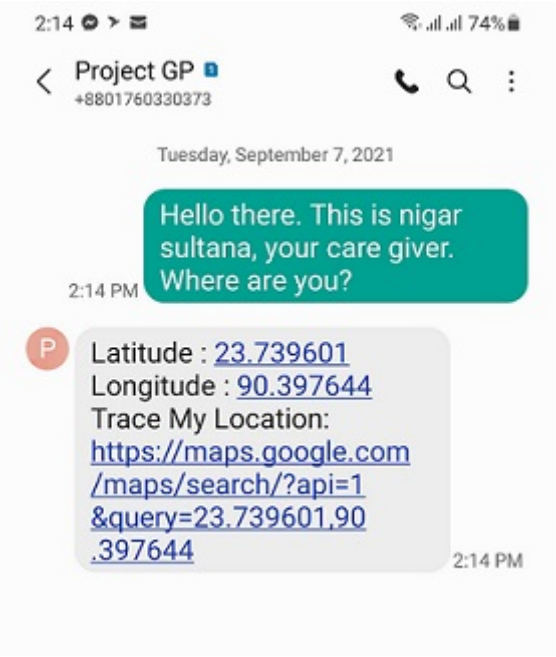

Figure 6.6: SMS containing location of the visually impaired individual

6.4 IR system test result:

For IR system, the type of remote that has been used will be automatically decoded by the sketch and which button of the remote is pressed will be identified. Opening the serial monitor in the Arduino IDE at 9600 bps and hit the “ch” or “1” button of the remote, the buzzer will turn on. There is different codes for different buttons. Specific button is to programmed as for turning on and off.

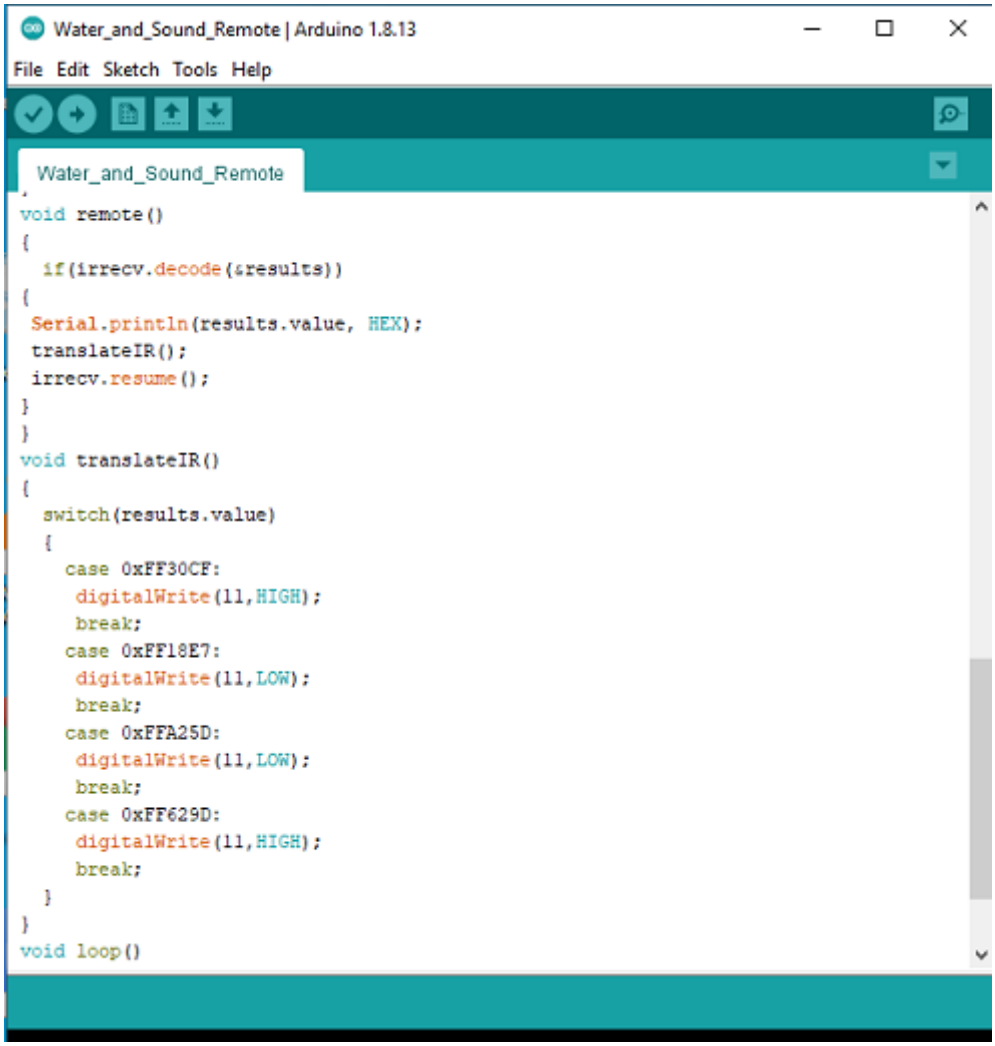

Figure 6.7: Snapshot of the code for IR remote and receiver function

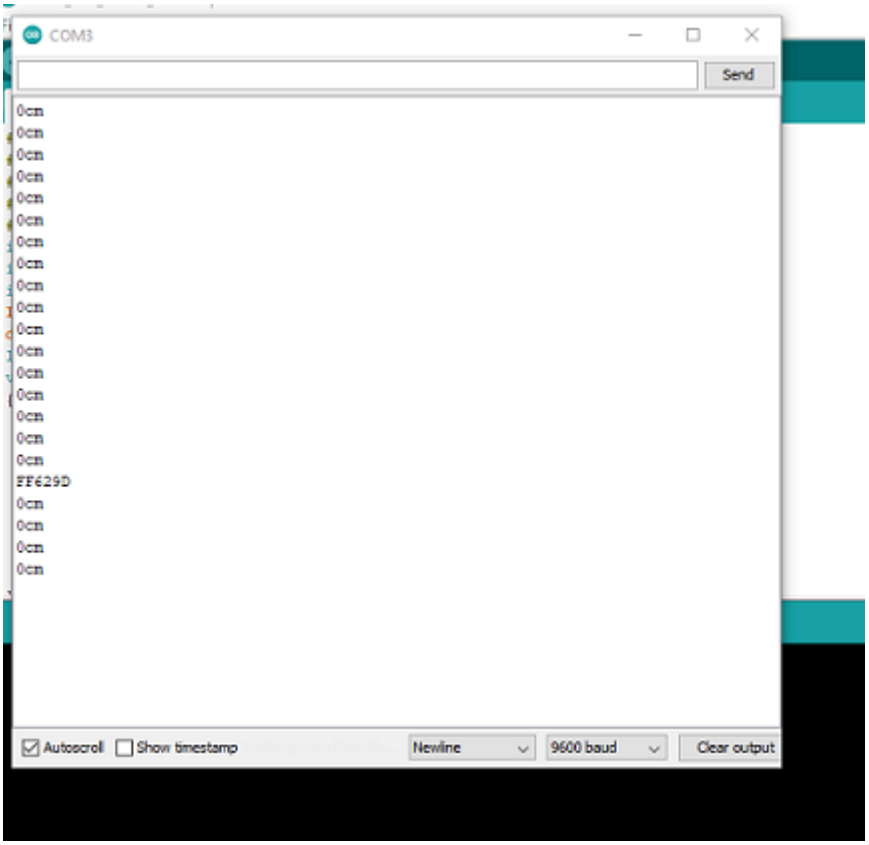

Figure 6.8: Terminal window displaying after pressing the "on" button of the remote

The way IR remote control system evaluated is by placing the prototype in one place and then pressing the remote control from different distance. Pressing the remote control and going as far as possible and observing the sound of the buzzer to observe the range of the IR remote system. The maximum range here is 2.2 meters.

Chapter 7

Conclusion

There are two primary objectives of the project, first one is to enhance the mobile capability and second one is to inform the known person through the message if the person is in danger zone. In this project, the hardware and software had been successfully integrated and worked to meet the requirements. The prototype of a smart walking stick is built and the function meets the objectives of this project. By implementing this, a visually impaired person can move to an unfamiliar environment without any human guidance. It is suitable for the blind person to travel in the unknown environment more independently. This stick is also beneficial for the elderly with their poor vision.

Compared to the existing white blind stick or guided dog this stick is more convenient and as low cost and less weight proves to be a great luminance with its augmented features to the visually impaired person. In future, Image processing or artificial intelligence could be added to the system for more comfort including voice command or find the best path for his destination.

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