Design and Development of a Low-cost Smart Stick For Visually Impaired People

By

Md. Ashrafuzzaman Shakil, ID: 16173103136

Neser Uddin, ID: 16173103128

Pranto Kumar Saha, ID: 16173103091

Sojib Hossen, ID: 16173103102

Zinat Ara, ID: 16173103129

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Declaration

We do hereby declare that the project works presented in this thesis entitled Design and Development of a Low-cost Smart Stick for Visually Impaired People are the results of our own works. We further declare that the thesis has been compiled and written by us. No part of this thesis has been submitted elsewhere for the requirements of any degree, award or diploma, or any other purposes except for publications. The materials that are obtained from other sources are duly acknowledged in this thesis**.**

Md. Ashrafuzzaman Shakil
ID: 16173103091 _____

Neser Uddin
ID: 16173103128 _____

Pranto Kumar Saha
ID: 16173103091 _____

Sojib Hossen
ID: 16173103102 _____

Zinat Ara
ID: 16173103129 _____

Approval

We do hereby acknowledge that the project works presented in this thesis entitled " Design and Development of a Low-cost Smart Stick for Visually Impaired People " result from the original works carried out by Dr. Muhammad Firoz Mridha, Chairman and Associate Professor, Department of Computer Science and Engineering, Bangladesh University of Business and Technology. We further declare that no part of this thesis has been submitted elsewhere for the requirements of any degree, award or diploma, or any other purposes except for publications. We further certify that the dissertation meets the requirements and standard for the degree of Doctor of Philosophy in Computer Science and Engineering.

Acknowledgement

We would like to express our heartfelt gratitude to the almighty Allah who offered upon our family and us kind care throughout this journey until the fulfilment of this research.

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Abstract

One of the biggest problems faced by visually impaired people is to navigate from one place to another. They always need human support for moving either indoors or outdoors. The unfavorable conditions of the environment make it more complicated for visually impaired people. A blind person always needs to be alert to get off the situations like crashing with obstacles, holes, staircases, slipping down wet territory. Also, in case of any emergency, they might want to send an alert message to their families or friends nearly their location. Considering the above, in this paper, we have addressed all these issues and provides a solution to assist visually impaired people so that they can live without the much help of others. The Ultrasonic sensor of this system helps blind people to detect obstacles, hole, and staircase alongside water sensor is used to detect the water. The buzzer is placed at the smart stick which provides a sound when any obstacle is identified. The GPS and GSM module of this device assists peoples to obtain the specific location of the smart stick. In the system, Arduino UNO is used as a controller of the device. The proposed smart stick is a low-cost device with faster response, user-friendly, and low energy consumption.

Index Terms—Smart Stick, Obstacles Detection, Human-Computer Interaction (HCI), Internet of Things (IoT)

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GPS Global Positioning System

GSM Global System for Mobile Communication

RF Radio Frequency

Contents

Introduction

1.1 Introduction

According to the report of the World Health Organization (WHO) and National Federation of Blind, Globally, almost of billion people have a vision impairment that could have been prevented or has yet to be addressed. According to the data from World Health Organization (WHO) and National Federation of Blind, Globally, 1 billion people have a vision impairment that could have been prevented or has yet to be addressed. This 1 billion people includes those with moderate or severe distance vision impairment or blindness due to unaddressed refractive error (123.7 million), cataract (65.2 million), glaucoma (6.9 million), corneal opacities (4.2 million), diabetic retinopathy (3 million), and trachoma (2 million), as well as near vision impairment caused by unaddressed presbyopia (826 million) [9]. Bangladesh ranks among the poorest countries in the world, with more than one half of its 161 million people living below the poverty line and an estimated 800,000 people afflicted by blindness [10]. In our country we found that the main aids of blind people are their sticks and that we don't think good enough to help that person to walk freely as a normal person. But in other country the use trained dogs to help blind people to walk. But that is very costly for a poor county like us. By addressing all above – defined problems we are trying to make an affordable solution. Our main aim to work in this project to provide all blind people of our country a low-cost assistant for walking in the street and not become a burden for anyone. We will try to provide a smart stick as an assistant for all the blind people of our country at a low cost and that will improve their felling of existence in this rough world. We will use deferent sensors to observe the surrounding of a blind people and alert the person about it. And we will use a remote to find the stick when the blind person lost it. We will also use GPS-GSM module to inform the family about the location of the blind person.

1.2 Problem Statement

Our problem statement is there is no effective and cost-efficient device which can detect upward, downward stairs, water, hole, obstacles and can't provide a global positioning system and no remote to find the stick. Several devices are designed to guide blind people. Many institutions, organizations and companies have been working for a long time to make smart stick at low cost for blind people. Smart mobility aid, infrared sensor-based stick, mobile handset ancillary device, white and smart cane and SoS navigation-based stick are mentionable devices. White cane does not support the space and orientation awareness.

1.3 Problem Background

This system only detects obstacle, water, hole and stair. Also sent the present location to given number. Detecting object or water is a major need for blind people. Sending exact location to given number is a very challenging task of the system. Set up for detecting water and object also there was a little trouble, because these things were just getting ruined in the time of implementation.

1.4 Project Objectives

Following project objectives can be achieved from this project,

1. To provide an object detection system that will help blind people to walk.
2. To provide a system that can help the blind people knowing about the surroundings.
3. To provide a system that will help the family member find the blind person easily.

4. And finally, to provide a cost-efficient device that will change the living of blind people of our country.

1.5 Motivations

With the rapid growth of technology people facilitating their regular daily life with many kinds of smart electronic devices. Progressively, responsibility for the impaired population of the world is also aggregating. In some cases, dependency on such technologies is praiseworthy and assisting us in many ways. Learning all these, this low cost and smart walking stick has developed for the visually impaired peoples and tested with real impaired people. Though several designs of smart stick for the blind peoples are available, but affordability for all is yet to achieve. Keeping that in mind this design of the stick has developed. Which is very simple structured, inexpensive, feasible and user friendly as well. It can be affordable for mass peoples who are visually impaired. This stick has given the faster detection of the objects in a very effective manner. Thus, this designed and developed smart walking stick is practical and obviously such stick will improve the quality of the daily life of the visually impaired people worldwide in the near future.

1.6 Flow of the project

This project is developing into several steps. At first, we analyzed the project topics and read some paper about this topic with theorical study. Secondly, we talk with our supervisor how we can implement the project. From our combined decision and idea, we buy the equipment's and implement the project. After implementing the project successfully, we write the paper and submitted to ICSCT 2021.

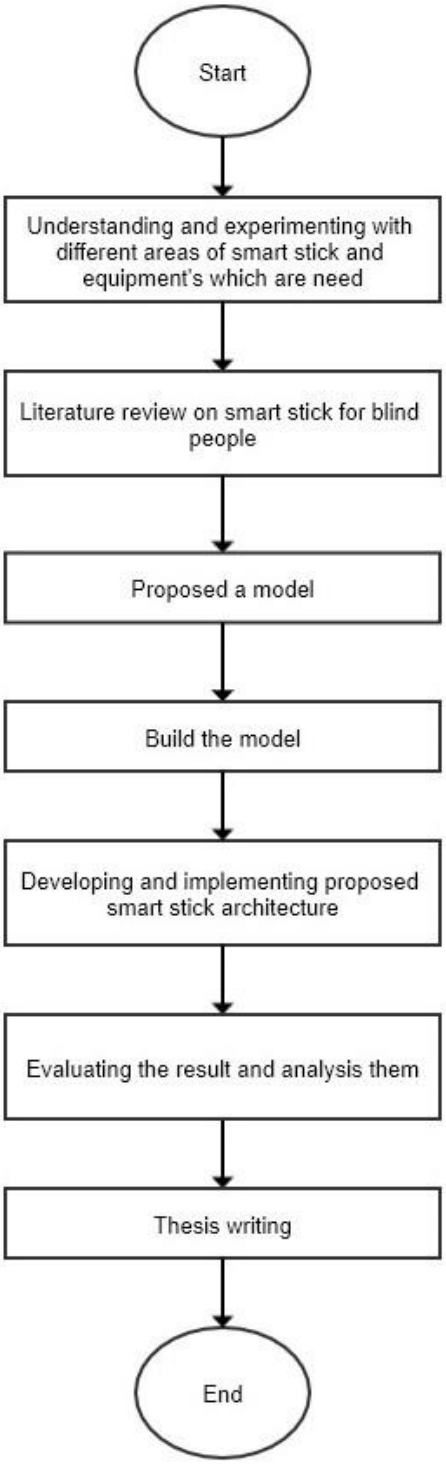

Figure 1.1 The flow of the thesis work

1.7 Significance of the Research

We have created a smart stick for the blind which they can use they will be able to walk frequently. We have analyzed the blind people what adversities they face. The smart stick has been made by thinking about the problems of the blind. Using this stick blind man can easily detect stair, water clay, water, and wall. I f the stick lost for any reason it can be found by buzzer on pressing remote. There are also use GPS, GSM connection that can assist the users by sending notification as a message to concern the family members in case of any emergency. Above all the main reason of the research is to make an effective stick for blind people considering their difficulties.

1.8 Research Contribution

This research will contribute in blind people's regular life. A blind person is not able to go anywhere without help of a helping hand. If a blind person wants to go somewhere it affects them a lot. Because they cannot see anything so, if any obstacle or anything comes in front of them, it will be a trouble for them. For overcome this situation we build a system with a stick which alert the persons about the obstacle or anything that comes in his way. And also, a system for sending the users location to the given number if user feel danger in any situations.

1.9 Thesis Organization

This thesis is organized in this way, Chapter 1 contains problem statements, problem background, project objectives, motivations and flow of the project. Chapter 2 highlights literature review and problem analysis. Chapter 3 explain proposed system, feasibility analysis, project methodology, data processing of the project and project environmental

setup. Chapter 4 explain about implementation, testing and result analysis. Chapter 5 discuss the stands (sustainability), impacts (on society), ethics, challenges, constraints timeline, grant chart. Chapter 6 explain the conclusion of the overall thesis work.

1.10 Summary

This chapter explains the problems encountered while doing research, and research objectives to provide a cost-efficient device that will change the living of blind people of our country. So, designed and developed smart walking stick is practical for blind people. The flow of the research reviles the process of how this thesis work is done. The significance of the research describes the reason for the project. Research contributions show, how this project contributes in blind people's life. And thesis organization describes the whole work of the research.

Background

2.1 Introduction

In past years many researchers are research on about this project topic. All the researchers are focus on obstacle detection, sensing water and send message to users' family if user in danger. Included all this thing we add some feature and implement successfully.

2.2 Literature review

In [2] authors made a Smart Stick for the Blind and Visually Impaired People. They used Ultrasonic sensor for detecting object and GPS-GSM module to send location of the person to their family. They also use a RF module for finding the stick when lost. They used a microcontroller for their processing unit and a water sensor to detect water in the path.

In [3], the authors made an Embedded Assistive Stick for Visually Impaired Persons. They used IR sensor for whole detection, Moisture sensor to detect water in the path. And the also used IR sensor for object detection and a Rf module used to find the stick when lost. And then they arranged all the sensors with an Arduino to work properly.
Here authors proposed a system on cost effective smart stick [4]. The main purpose of their research is to detect any kind of obstacles in front of blind people. In this system they use Ultrasonic sensor for detect any obstacles in front of blind people and SD card for pass the distance between obstacles or up stair or hole and blind people. They use headphone for hear the distance between any obstacles and blind people.
Authors proposed a beautiful system on smart stick for blind people [5]. This system does not have GPS and GSM module for tracking location but blind peoples can operate by their relatives. Blind people can press the SOS button on his stick which will enable the process of live streaming system. The streaming signal is sent to their relative's

phone via an app. If blind peoples don’t press the SOS button then they can walk using ultrasonic sensor. Authors use raspberry pi 3 and raspberry pi camera for live streaming system and ultrasonic sensor for detect for obstacles.

The authors build a smart assistive device for blind people [8]. The purpose their research is blind people can move easily using this device. In their research main content blind people can detect obstacle and notify about this obstacle using IR sensors. And also include their research traffic signal information unit using IR transmitter module that will help blind people when blind people cross street independently without others help, Bus Route information system will help blind people providing the information about the buses, in this device a function is included that help blind peoples find their stick when their stick misplaced and also included wheel that generates electrical energy.

In [7] authors discussed about smart e-stick for visually impaired using video intelligence API. In their research main purpose not only detect objects. They have main focused their research on camera that used for recording video from the surrounding environment and this video can be uploaded in cloud. In their research included Google's Video Intelligence API for extracting and analyzing relevant information. And their systems cannot only recognize objects it can read text easily then provides outputs via earphones or speakers and advantage is that it completely eliminates the dependency on sensors like LDR, Ultrasonic, and IR etc.

We know that before this project old blind stick are very expensive, not very effective and limited feature [9]. But the publisher work hard for cost the money for this stick. So, they use ultrasonic sensor for detecting obstructer distance of 2-450cm, soil measure sensor for detect the presence of water in the path, Infrared sensor. In this project an IR sensor is used with a theoretical detection distance of 2 - 30cm and a detection angle of 35°.RF module for find out the stick, GPS-GSM for detect and send the location of the user to his family if he in danger. Buzzer and vibration motor. The main stick has a start and off button if user press start it will start. Then the all sensors are active. By walking

if the stick is fall down front the user and he could not find it then he presses the remote and in remote it has RF transmitter and the receiver mounted in the stick. When user press the remote it will sound (buzzer) and easily can find the stick. And if the user fell, he/she in danger then user can press the button to send his location to his family.

In [6] they also minimize the cost. They also use ultrasonic sensor, GPS-GSM module. Detection of obstacle is done by using ultrasonic (HC-SR04) sensors. It is a transducer whose job is to send and receive echoes continuously while it is active. Here, in this model three sensors are used in three sides (right, front and left) of the stick. These sensors produce ultrasound waves which get reflected if there is any obstacle in range (2.5 m). That means if there is any obstacle within 2.5 m distance from the stick the sensor will receive the reflected echo. A micro C program is developed in its programming IDE called “MikroC PRO” of version 7.1. The working procedure of this program follows the flow chart. But they try to using Analog to Digital Converter (ADC).

2.3 Problem Analysis

In past years every project on this topic, everyone done this separately or not included all in one. Like some project on only obstacle detection and water detection, or obstacle, water and hole detection. Some project done with only GPS tracking and some additional feature. But in this project, we implemented all this thing in one. This project does obstacle, water and hole detection. Also does GPS tracking and sending location by GSM and finding stick with help of remote.

2.4 Summary

This chapter fined the old project methodology, review them, and investigated the drawbacks. Where a lot of authors already do projects or research work about this topic. So, From the work, they do we have tried to do something new with the idea from their work. The goal of this project is to get rid of the imperfections as a good deal as viable and delivered a new mixed strategy to deliver all things in one combined project.

Proposed Model

3.1 Introduction

In this section, we focus on the feasibility analysis of identifying the obstacle, analysis data and give output by Arduino. After finishing this chapter, it will clarify the whole model and workflow of the project with detailed explanation.

3.2 Proposed System

At first, the system uses 2 Ultrasonic sensors, one for object detection and the other one is for hole and stair detection. If any obstacle or stair is detected by the sensor then the buzzer will buzz to notify the person about the obstacle, or hole, or any kind of stairs ahead of the person. Next, the system will use a water sensor for detecting water in the path of the blind person. If such kind of water is detected by the sensor then the buzzer will buzz again in a different tone than the previous one to differentiate water from other obstacles. After that, the system will use a 4-way remote signal to locate the device and for sending GPS location. To find the stick we have to press a button in the remote then the buzzer will buzz continuously for 5 seconds to determine the location of the stick. The system also uses a GPS module to get the coordinates and use GSM module to send the coordinates of the person's current location to their family members. In our system, the Arduino UNO is used as the processing unit to process all the data and give outputs. And we have used a 9V battery to power the system. Figure 1 shows the system architecture of the device.

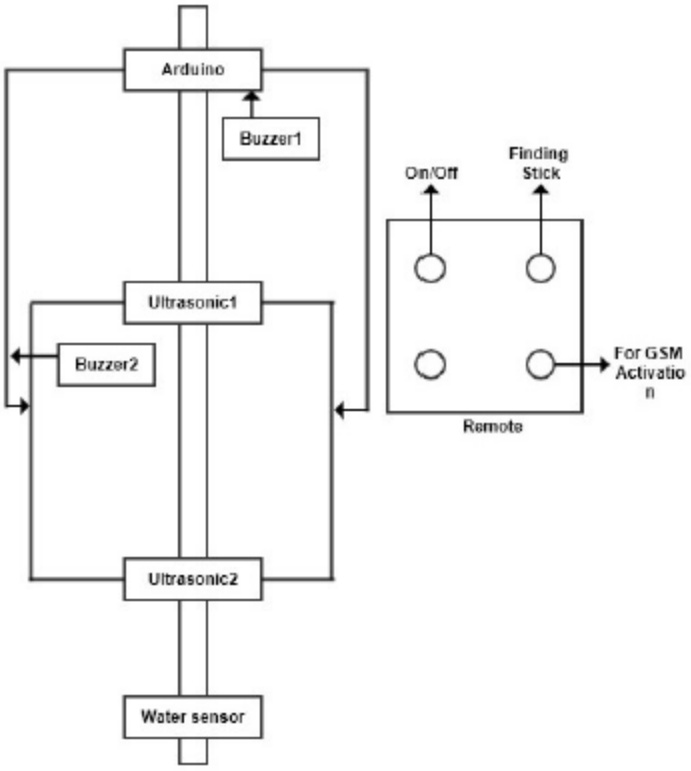

Figure 3. 1 System architecture of the device

3.3 Feasibility Analysis

This project is done by five members with one supervisor and took ten months to implement. This project all about hardware and application based. Where hardware (sensors) required true or false data as an input and system motherboard (Arduino) make the output.

3.4 Requirement Analysis

To implement the proposed project, it's requires:

1) Arduino UNO

Arduino Uno is a microcontroller board based on the ATmega328P. For communicating different sensors, switches, and modules, an Arduino Uno microcontroller is used in different IoT-based projects [11]. However, it serves as the mother of our system. Since every sensor which is used in this project and all other related things are dependent on this microcontroller. Also, every decision is made by this module.

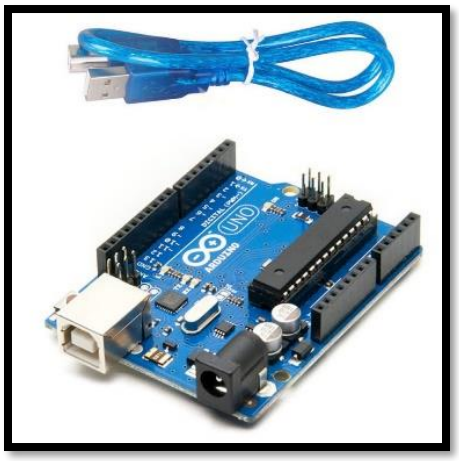

Figure 3. 2 Arduino UNO

2) Ultrasonic sensor

Ultrasonic sensor gadget estimates the distance of an objective item by producing ultrasonic sound waves and then converting the reflected sound into an electrical sign. It calculates the distance of an objective by calculating the time between the outflow and gathering [12]. With this Ultrasonic sensor, our system will recognize the obstruction.

Figure 3. 3 Ultrasonic sensor

3) Neo-6m GPS module

The NEO-6M GPS module is a GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna that provides search capability to a strong satellite. The NEO-6M GPS module is equipped with power and signal indicator lights and a data backup battery that saves data when the main power is shut down accidentally [13]. In our system, we have used this equipment for collecting the location of the user.

Figure 3. 4 GPS module

4) SIM 800L GSM module

SIM800L GSM module is a tiny GSM modem. The module can be used to attain almost anything like a normal cell phone can SMS, phone calls, or connecting to the internet through GPRS, TCP/IP, etc. For it off, the module supports quad-band GSM/GPRS network [14]. We have used this module for sending the location through by a message to user's family members.

Figure 3. 5 GSM module

5) Water sensor

A water sensor is used to understand the presence of water. When it touches the water, the circuit is shorted and interrupts the micro-controller and activates the motor and play a sound [15]. In our system, we have used this for if a wet surface comes in front of the user then the user will aware.

Figure 3. 6 Water sensor

6) Remote

A 4-channel wireless remote control is an electronic device is used to operate other devices from a short distance. It allows any person to operate a device that they would not be able to reach [16]. In this system, we have used this equipment for finding the stick if a user lost it. And also, the user can send the location to the family members by clicking a button on this remote.

Figure 3. 7 Four channel remote

7) Buzzer

A buzzer is a small speaker that can be connected directly to Arduino Uno [17]. In our system, we have used it to make sound by using a tone at a frequency as we set with this buzzer.

Figure 3. 8 Buzzer

8) 9-volt battery

The 9-volt battery is a common size of battery that is used mostly in many devices. It has a rectangular shape and at the top of the battery, there is a connector of it [18]. In our device, we have used it for supplying power to Arduino. Generally, Battery is the powerhouse of this system.

Figure 3. 9 9V battery

3.5 Project Methodology

A smart stick is intended and executed to aid blind persons so that they can walk independently without much difficulty. Firstly, pothole detection and avoidance system are implemented by setting the ultrasonic sensor at 30-degree angle on a suitable blind stick to sense if there is a hole or staircase in front of the blind people at about 30 cm distance to avoid a person from falling and as a result may be producing many damages. Secondly, a water sensor is placed at the down of stick to measure the degree of water and in forward-facing of the user and aware him as soon as that degree exceeds a measured level that may submerge the foot of him. Thirdly, obstacle detection and avoidance system are implemented by using an additional ultrasonic sensor on the top of the stick to turn an alarm and vibration ON when there is a person, obstacle or wall at a distance of 40 cm in front to avoid an accident and thus helping the person to move independently. Fourthly, a 4signal wireless remote is implemented, so if a person drops

stick or forget it somewhere, he can press a switch of the remote consisting of transmitter part, and as a result alarm with vibrations will turn on, so the user can know the location of the stick. Fifthly we use a GPS and GSM module to send the current location of the blind person to his/her relative or intended person when he/she in danger and need help. The stick is implemented practically using single wheel leg blinding cane, Arduino microcontroller two ultrasonic sensors and 4 signals wireless remote. Also, two buzzers and one vibration motor, one GSM and GPS module are used on the stick to fit on when any difficulties occur.

3.5.1 Data Processing

Here data are process by sensor and Arduino. Sensors give the input to Arduino and Arduino process that data based on our code and generate output.

Ultrasonic sensors work by way of measuring sound waves at a recurrence as nicely as tall for human beings to listen[19]. They at that factor maintain up for the sound to be mirrored back, calculating eliminate primarily based on the time required. Typically similar to how radar measures the time it takes a radio wave to return after hitting a protest.

Figure 3. 10 Wave transmission

Whereas radar and ultrasonic sensors can be utilized for a few of the identical purposes, sound-based sensors are simply available they can be had for truthful a few greenbacks in a few cases and in sure circumstances, they can also pick out objects greater efficaciously than radar.

Figure 3. 11 Wave receive

In this project, we use ultrasonic sensor for detecting obstacle and hole. For obstacle the distance is <30cm, for hole it is >40 and foe stair it is <20.

The working of the water sensor is incredibly straightforward [20]. The collection of uncovered parallel conductors collectively acts as a variable resistor like a potentiometer whose resistance varies in accordance to the water level. The alternate in resistance corresponds to the distance from the pinnacle of the sensor to the floor of the water. The resistance is inversely proportional to the peak of the water. The greater water the sensor is immersed in consequences in higher the conductivity and will end result in a decrease resistance. The much less water the sensor is immersed in, outcomes in bad conductivity and will end result in greater resistance. The sensor produces an output voltage in accordance to the resistance, which by using measuring we can decide the water level.

Remote manipulate gadgets are generally primarily based upon one of two principal sorts of technology, infrared (IR) technological know-how or radio frequency (RF) technology

[21]. Let's appear at how these kinds of science assist you manipulate units from afar. When it comes to televisions and domestic theater devices, the dominant science tends to be infrared. An IR far off (also referred to as a transmitter) makes use of mild to lift indicators from the far off to the gadget it controls. It emits pulses of invisible infrared mild that correspond to precise binary codes.

Radio-frequency remotes work in a comparable way. Instead of the use of infrared light, though, they transmit binary codes to a receiver with the aid of radio waves. This offers RF remotes a lot higher vary than IR remotes. RF remotes can work at distances of one hundred toes or more. RF remotes vary is noticeably multiplied in contrast to IR remotes, interference can be a problem for RF remotes due to the massive wide variety of radio waves all round us almost all the time. That’s why we use RF remote.

In this project we use remote for finding the stick if user lost it. And also, user send his/her location to his/her family by click another button of this remote. So remote is another crucial module for this project

With three facts that make up the GPS network [22]. First factors are the satellites that orbit Earth. They work to transmit alerts to customers about their geographical positioning and the time of day. Second one is floor control, which is made up of Earth-based monitoring stations, grasp manage stations, and floor antennas. These are in area for monitoring functions and for running the satellites that are up in space. There are monitoring stations all over the world on each continent. The final one is GPS receivers. We use NEO-6M GPS module, it has a receiver with a built-in 25 x 25 x 4mm ceramic antenna that provides search capability to a strong satellite. GPS module is equipped with power and signal indicator lights and data backup battery that save data when the main power is shut down accidentally. Its power supply 3-5V and also default baud rate 9600bps.We use this module for collecting the location of user.

The GSM has 4 separate components that work collectively to feature as a whole first one is the cellular machine itself, second the base station subsystem (BSS), third the community switching subsystem (NSS) and final one is the operation and guide subsystem (OSS) [23]. The cellular machine connects to the community through hardware. The subscriber identification module (SIM) card. The BSS handles site visitors between the mobile phone and the NSS. The BTS consists of the gear that communicates with the cellular phones, and the BSC communicates with and controls a crew of base transceiver stations. Which are two foremost components of NSS. The NSS element of the GSM community architecture, frequently referred to as the core network. These aspects function distinctive functions, like Short Message Service (SMS) and authenticating and storing caller account facts by means of SIM cards.

In this project we use SIM800L GSM module, which is a tiny GSM modem. You can use this module to attain almost anything a normal cell phone. It can SMS, phone calls, connecting to internet through GPRS, TCP/IP etc. For it off, the module supports quad-band GSM/GPRS network. This is a very important part for this project. We use this module for sending the location through by a message to user's family members

3.5.2 Environmental Setup

For experimenting, we have used the Arduino Uno board as the project motherboard and connected different types of components with it. After connecting all the pieces of the component with Arduino Uno, we upload a script in it and run it for testing the device. The Arduino Uno is programmed using the software Arduino IDE and the script is written by C programming language to control the sensors. However, figure 4 displays the system setup for conducting the experiment.

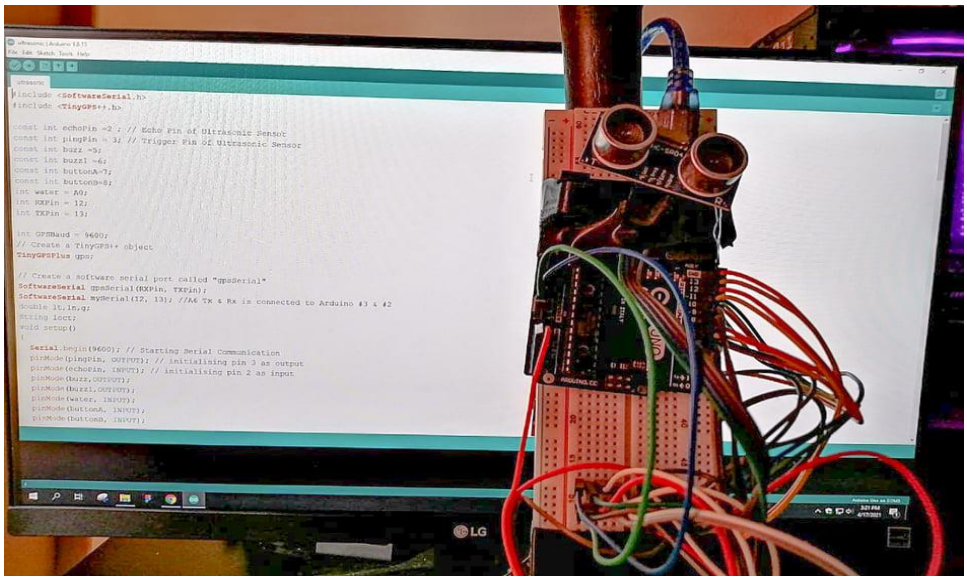

Figure 3. 12 Smart stick system setup

3.6 Design, Implementation and Simulation

This is the workflow architecture of the project. All the step of the given diagram is done with Arduino code in Arduino IDE software. Before the physical simulation, we use Proteus simulation software for virtual simulation. Here first when the system is off, the user has to start it with an off button from the given remote. If the user presses button 2 it will buzz for the attention of the user and then press button 3, it will send the location of the user to the given number. When the system is on all sensors are running. If the primary (top) ultrasonic sensor is high it buzzes the buzzer. In the same way secondary (bottom) ultrasonic is buzz if it detects any hole, stair, or object. And when the water sensor detects any moist place or water it will be high and also buzz the buzzer.

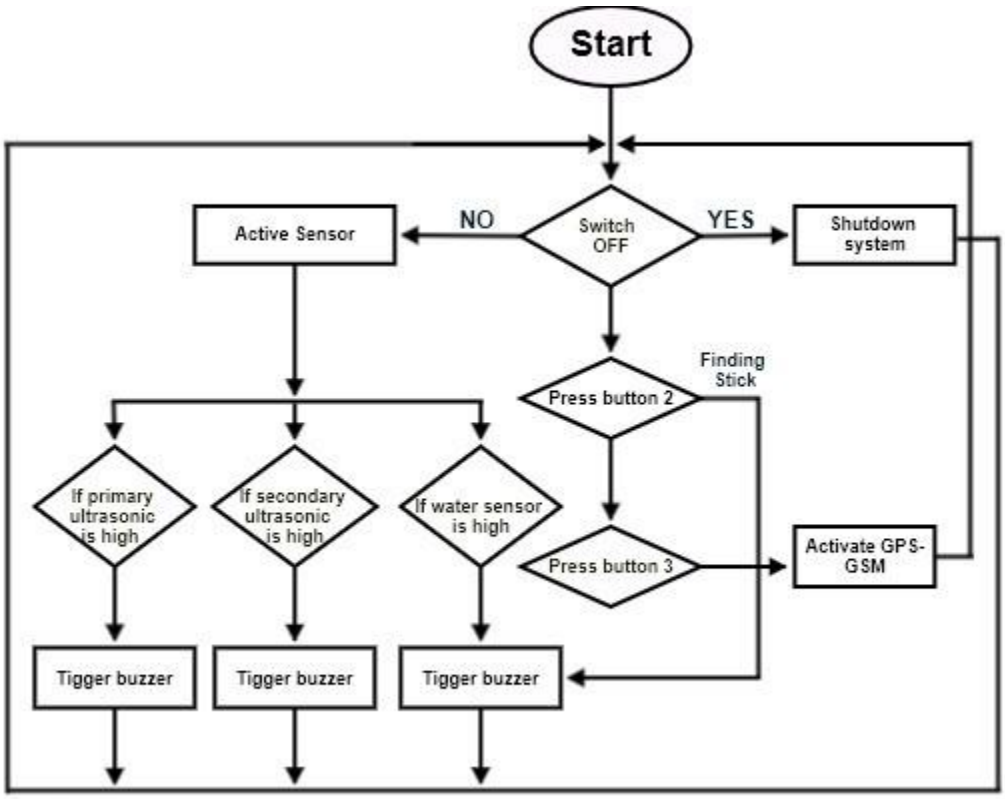

Fig 3. 13 Flow chart of the smart stick system

3.7 Summary

This section covers the architecture, design, and implementation process of this project. Here we talk about the equipment used for implementing the project, how the design work, and also the flow chart of the project. Also, talk about how data process by Arduino and other sensors and output deliver to the user by buzzer in this section. There is an environmental discussion and show the real-time stick. The whole project is based on Arduino code and the performance of the sensors.

Implementation, Testing, and Result Analysis

4.1 Introduction

In this section, we have presented the experimental result in the simulation environment. At first, we have discussed the system setup and then check the performance of the ultrasonic sensor of the device against different obstacles followed by a water sensor in different levels of water. We have also placed the stick in a different position to determine whether it is giving the right coordinates of the location or not.

4.2 System setup

We have used the Arduino Uno board as the project motherboard and connected different types of components with it. After connecting all the pieces of the component with Arduino Uno, we upload a script in it and run it for testing the device. The Arduino Uno is programmed using the software Arduino IDE and the script is written by C programming language to control the sensors and modules.

4.3 Result and Discussion

We examine the performance of our device in terms of detecting the obstacle, water, determining the device location, sending an alert message to the fixed numbers. We check the exhibition of the ultrasonic sensor for detecting obstacles such as the wall, bed, chair, and moving vehicle. We have tested 10 times for determining the accuracy of the device in detecting the obstacle.

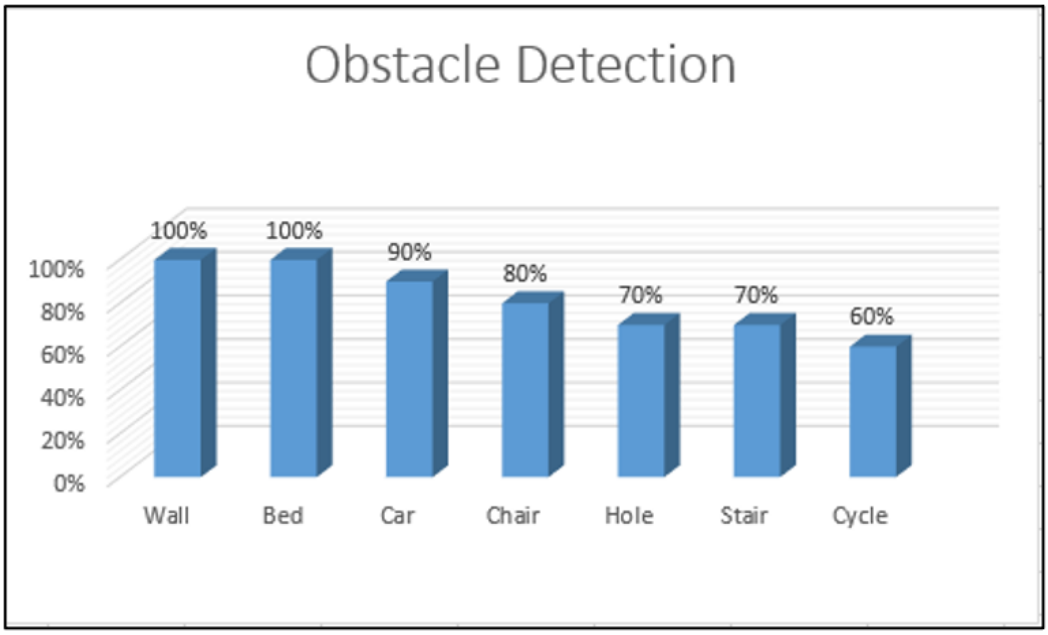

Figure 4. 1 Accuracy of ultrasonic sensor

We have placed the device in different positions to check whether the device provides the correct coordinates of the area and sending the message to fixed numbers or not, table 4.1 shows the data. However, most of the time the device provides the end location around 75-100 meters from the user by GPS.

4. 1 The table shows the accuracy of ultrasonic sensors

Distance from a person	Times
75-100m	7times
120m	2times
37m	1times

The device used GSM technology for sending a message which works perfectly in our system. The maximum time it sends an alert message to the number we have fixed in the system.

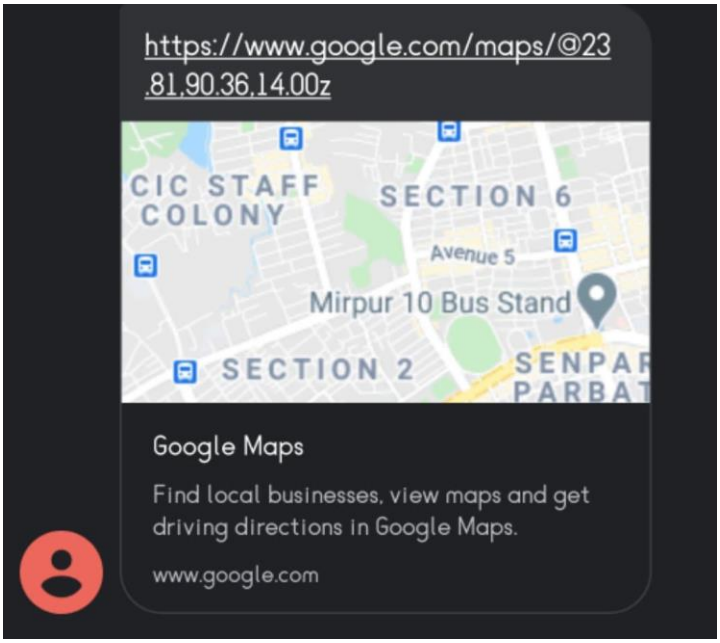

Figure 4. 2 Location from GSM

The GSM Module can send messages and give out the exact area of the relative within 0 seconds to 120 seconds, table 4.2 shows that.

4. 2 The table shows the Accuracy of the GPS GSM system

Duration	Times
0-24 seconds	1
25-49 seconds	6
50-74 seconds	1
75-99 seconds	0
100-120 seconds	2

The water sensor is tested in a moist place, clay, and up to 10cm deep water. Most of the time device works perfectly in 1cm-10cm deep water and clay by using the water sensor. But it provides average performance for the most place.

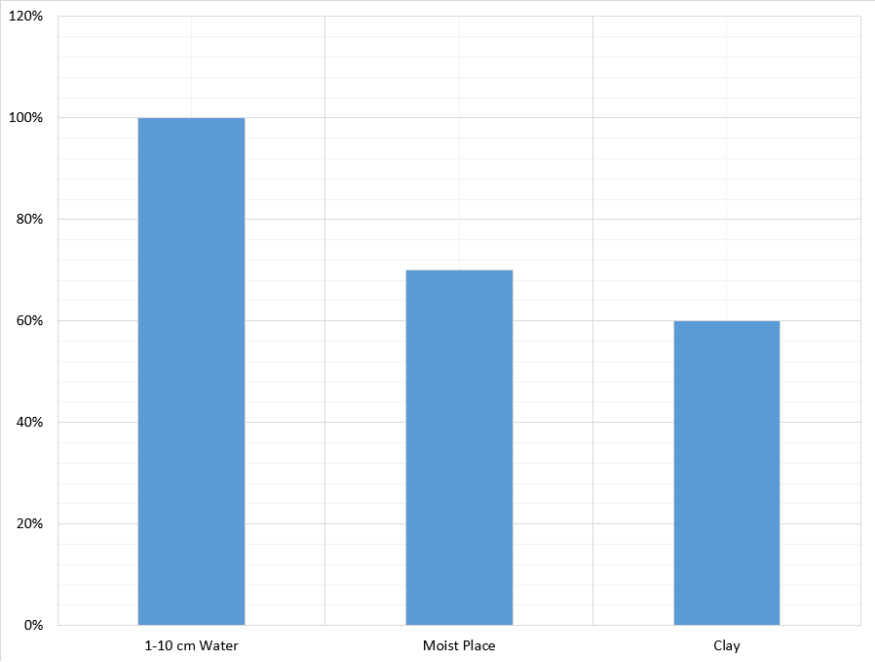

Figure 4. 3 Accuracy of water sensor

4.4 Cost Comparison

4. 3 The table shows the cost of material used in this project

Component	**Quantity**	**Price, USD**
Arduino UNO	1	5
Ultrasonic Sensor	2	1*2 = 2
Water Sensor	1	1.20
Neo-6m GPS Module	1	4.31
SIM 800L GSM Module	1	7.67
4-Channel Remote	1	4.13
Buzzer	2	0.29 * 2 = 0.58
9V Battery	1	0.83
9V Battery Connector	1	0.24
Female to Female Jumper Wires	1 set	0.59
Male to Female Jumper Wires	1 set	0.59
Male to Male Jumper Wires	1 set	0.59
	Total Price in USD	**27.73**

Table 4.3 shows the cost of materials. The device is prototyped for the users in a way that anyone can finish the manufacture with the minimal toolkit. The cost of materials for our device is summarized in table 4.3. Compared to other similar commercial solutions [24], [25], [26], [27], [28], the proposed device is much cheaper.

4.5 Summary

We have shown the performance of our device in terms of detecting the obstacle, water, determining the device location, sending an alert message to the fixed number. And we have shown the cost of materials for our device which is much cheaper than others. From the above analysis, it is proved that this device performs the most satisfying for blind people.

Standards, Constraints, Milestones

This section determines the Standards, Impacts, Ethics, and Challenges of the project work. Thereafter, the Constraints and Alternatives are illustrated. Finally, the Schedules, Tasks, and Milestones of the proposed work are presented.

5.1 Standards (Sustainability)

We ensure that our project work will be sustainable for many years. Obstacles detection for blind people is a popular research topic. Using this smart stick, blind people will move freely that can be helpful for society and the country. We used different types of sensors and Arduino for the implementation which is used in the current work approach. As our used resources will be available for long periods, we can say this smart stick will be sustainable.

5.2 Impacts (on Society)

Different types of people live in our society. Different people have different health conditions in our society and some people among them are blind. According to the report of the World Health Organization (WHO) and National Federation of Blind, Globally, almost of billion people have a vision impairment that could have been prevented or has yet to be addressed [1]. These physically handicapped people are neglected by society. Then we have made a low-cost smart stick inspired by this, which will be helpful for blind people. Using this smart stick, a blind person will be able to identify holes, obstacles, and water. There is also a buzzer in this smart stick which will help to warn blind people. There is another special feature which will send a message to the family member of the blind people. And as a result of using this smart stick, the blind will be able to move freely. For

this, the blind does not have to depend on others and if there is a problem, they can take help of others by sending a message. Using this smart stick, it is possible to reduce the dependence of blind people on others day by day. Which will have a positive impact on society. And one of the aspects of this smart stick is that it is low cost. Bangladesh ranks among the poorest countries in the world, with more than one-half of its 161 million people living below the poverty line and an estimated 800,000 people afflicted by blindness [2]. As a result, this low-cost smart stick will help to have a huge positive impact on Bangladesh.

5.3 Ethics

We have used different types of sensors in this project which will not have a bad effect on the environment and the nation. As a result of using this stick, there is no possibility of any kind of information being stolen from the user. Moreover, it is also impossible to use this stick for immoral purposes.

5.4 Challenges

Since our project is based on Arduino and different types of sensors. So, we purchased some sensors first and then tested them as they could not detect the object well. As a result, we repurchase some new suitable quality sensors.

Our project started during the Corona epidemic that made it difficult to get suitable quality sensors. And for this epidemic, communication distance is created between our teammates, which made it difficult to maintain the workflow of the project work. Since this project is based on Arduino and sensor, we needed a computer with high configuration to training the project that we did not have. As a result, different problems have arisen several times.

5.5 Constraints

This section covers a variety of constraints such as design constraints, material constraints, and budget constraints.

Our project structure is based on Arduino and various sensors. So, this material is used to train our project:

• Minimum processor: Intel Core i3 (8th gen)

• Minimum memory: 4GB (DDR4, 2400bus)

However, the budget can vary in the market environment because the product material's price is not consistent.

5.6 Timeline and Gantt chart

Our project workflow timeline is divided into three steps. To complete our project, we get three semesters which duration was one year. We have conducted our work through the execution procedure of our supervisor. In the first semester, we were planning and topic selected. Then we submitted a proposal and reviewed the related work of the thesis work. Also, we built the prototype of the proposed systems by analyzing the existing systems. In the second semester, we designed a data flow diagram and prototype design. Then submitted this design and implemented the model partially. Lastly, in the third semester, we have implemented the overall project architecture and testing with performance. In the meantime, we also wrote a research paper which has been accepted.

The following Gantt chart (Figure 5.1) represents the work execution process to complete this thesis work which is completed within one year.

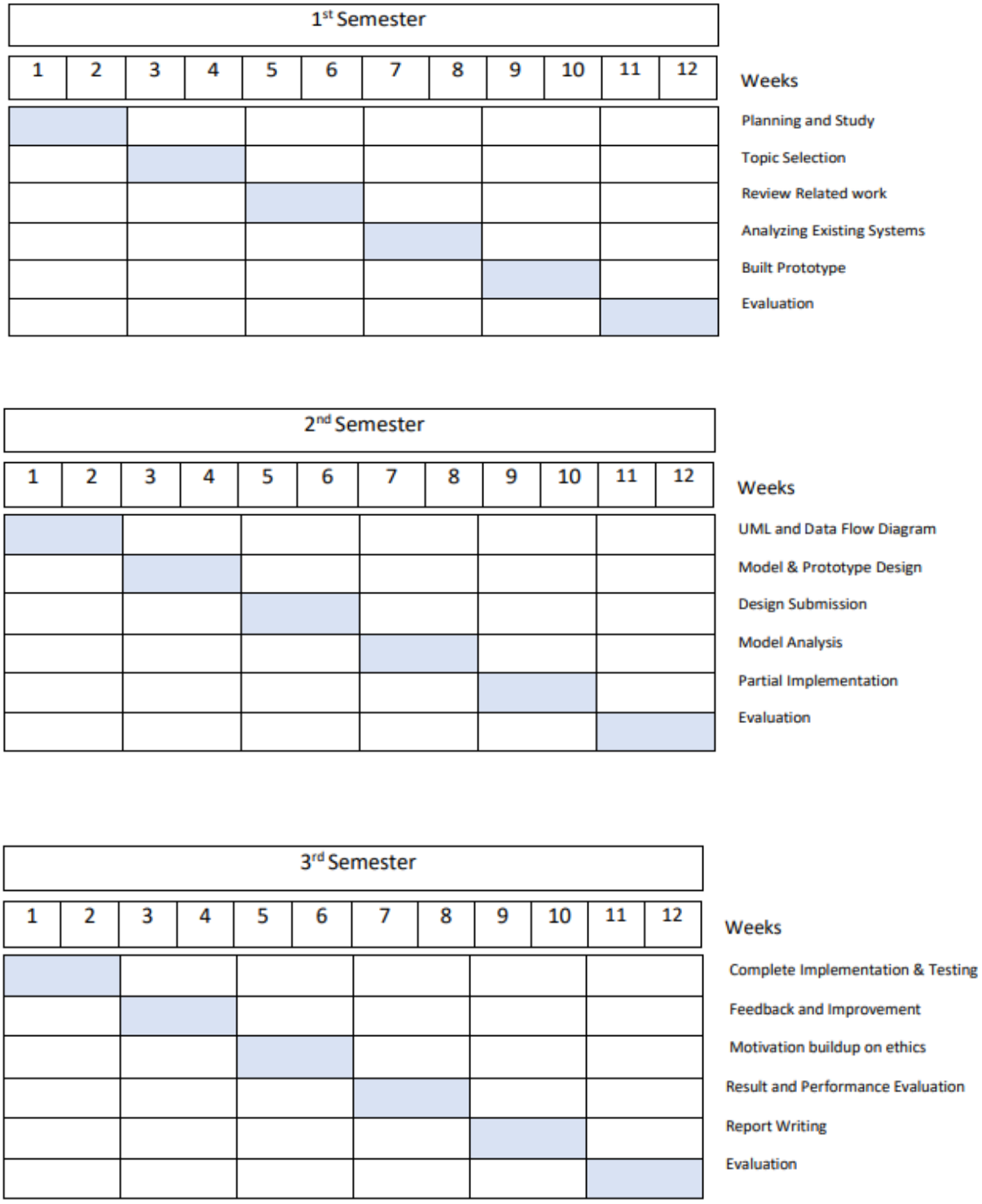

Figure 5. 1 Gantt chart of the work execution process.

5.7 Summary

However, this chapter shortly explains that our project has maintained standards and the impact of good and bad on our society and, this low-cost smart stick will help to have a huge positive impact on Bangladesh. This chapter discussed ethics that means impossible to use this stick for immoral purposes and different challenges of the project work. Also, discussed a variety of constraints such as design constraints, material constraints, and budget constraints. Our project workflow timeline is divided into three steps. These three steps are discussed in phases. Also, tasks and milestones of the proposed work are demonstrated.

Conclusion

6.1 Introduction

This report experiments and evaluates a smart stick that serves as an assistant by supporting and taking care of the difficulties looked at by blind people in their daily life. The device has RF control module, GPS and GSM connection, water sensor, ultrasonic sensor that's made stick useable for the blind people to move freely. It detects obstacles, stairs, water and clay. RF control module locate the stick, GPS and GSM connection can assist the users by sending the notification as message to the concerned family members in case of any emergency. This smart stick is cost-effective, response in short time, light in weight and simple to control the device. Which is very effective for movement of the visually impaired people.

6.2 Future works and Limitation

In the future we would like to improve the user's needs such as adding more features like with image processing may our system be done recognize family member, bus stand, and many other important things.

First of all, thank God and after all our supervisor has helped us a lot in making this project successful. We faced lots of difficulties to done the project. When we attempt to start this at that time corona pandemic swallowed in a very bad way. But we never stop, we work from home and done this. But sometimes the equipment’s also a cause for our work has been delayed. Because sometimes these are not worked or we bought the bad stuff, where there was no way to know if it was good.

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