Abstract

In the today's age and time, there are many technologies designed to help human's deal with any kind of disability that they might be facing. Out of many disabilities, the one that usually stands out the most is vision. Vision is the ability of a living creature to see, and human's also face this disability on huge scale. Many ways are developed constantly to help us face this issue such as having guide dogs or having another person guide us through our journey around our environment. Some of these ways can be very time consuming and expensive depending on the method used. We are engineers who need to address such issues with innovative ideas and methods. One way to deal with blindness disability is to develop a smart stick that can guide the patient to his destination through many features it possesses. To develop such a technology, we have to apply our knowledge of electrical and computer engineering that we have accumulated throughout the years from our specialized educational services and expert professors. We have revised many projects that are interesting and chosen to address the problem that is blindness being faced by people. This project will challenge us to be the best version of our engineering self's.

As mentioned earlier, we will be applying our knowledge to develop a smart stick that will contain many features to help a blind patient to navigate his surroundings. These features will make the designed technology to sense the environment around the person through sensors which will allow the user to know if there are any obstacles in the path through alerting him/her by use of beeping sounds. Also, a Smart shoe will be used to detect any obstacles that will be in front of the user's feet such as stairs and sidewalk edges. A GPS system is also developed which will help to navigate the patient's caretaker to reach the patient himself in-case of getting lost or facing an emergency situation. The caretaker of the blind patient will be able to receive SMS from the patient with his GPS coordinates of the patient on the phone and reach him/her in appropriate time.

Key Words: *Smart Stick, Smart Shoe, Smart Helmet, GPS Tracking System.*

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CHAPTER 1: INTRODUCTION

This chapter is dedicated to providing the reader with background (section 1.1), problem statement (section 1.2) of the research, its aims, and objectives (section 1.3). Section 1.4 represents the significance and scope of this research and provides the different types of terms used. Furthermore, section 1.5 provides SWOT analysis of the research. Finally, section 1.6 is an outline of the overall Report.

1.1 Background

When we hear about a visually impaired person, we start to think what their daily life might be like and how are they able to do what normal people can do. We thought to ourselves, what if we were in their position?. Being visually impaired is a challenge to everyone ranging from strangers to closest relatives as is the case for one of our project member who has a relative that is visually impaired. This project was an idea provided by research supervisor (Dr. Khalid Sultan) and gratefully accepted by project members as this project gave us a sense of responsibility towards our society.

1.2 Problem Statement

Nowadays, there are many technologies designed to help humans deal with any kind of disability that they might be facing. Out of many disabilities, the one that usually stands out the most is vision. This disability causes almost 90% of the blind people to face experiences and accidents such as obstacles or overhanging branches [6]. Guide dogs, walking sticks, and human assistants have been the traditional ways to help blind people for long time. However, some of these ways can be very expensive such as buying guide dogs and spending finances on them. According to “puppy in training” website, the initial cost for a guide dog = $50,000 and the ongoing cost = $1,200 a year [7]. Walking sticks (canes) have gone through some improvements from the regular walking sticks to obstacle sensing sticks. In this project, we aim to improve obstacle sensing walking sticks with innovative features. Specifically, we propose to develop a smart stick to guide blind people. The proposed smart stick is equipped with sensors to avoid small obstacles, a helmet which by itself is equipped with sensors to avoid any obstacles and a voice recording navigation module for guidance purposes. Another feature is the GPS System that will allow the user to send emergency SMS requesting help with his location.

These features will enable the smart stick to sense the path of the blind person and inform him/her about any small obstacles or holes in the way by producing a beeping sound through a buzzer. Also, the sensors of the helmet will sense the environment around the user to identify any big obstacles such as walls or cars and provide the user with audio directions to help him/her reach the destination. Moreover, the system will help the caretaker of the blind person to easily reach him/her in case of getting lost or facing an emergency. The caretaker will receive the location on the phone from the smart stick through an emergency SMS along with coordinates of google maps and identify the location of the blind person so that he/she can guide the stick user or reach him/her in a timely manner, if needed. To develop such a technology, we will apply the electrical and computer engineering knowledge that we have accumulated throughout the years of our study.

1.3 Aims and Objectives of the Project

Aims:

- To Facilitate the life of blind people.
- To use the state-of-art technologies in solving peoples' problems.
- To help people move forward towards smart cities.
- To spread awareness about minor groups in the communities.

Objectives:

- Developing a multifeatured product for Visually Impaired People (VIP).
- Integrating voice command system into the Smart Helmet.
- Designing a lightweight product with user comfortability.
- Connecting the blind person with their family/caretakers while outside the home.
- Utilizing the GPS and navigation services.
- Providing sensor-based navigation.

1.4 Significance, Scope and Definitions

This research is very important in field of medical health. It is designed to be an answer to the issue that visually impaired people face which is navigating through their surroundings. This research has been conducted by many professionals but the important element that not everyone uses is the system of 3-way navigation that is the navigation for every single major part of the body. Truly, the body is controlled by the patient, but can each body part detect the surrounding?, the answer is no, so this research narrows its focus on providing navigation to the user by providing navigation for his body sections such as head, waist, and feet. This is the main focus of this research as it will revolutionize this field and help many visually impaired people around the world.

1.5 SWOT Analysis

Figure 1: SWOT Analysis.

1.6 Report Outline

In the upcoming chapters, we discuss as follows:

- Chapter 2: Literature review which will provide the literatures that were researched.
- Chapter 3: Methodology, Design and Analysis which will discuss the methodologies used, Designs used and the analyzation of the project.
- Chapter 4: It will be used to discuss the Implementation of the project and how it was built along with what type of software and hardware's were used.
- Chapter 5: Evaluation chapter is used to show how the project will affect its field and its future outcomes.
- Chapter 6: This will discuss the overall conclusion of the report and discuss the future works that are related to this project.

CHAPTER 2: LITERATURE REVIEW

This chapter will start with the review of literatures of the following research topics: "Design and Implement Smart Blind Stick" (section 2.1) which focuses on developing a smart stick using Proteus software; "Effective Fast Response Smart Stick for Blind People" (Section 2.2) that focuses on using 18F46K80 embedded system for implementation; "The Voice Enabled Stick" (Section 2.3) that discusses usage of headphones to provide navigation for the visually impaired people; "Design and Implementation of a Walking Stick Aid for Visually Challenged People" (Section 2.4) that will provide information about how a smart stick can be developed using Raspberry Pi and a programmable interface controller (PIC) along with global position system (GPS) module. The last section of this chapter (Section 2.5) will discuss the overall affect of the literature and how the framework of the project was developed.

2.1 Design and Implement Smart Blind Stick

This research topic is about designing and implementing a smart stick for blind people to help them move around their surroundings without bumping into obstacle as the smart stick will be used to detect the obstacle so that the user can avoid them beforehand. The basics for making a blind stick which uses components like the sensors that detect the motion from almost every side. The technology used in this project is the microcontroller technology and use of Arduino NANO along with raspberry pi to develop it. The components that are used to detect the obstacles are the three ultrasonic sensors for 3 sides (left, right, front) and also an IR sensor along with a water sensor where these sensors help blind people who suffer from the lack of ability to do their activities. Finally, there is an alarm system that helps the person to notice any of the obstacles in his/her path. To alert the user, a buzzer that makes a beeping sound and vibration motor are installed for this purpose. The Proteus software program helps to implement the project by designing the product in more than one dimension. The electronic system is being controlled by using Arduino UNO. When the switch on the top of the stick is clicked; the Ultrasonic immediately sends the signal from the transmitter however when the signal impacts the level surface, it reflects to the sensor`s receiver meaning the Arduino will send a pulse to the actuators. The following table shows the key features and drawbacks for this research topic:

Table 1: Key features & Drawbacks

Key Features	Drawbacks
Detection of obstacles such as water puddles, walls, and cars.	Stick is not suitable for stairs.
Coverage of 3 directions: • Left Side. • Right Side. • Front Side.	No Coverage for any moving obstacle behind the user.
3 Ultrasonic sensors used to have more coverage area for the stick at quite low cost.	Can't detect smoke or fire putting the user's life in danger.
A Buzzer and Vibration Motor to alert the user.	No Navigation/GPS System

2.2 Effective Fast Response Smart Stick for Blind People

In this research paper, it is discussing about the professional smart stick because there are many people who have tried to do a smart stick but instead have faced many problems such as it being very heavy stick, doesn't detect all possible obstacles and is very expensive. It is further discussing about how new sensors such as infrared sensor can be used to detect the stairs and the fire. It shows the usage of infrared sensor to detect the obstacle such as the stairs. The A/D converter is used to read and convert the received analog signal to digital signal. MCU is used for the purpose of calculating the distance between the obstacles and the stick. Also, MCU is designed to know how far the stairs are from blind person by checking the variation of averages which will increase. Finally, the application of speech warning message (earphone) is used to detect the obstacles and alert the user to help him/her navigate more easily through his surroundings. The system works in such a way that it will firstly initialize the microcontroller and then transmit the pulsed IR signal along with horizontal IR sensor receiving signals. If it detects the signal, it will initialize the threshold to calculate the distance and then play the appropriate message. If it doesn't detect any signal then it will incline the IR sensor and then calculate the average of the signal form. It will then detect the presence of stairs depending on if the stairs are going up or down and will play with appropriate message. The following table shows the key feature and drawbacks in this research topic:

Table 2: Key features & Drawbacks.

Key Features	Drawbacks
PIC 16F877A is used which has low cost and is widely available.	No way to have a battery that recharges automatically through motion of the stick.
Use of Infrared Sensors to help detect new obstacles like stairs.	The detection range of the stick is quite low.
Playing an appropriate message to help user to navigate through the stairs whether he/she wants to go up or down.	No way to detect moving obstacles that might be coming from behind the user.
Very low power consumption meaning the batter life is up to 14 hours before needing to recharge.	No GPS Tracking System.

2.3 The Voice Enabled Stick

This literary paper discusses a device named Voice Enabled Stick (VES) which is basically a novel embedded system. The device will help a blind person move around easily through the commands from the device in the form of voice that is generated from the headphone. It can tell the user the direction that he/she must take to avoid any obstacles through the 3 ultrasonic sensors it is using. The 3 ultrasonic sensors are positioned in 3 directions which are front-side, left-side, and right-side. These sensors are connected to the microcontroller Arduino UNO. The 3 sensors transmit the signals & receive these ultrasonic signals after they bounce back from the obstacles in the environment. The time it takes for the signal to reach the obstacle and return back to the sensor is calculated between the transmit and receive time while the user is informed of an obstacle in the path if any. The voice command module is then used to communicate with the user. The commands that the user hears from the device are saved in an SD card to be used depending on the position of the obstacle whether it is in front, left or right. The R-2R network is used to work with the signals that are bouncing back and forth by converting them from digital signals to analog signals. The following table shows the key features and drawbacks of this topic's project:

Table 3: Key features & Drawbacks.

Key Features	Drawbacks
Compact & lightweight.	No help in form of Visual AID.
Low cost.	No GPS Tracking System.
Low battery consumption	No way to detect moving obstacles that might be coming from behind the user.
Low NRE cost	No way to contact any caretaker in the stick such as emergency SMS.

2.4 Design and Implementation of a Walking Stick Aid for Visually Challenged People

This project paper introduces a device that is designed to help visually impaired people for moving around. It uses Raspberry Pi to develop the device needed along with 2 types of sensors that are the water level sensor and ultrasonic sensor in this device. The ultrasonic sensor is used to detect any object in the path of the user while the water level sensor is used to detect puddles of water or any wet ground in the path of the user. The device also has GPS system that can record the location of the user in the database. An app is connected to the GPS incase a need arises to contact the caretaker of the user. Furthermore, it consists of a vibration motor and a buzzer to alert the user of any obstacles in his/her path. The system is design to work in such a way that the ultrasonic sensor sends a signal in the environment to detect any obstacle in the path of the user. The concept of "Echolocation" is applied in this device. The signal contains the information of the obstacle that will be detected. The data that is received contains information of the type of hurdle in the way which could be an object or a water puddle. Another information that is in the signal received, is the size of the object. The information is then passed onto the Raspberry Pi microprocessor which will compute the program code for the device turning on the vibration motor to alert the user of the obstacle in the path. The following table shows the key features and drawback faced in this research project:

Table 4: Key features & Drawbacks.

Key Features	Drawbacks
Long detection range.	Internet connection required.
Water puddle detection.	Cannot detect fire or smoke around the user.
GPS location tracking.	No way to detect moving obstacles that might be coming from behind the user.
Emergency App.	Complex project build.
Lightweight	-
Automated Social Media usage.	-

2.5 Summary and Implications

The research projects mentioned in sections 2.1, 2.2, 2.3, and 2.4 are used to provide the team with focus on analysing and comparing the project in terms of hardware's and software's used along with the circuit connections. Moreover, these mentioned projects are used to highlight the comparisons with "Smart Stick for Blind People" project developed in this research project. It can be seen in the previous section topic's that most of these projects use the same components such as ultrasonic sensors and voice recording module for navigation with some exceptions. This "Smart Stick for Blind People" project is designed to be an improvement and combination of all the mentioned research topics to a good extent. Researching these literature topics has allowed for this project to not only have a good base to start off from but also has supported in avoiding mistakes or errors that might have been faced in the topics mentioned above.

CHAPTER 3: METHODOLOGY, DESIGN AND ANALYSIS

To develop an answer for the problem faced that is navigation for blind people, we build a system made up of 3 subsystems. The 3 subsystems are the Smart Stick (Primary subsystem), Smart Helmet (Secondary subsystem) and Smart Shoe (Secondary subsystem). The method to develop each type of these subsystem was using models. The Model applied for this project is the "Waterfall Model" or otherwise known as linear-sequential life cycle model.

3.1 Methodology

The methodology used for addressing the issue of navigation for the blind is by using Waterfall Model as mentioned above. It's way of working is that the system is divided into different phases of development of different subsystems. The subsystem at phase 2 can't be started unless the phase 1 subsystem is completed. In our case, we also had 3 phases that we went through which was: Phase 1-Development of Smart Stick, Phase 2-Development of Smart Shoe and Phase 3-Development of Smart Helmet. Most of these phases in the Waterfall model are same with minor changes according to the subsystem developed. The following figures show model of each subsystem:

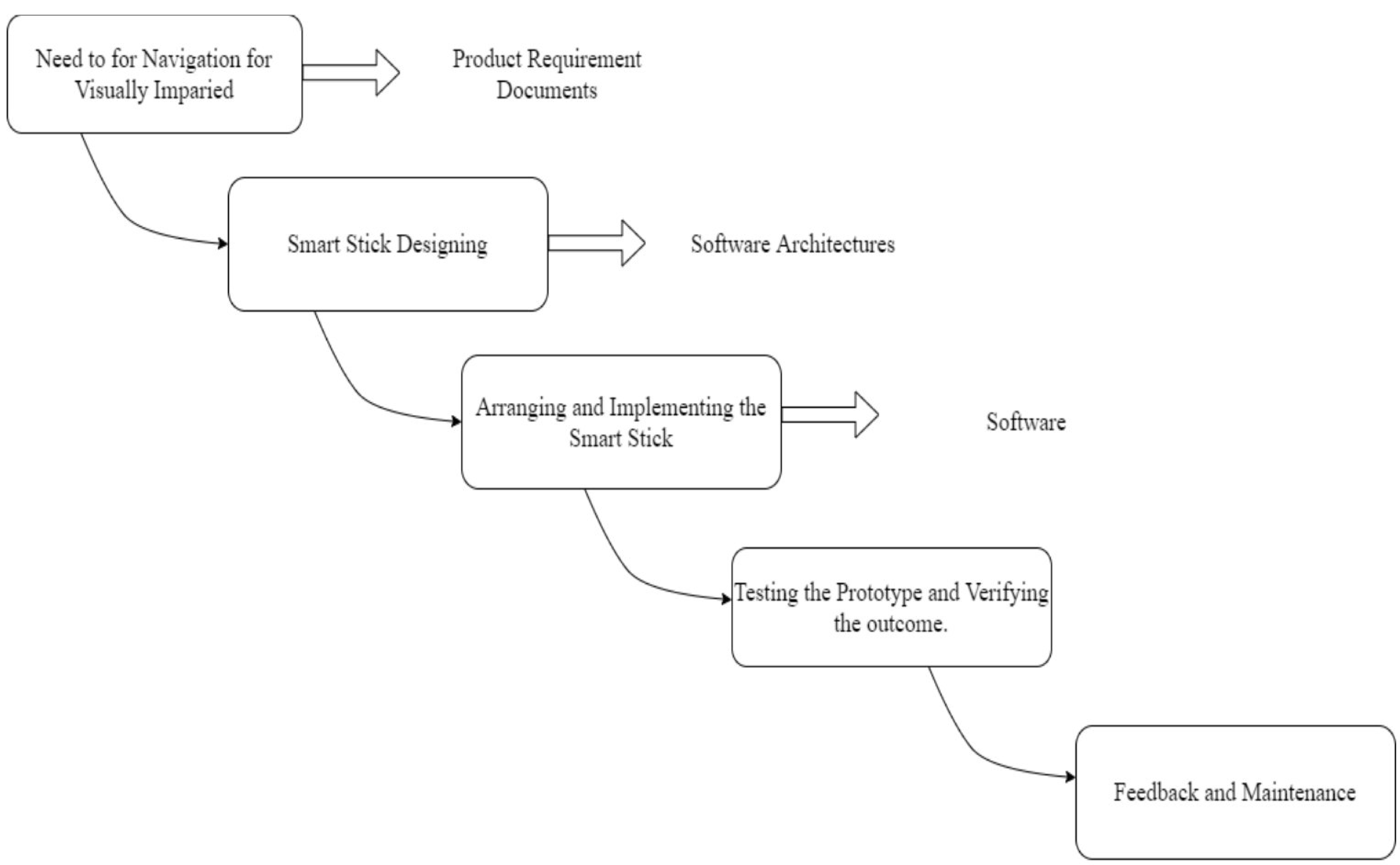

Figure 2: Water-Fall Model for Smart Stick.

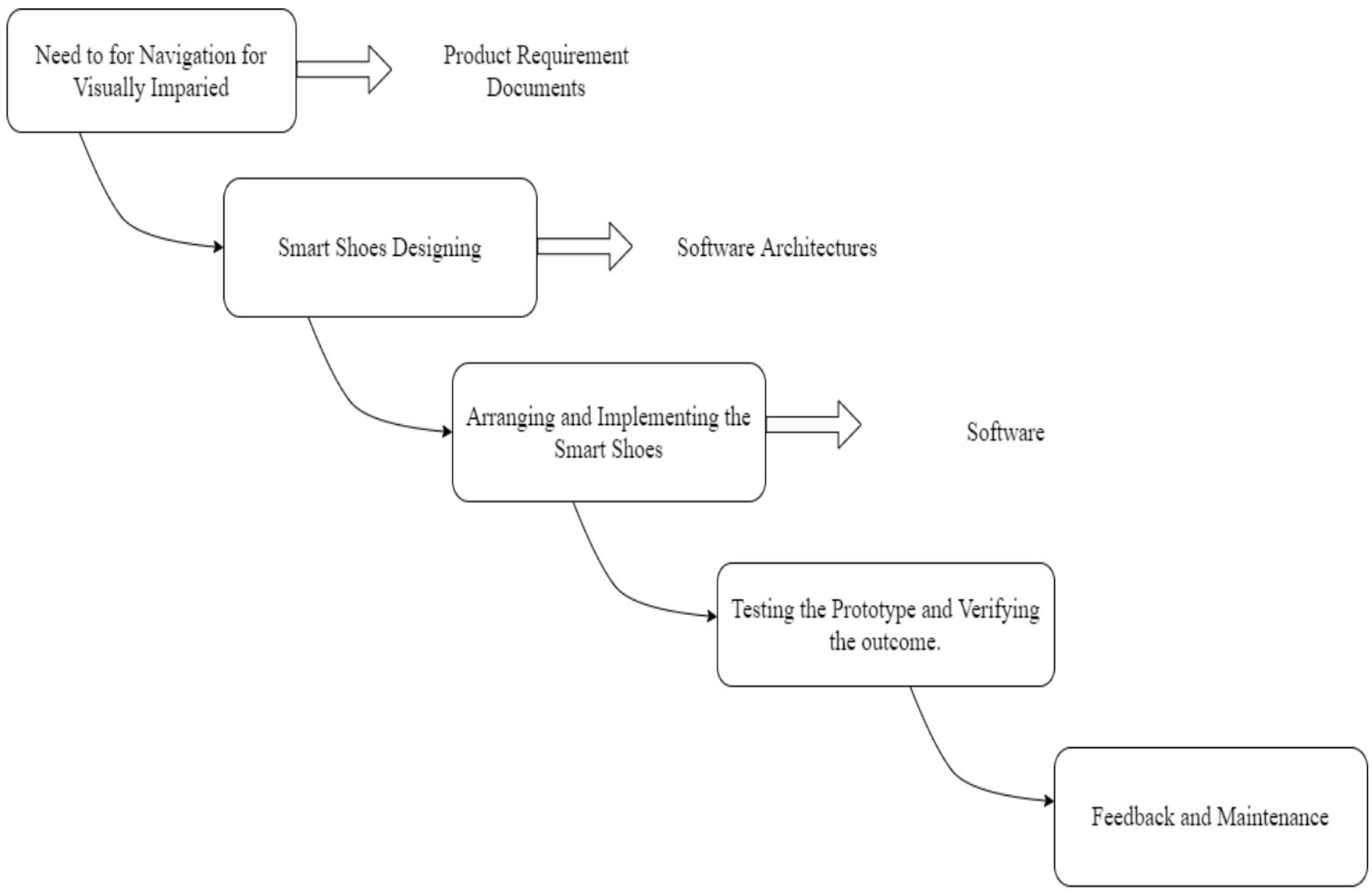

Figure 3: Water-Fall Model for Smart-Shoe.

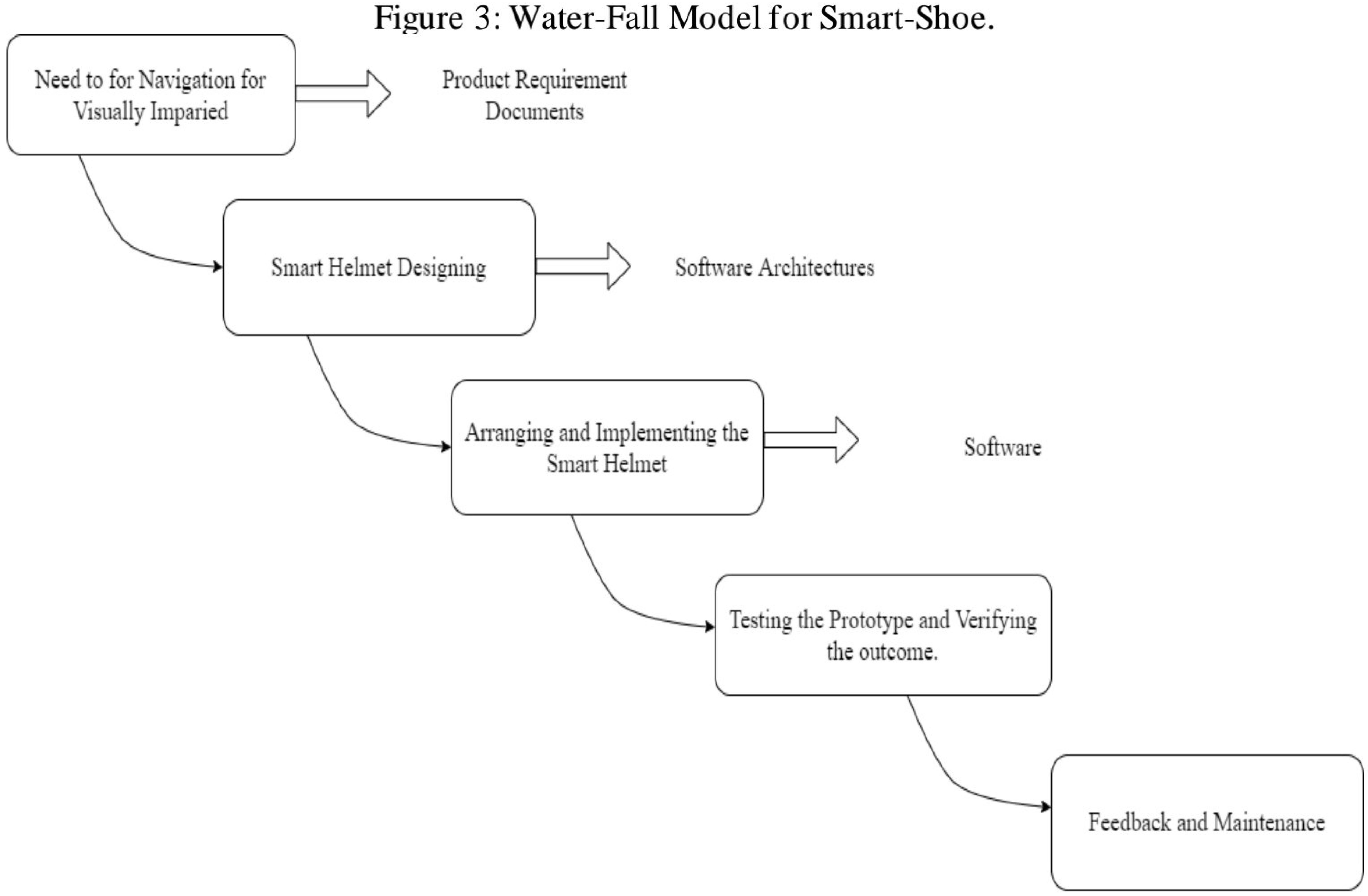

Figure 4: Water-Fall Model for Smart Helmet.

3.2 Research Design

Project team have conducted enough analysis to understand the implementation needed for this project. We decided the project will not have too many alternative other than these upcoming 2. These 2 represent the alternatives considered and investigated by the team.

3.2.1 Design Alternative 1

The GPS Tracking System on the "Smart Stick" uses the GSM SIM900 module. It can be replaced with GSM SIM800 which consumes even less power although at cost of vulnerability to any jumps towards high voltages. This GSM SIM800 can work with Arduino UNO but the program code will need to be changed as the pins and connections will be different. Furthermore, camera system can be implemented if needed to capture the surroundings of the user and send along with the emergency SMS through the GPS Tracking System to provide more clear info about the location user is at that moment.

3.2.2 Design Alternative 2

Another alternative way to develop this project is by replacing the whole GPS Tracking Circuit with a Mobile application which can be implemented using through coding on the Android Studio software. The code will be developed to provide the default location of the user's house on google maps and the secondary positioning will show the current location of the user on the app. To develop this idea, there are further 2 more ways of which the first is to develop a full-fledged mobile app and secondly to have a circuit which emit GPS signals which can be detected by the care-taker's mobile application named "Blynk". Blynk is an app that is mostly used for making project through sending signals to satellite. "Blynk" app could be used as a substitute instead of making a mobile app from scratch. It will provide the current location of the user along with written coordinates data. These coordinates will be shown as longitude and latitude. The speed at which the user of the stick is moving is also shown on the "Blynk" app. The following figures shows the "Blynk App" and how the front view of project constructed on it will look like if used:

Figure 5: Blynk App Logo.

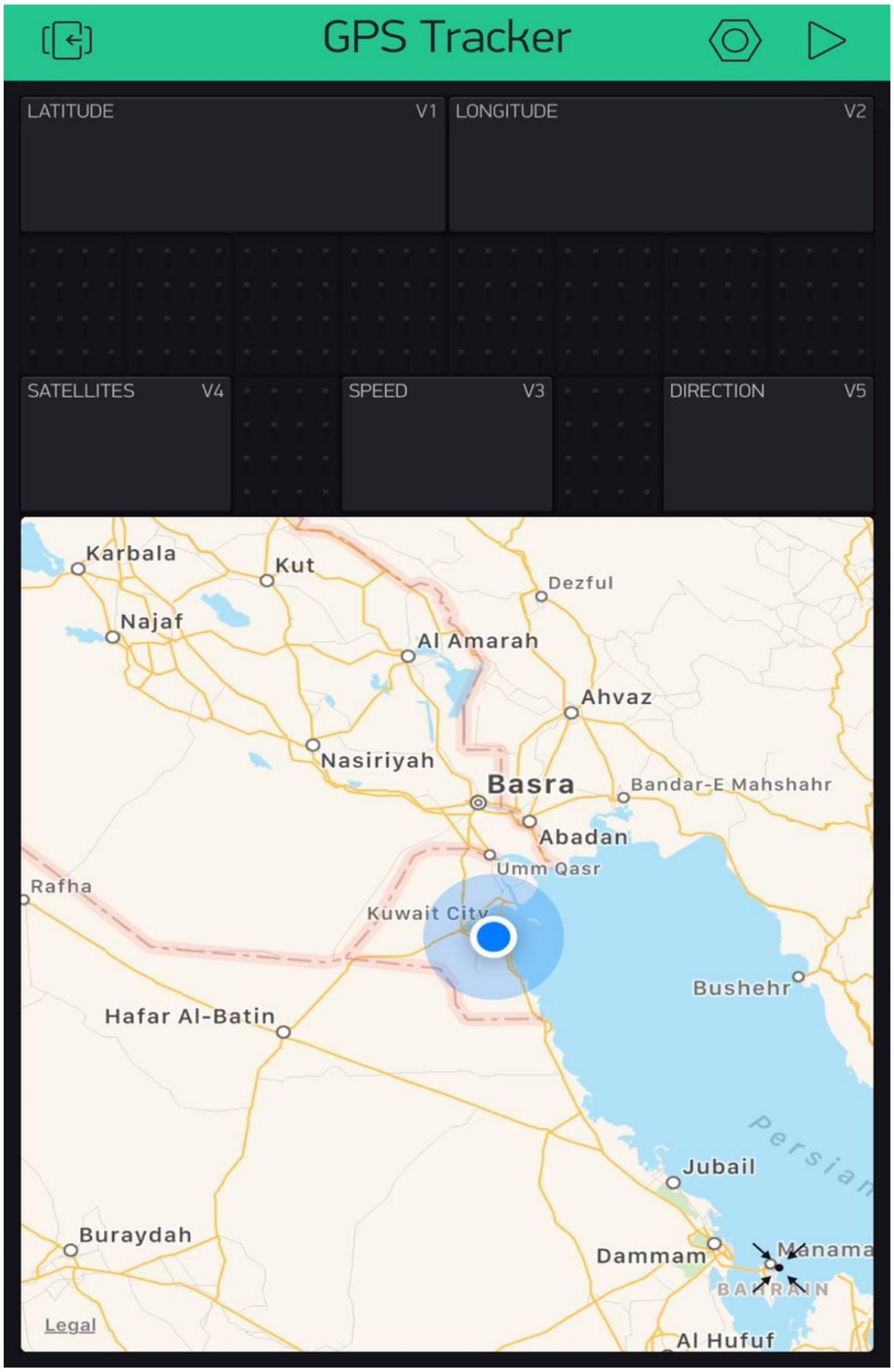

Figure 6: GPS Tracking System using Blynk App.

3.3 Software and Hardware

For "Smart Stick for Blind People" project, we used variety of hardware component and software. In the software part, we used the Arduino IDE which is used for each subsystem. The Arduino IDE is an integrated development Environment software that is used for coding purposes to develop different projects which use Arduino UNO or Raspberry Pi hardware. The following shows the software and hardware used in each systems of the project:

3.3.1 Smart Stick:

Software Used:

- ❖ Arduino IDE:

  It is a text editor that is used for purpose of writing codes and has many features such as a text console and message area. It is used in projects that use Arduino, Genuino and Raspberry Pi coding for development of an electrical application.

Figure 7: Arduino IDE.

Hardware Used:

- ❖ Arduino UNO:

  Arduino Uno is an open-source single board microcontroller. It consists of 14 digital I/O pins and 6 analog I/O pins. It works together with the software known as "Arduino IDE" to be programmed for any task that the user might need to do. In this project, Arduino Uno is used to as the base for the work as every component in each subsection parts of the project are connected to each other through the Arduino Uno. The software mentioned is where we apply the program code for each subsection parts of the project to get the intended outcome.

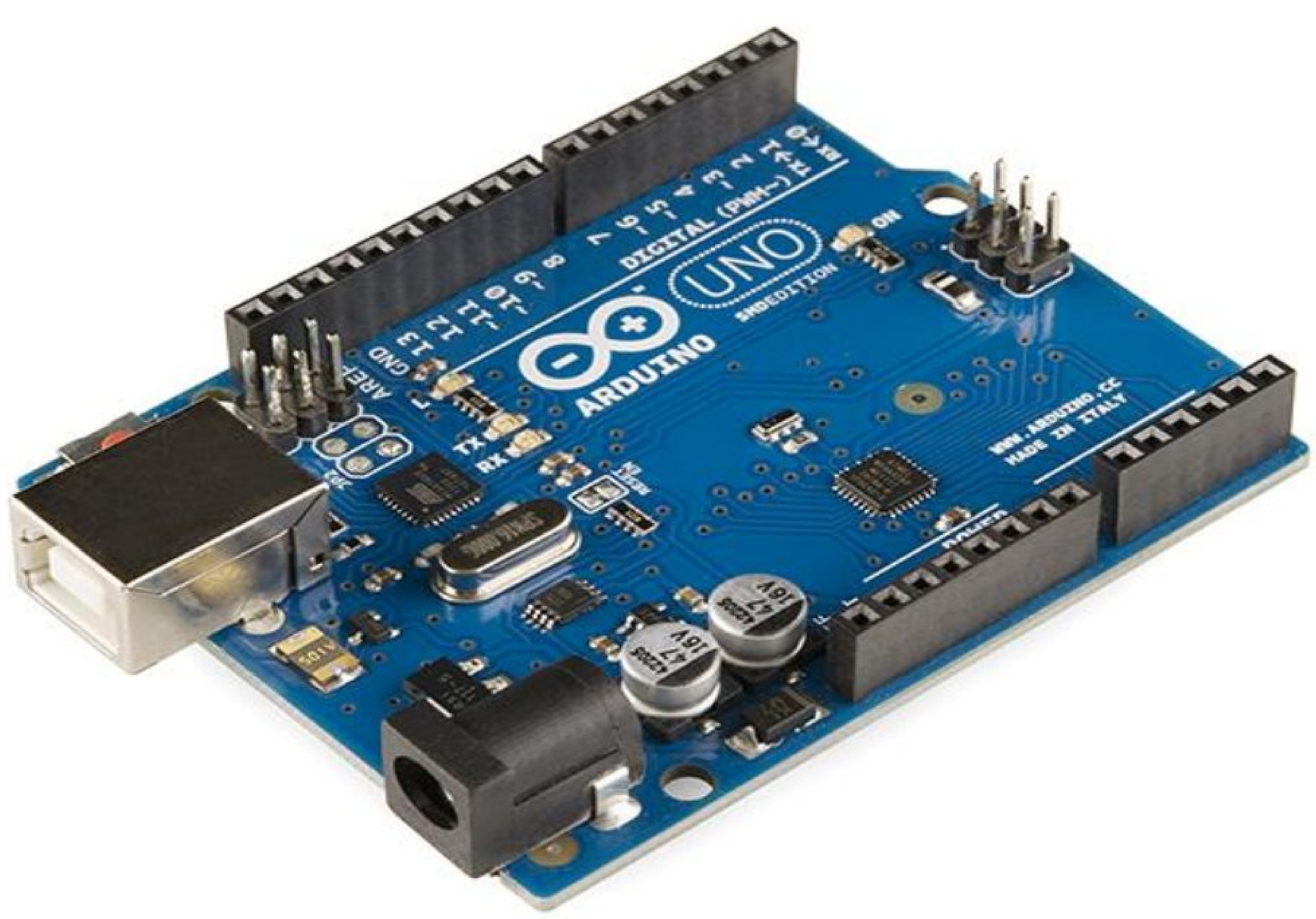

Figure 8: Arduino UNO.

- Ultrasonic sensor:

  It is an electronic device that is used for detecting any object and measuring the distance to it. it emits ultrasonic sound waves which are then converted into electrical signals upon reflecting back from the object. It is used in our project as one of the most important components as it will provide the ability to detect any obstacle in front of the user.

Figure 9: UltraSonic Sensor.

- Vibrating Motor:

  This motor is used to provide a silent alert function in the circuits. It can have many different purposes but in our project, it is used for providing vibration in the stick to let the user know he is encountering an obstacle. This motor is used in many other applications such as mobile phones and robotics for purpose of alerting the user.

Figure 10: Mini 3V Vibrator Motor.

- Buzzer:

  It is an active buzzer that works from frequency range of 2000Hz to 2600Hz. It is made up on 2 pins that are used to attach it to ground and power source. Once the current flows through it, it will expand the ceramic disk inside it which will result in making the disc vibrate. The sound that will be heard is the result of the vibrations occurring with the disk.

Figure 11: 5V Buzzer.

- 9V Batteries:

  This is a 9V battery that is used to supply voltage to a circuit or a system. It has a very long-life and is portable along with being lightweight. It is used in the project to supply voltage to subsystems created for different purposes.

Figure 12: 9V battery.

- NEO 6M GPS Module:

  It is a UART interface that is used for serial communication. It can be easily integrated with different range of microcontrollers. It needs a DC input which can range from 3.3V to 5V as it has its own built in voltage regulator. It has an antenna attached to it which is of type "patch antenna". It works well with the baud rate of 9600 and needs to be out in the open to function properly as it will have a direct line of sight towards the satellites.

Figure 13: UBLOX NEO-6M-GPS-Module.

❖ GSM SIM900:

SIM900 is GPRS solution which is in a SMT module where it is able to be embedded in any application. It has the ability to deliver voice, SMS, Fax and Data while consuming low power. It's relatively small size is helpful in situation where a project has space requirements so it can fit easily. To be able to use this module, it needs to be attached to either a PCB or a circuit. In our case, we used it in our circuit for development of our project. It works in such a way that it will be able to send SMS with google maps current location of the user.

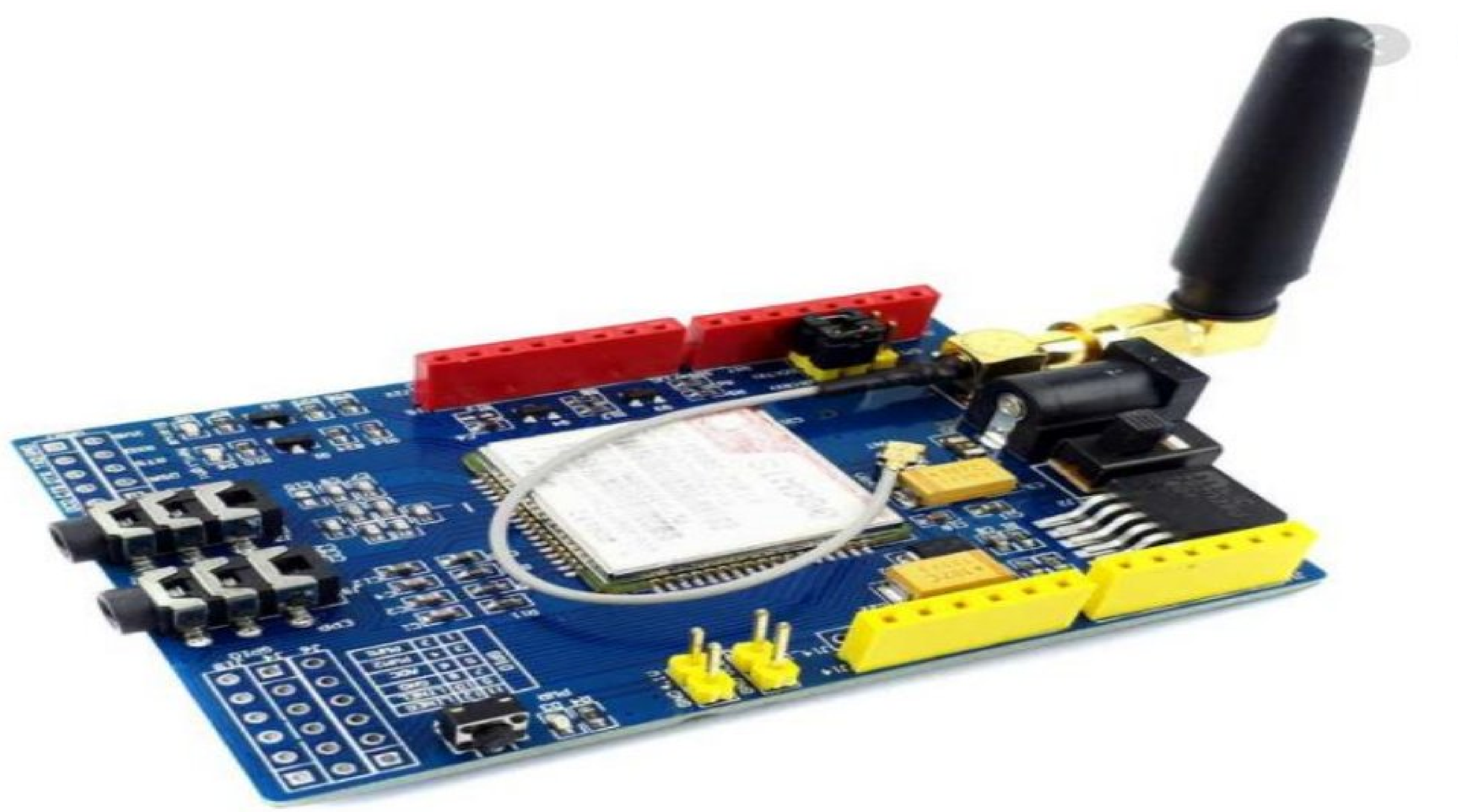

Figure 14: GSM SIM 900.

❖ Push button:

This is a type of switch has a very simple mechanism that is to turn something off or on. It allows the electricity to pass through from one of its points to the other when pressed and when it is released, it will break the circuit. It is most commonly used for circuit that are used for door-bells and power switches. It is used in our project for the reason of ability to send the SMS to the user's caretaker in case of an emergency.

Figure 15: Push Button Switch.

- Walking Cane:

  This is a basic walking cane which is used by many people for different reasons but at the end, it all comes to 1 simple purpose which is navigation through the surroundings. It is used by elderly people, disabled people, and visually impaired people. It is used in this project to act as a holder for the circuits created for purpose of helping navigation outside for blind people.

Figure 16: Basic Walking Cane.

- Sealed Lead Acid Battery:

  This battery is leak-proof sealed lead acid battery that can store electricity reliable for a very long time where its lifespan is around 10-12 years. It is used in GPS Tracking System to supply the need power which can't be done with simple 9V batteries. The charging and discharging cycles are above average and it provide very high performance.

Figure 17: Sealed Lead Acid Battery.

- ❖ Mini LED Dot Light:

  This LED Light is used to provide light in a dark environment. It is used in this project to act as a source of letting people around be aware of the person using it. It comes in various colors, but it was chosen to be white in this project.

Figure 18: LED light.

3.3.2 Smart Shoe:

The software and hardware's used in this subsystem are the same as in "Smart Stick" with some differences. The following shows the list of software and hardware's used in this part of the system:

Software Used:

- ❖ Arduino IDE:

Hardware Used:

- ❖ Ultrasonic sensor.
- ❖ Buzzer.
- ❖ Arduino UNO.

- ❖ Battery 9V.

3.3.3 Smart Helmet:

The software and hardware's that are used in this subsystem are the same as in "Smart Stick" and "Smart Shoe" with some understandable changes. The following is the list that shows the software and hardware's used in the system:

Software Used:

- ❖ Arduino IDE.

Hardware Used:

- ❖ Ultrasonic sensor .
- ❖ ISD 1820 Voice Board Recording System:

  This is a device that is used for capturing an audio of anything. It is a single chip recorder meaning that it will only record and play a single message. It has a non-volatile memory and can be used for storing message that can range from 8 seconds to 20 seconds. It is being used in our project for the purpose of providing audio navigation from the helmet to the user to let him/her know to change their direction when an obstacle is detected.

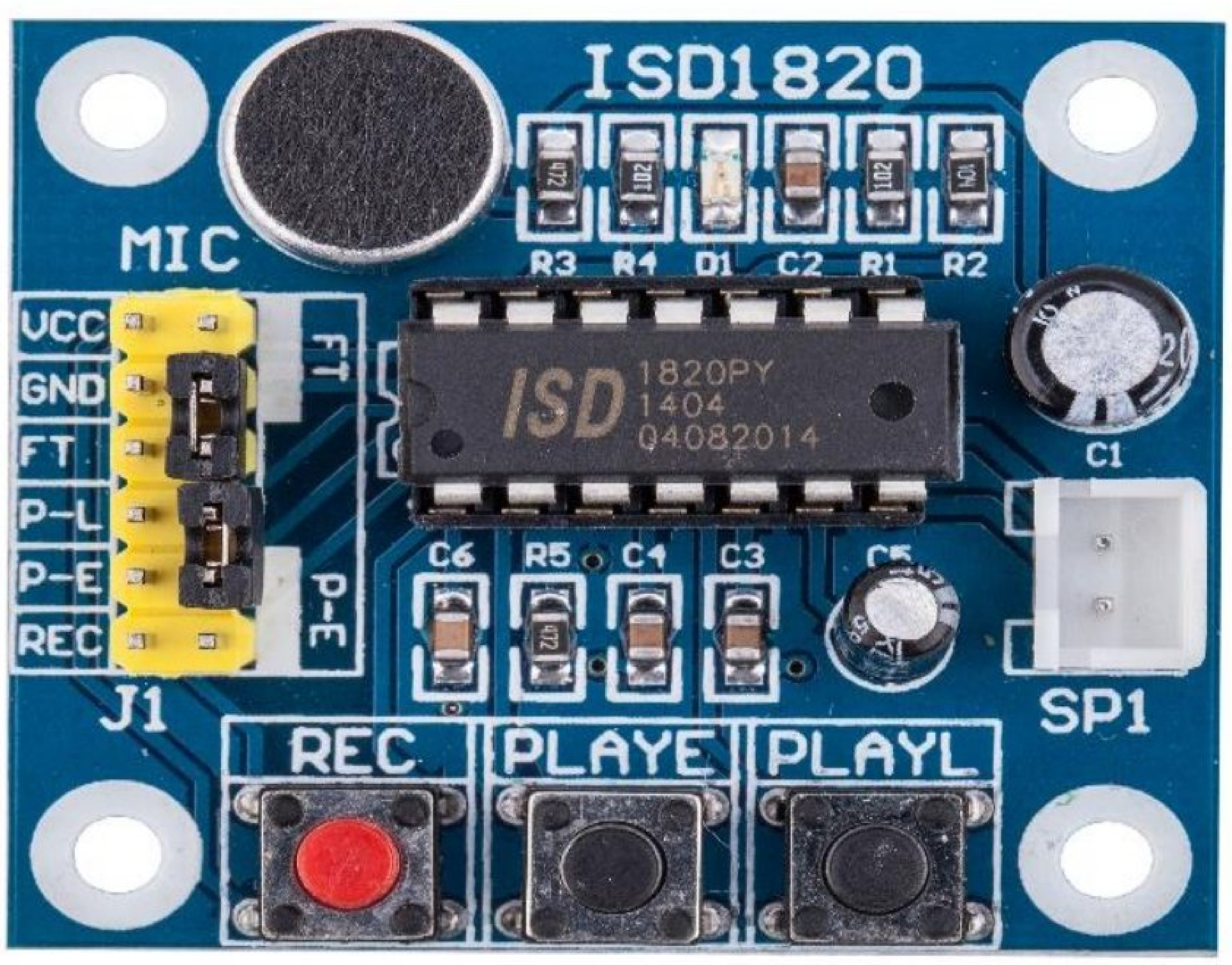

Figure 19: ISD 1820 Voice Board.

- ❖ Engineering Helmet:

  This safety helmet is designed to provide protection for the user against objects that might harm the head of the user. it not only protects against objects but also against electrical exposure. It is used in this project to act as a navigation subsystem that will detect any obstacle in front of the user from eye-level to above the head.

Figure 20: Engineering Safety Helmet.

❖ Breadboard:

A breadboard is also known as protoboard. It is used for purpose of acting as a base of making prototype electronics circuits. It is used in situations where soldering is not the best option, and it also has an important quality of being reusable. In our project, it is used to act as basic construction platform for the circuits.

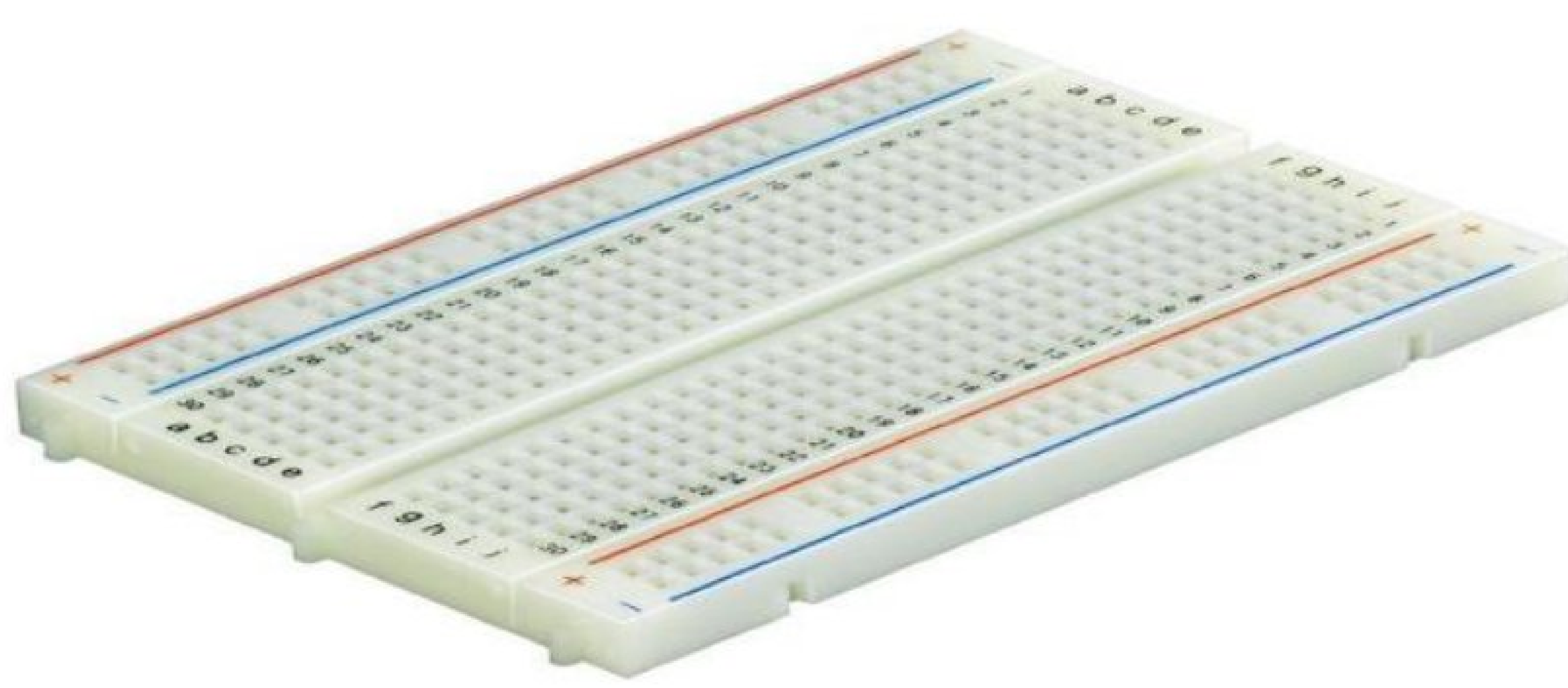

Figure 21: Breadboard.

❖ Mini-Speaker:

This simple and lightweight mini-speaker is important for use of playing audio. It has 8ohm impedance and is very good choice for small audio project where it’s small size and low power consumption makes it ideal.

Figure 22: 8ohm Mini-Speaker.

- Arduino UNO.
- Battery 9V.

3.4 Analysis

To understand how the data is processed and analysed for each Subsystem, we go through each subsystem in details to demonstrate the way it works. There are 3 Subsystems that are analysed named firstly “Smart Stick”, secondly “Smart Shoe” and thirdly “Smart Helmet”. There are many ways to develop each subsystem but our approach to developing these subsystems was by building 1 of them upon the other.

We firstly developed the “Smart Stick” circuits where it consists of 2 section circuits. The first section circuit focuses on detecting an obstacle in front of it after which it will send the distance measured into the Arduino Uno in the circuit where the distance is processed against the set distance value. If the obstacle is detected by ultrasonic sensor and the distance of the obstacle is within the set range, the buzzer will make a sound as well as the vibrator motor will vibrate to let the user know that there is an obstacle ahead of him/her. The second section circuit is developed in the way that it will have a pushbutton that when pressed, will send an emergency SMS to the caretaker along with the GPS Coordinates to allow the caretaker to reach him/her. The circuit works in way that the GSM SIM900 blinks slowly and the antenna is used to send the signal to satellite when the switch is turned on and the button is pressed. The signal will then travel to the caretaker’s mobile in form of SMS. The caretaker’s mobile number is embedded in the code developed for this part therefore having a destination for the SMS to reach. Another important part of the second section circuit is that the Mobile Sim used in circuit must have enough credit to send the message.

Secondly, we developed the “Smart Shoe” circuit which is similar to the “Smart Stick” circuit. The ultrasonic sensor will detect the obstacle in front of it on the foot level and in return send the obstacle detection alert in form of buzzer beeping to alert the user. The obstacle detected will have the distance sent to Arduino UNO to compare to pre-set distance value that acts as a set mark where if the obstacle is less than the set distance in the program code, the buzzer will beep to alert the user while if the distance of obstacle is less then the pre-set distance in code, it will stay turned off. This part of the System acts as a deterrent to obstacles that are on the foot level where the stick might not be able to reach. The obstacle it is designed to focus on detecting, are the stairs and sidewalk edges.

Thirdly, another subsystem was developed named “Smart Helmet” which also works like the previous 2 subsystem circuits with some minor difference. The helmet consists of Arduino Uno which has the program code embedded in it, breadboard which is placed for extra wire connections, Voice Recorder module that plays an audio “Change Direction” whenever the ultrasonic sensor detects an obstacle at and above eye level. There is also a 9V battery attached inside the helmet to provide the power needed to operate the whole circuit.

This approach of having 3 subsystem is considered by us to be better than the research sources method as if there is a single malfunction with any component, the whole system collapses but, in our case, it will not completely collapse. For example, if a component fails in “Smart Shoe” subsystem, the other 2 Subsystems named “Smart Stick” & “Smart Helmet” would still function. This idea of 3 subsystem provides a sense of security for the user so that they will not panic if the device does not work.

3.5 Ethics and Limitations

As engineers, we need to make sure our work is conducted on good standard to uphold and protect the integrity of our professions. We need to make sure that our project is safe to use and is of high quality as it will be used in real life for the blind people. The project focuses on another aspect as well which is making sure that it does not affect the health of the user and on the contrary, our project is designed to be healthy in a sense that it will treat the medical issue of blindness by providing the sense of navigation. The scope of the project is quite big as it will fulfill the requirements by the user and their expectation.

CHAPTER 4: IMPLEMENTATION

This section normally describes how the implementation was done, the tools that were used, the difficulties that were encountered and the way they were overcome. The structure of this chapter should reflect the major stages in the development process and/or the major components. The proposed implementation must clearly state and comply with the IEEE standards related to the topic and product. Add a table listing any IEEE standards corresponding to the technologies used in the implementation of the product in an appendix.

4.1 Hardware Implementation

After thorough research and study of the best as well as easily implemented hardware & software, we were able to apply the most suitable methodology to create our project's prototype named "Smart Stick for Blind People". The hardware used is mentioned in Chapter 3 section 3.3 but here the connections for each subsystem are provided. The following are the subsystem hardware's:

4.1.1 Smart Stick

This section is dedicated to the development of the "Smart Stick and GPS Tracking System". The "Smart Stick" is designed to detect the obstacles in front of the user and alert him/her through the use of buzzer and a vibrating motor. This smart stick is made up of 9V battery, Arduino UNO, Ultrasonic sensor, buzzer, vibrating motor and dynamo tires that will turn on the LED light which turns on as the tires have movement. The sensor will be detecting an obstacle within the provided range in the program code (explained in section 4.2.1). The data obtained through the sensor readings will be sent to the Arduino UNO which has power supply of 9V through the battery. The pins of the sensor that are "echo" and "trig" are connected to the Arduino uno while the other 2 pins are connected to Vcc and ground respectively. The buzzer is also connected to a power supply pin in Arduino and its other pin is connected to ground. The same concept is applied on the vibrating motor which is connected to the circuit where one of its pins is connected to power supply while the other one is connected to ground. When the ultrasonic sensor detects any object in its vicinity from the sides or front, it will send the data to Arduino uno which will send the executed command to the buzzer and vibrating motor to alert the user. The following figures show these implementations:

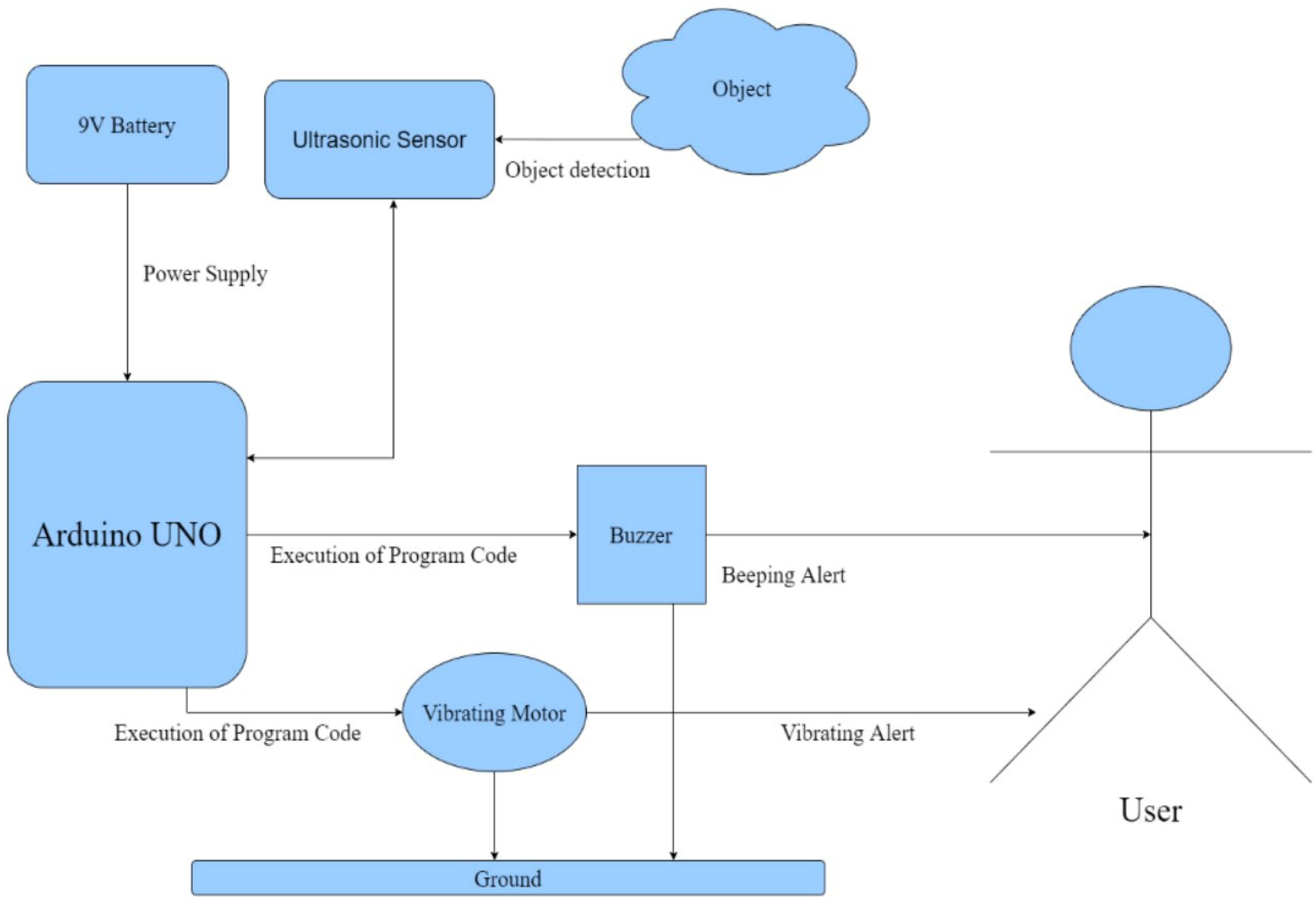

Figure 23: Smart Stick Dataflow Diagram.

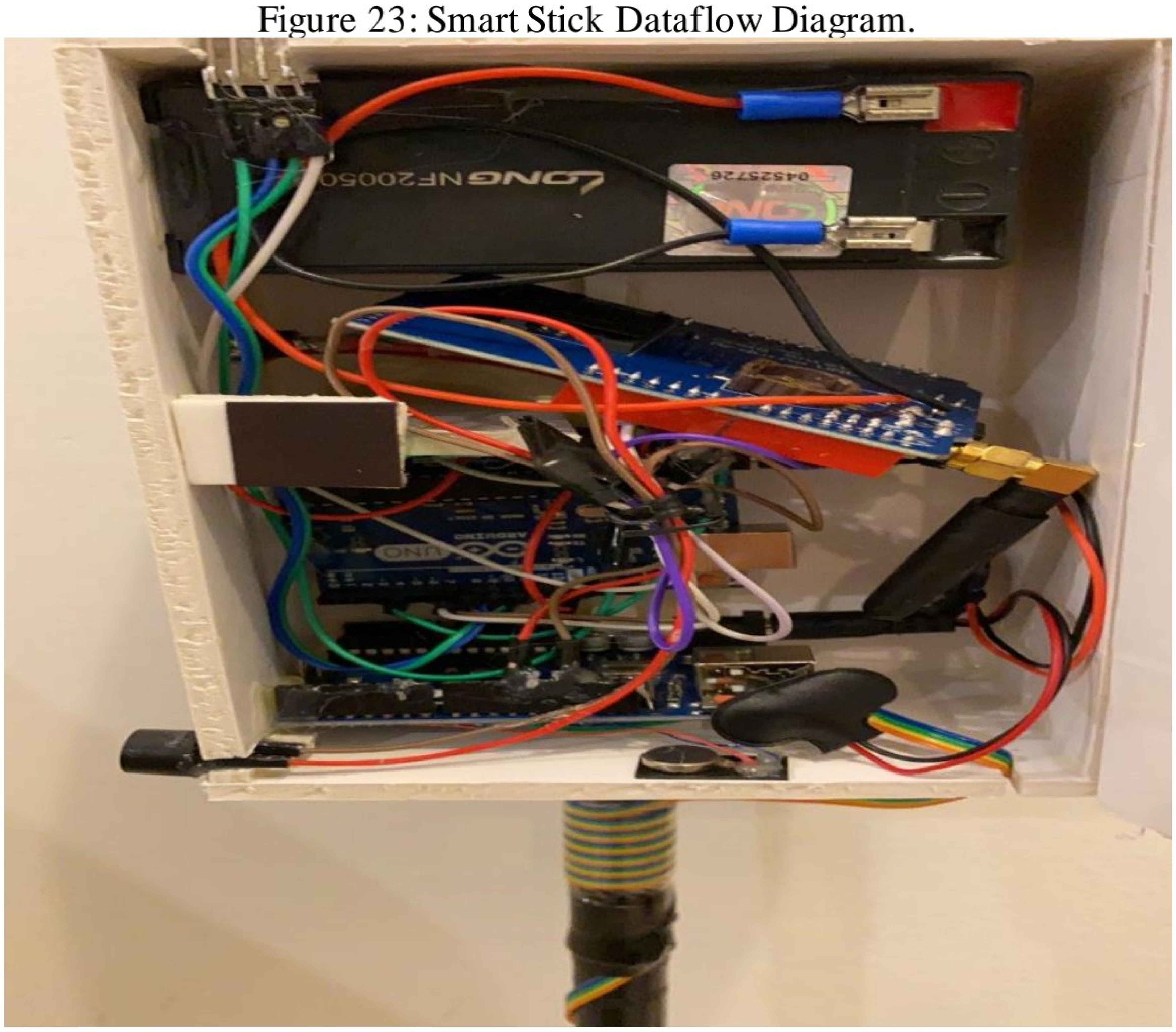

Figure 24: Smart Stick & GPS Tracking System in the box.

Figure 25: Final Smart Stick prototype with GPS Tracking System.

4.1.2 Smart Stick's GPS Tracking System

This section is focused on the designing a "GPS Tracking System" which will be able to share the user's location to his/her caretaker. The way it was constructed is that the Arduino Uno is programmed to send an emergency SMS to the user's caretaker when he/she presses the push button. The Arduino is power by a 12V battery. Arduino is connected to GPS Tracking system which is a component called GSM SIM900. The code in Arduino will execute to start the GPS module to be "ON" which will then send the location data back into Arduino. When the push button is pressed, it will prompt the location data to be sent through the SMS to the user's caretaker. The data send will contain the user's location along with any embedded message in the system. The following figures show these implementations:

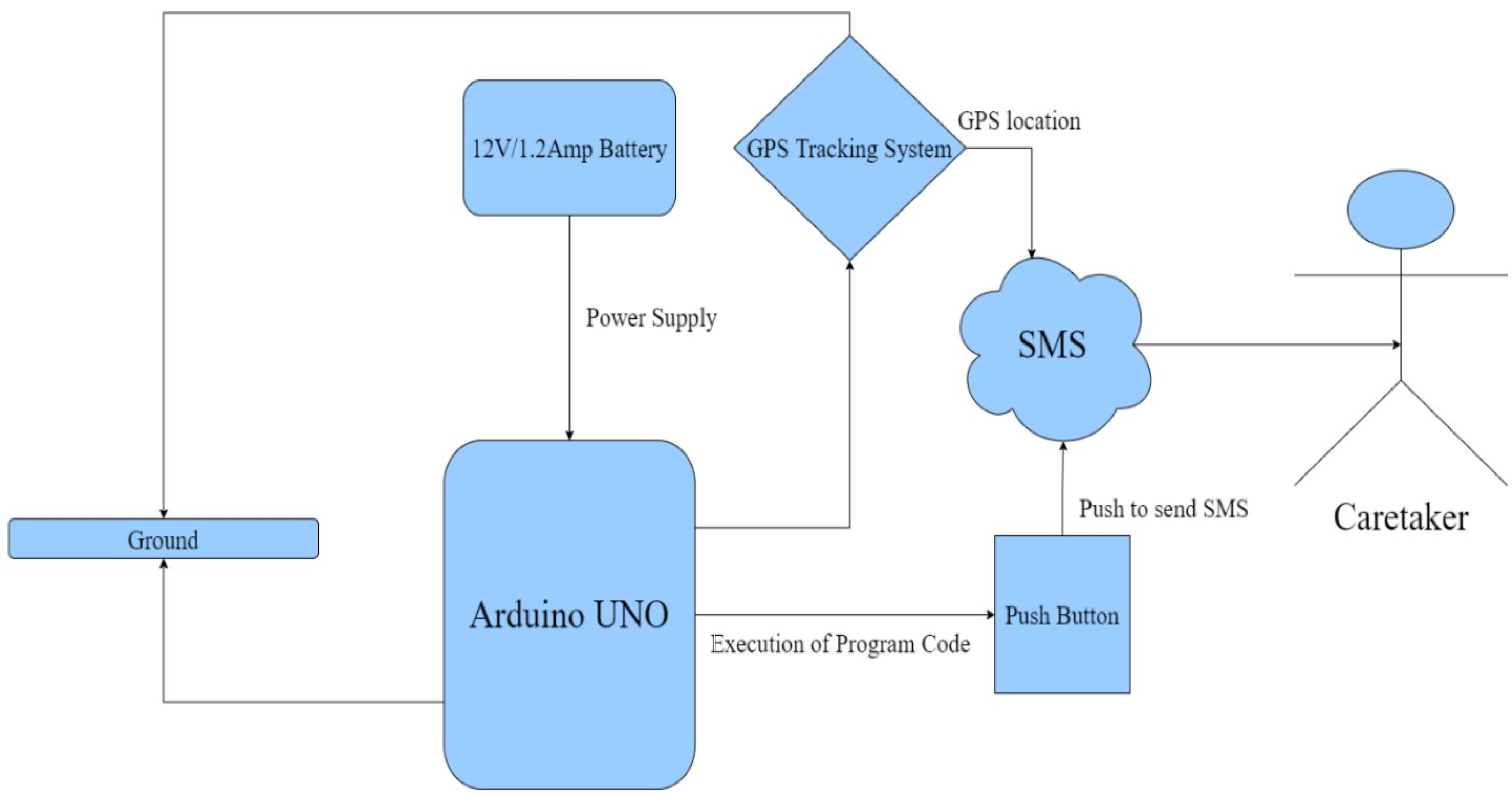

Figure 26: GPS Tracking System Dataflow Diagram.

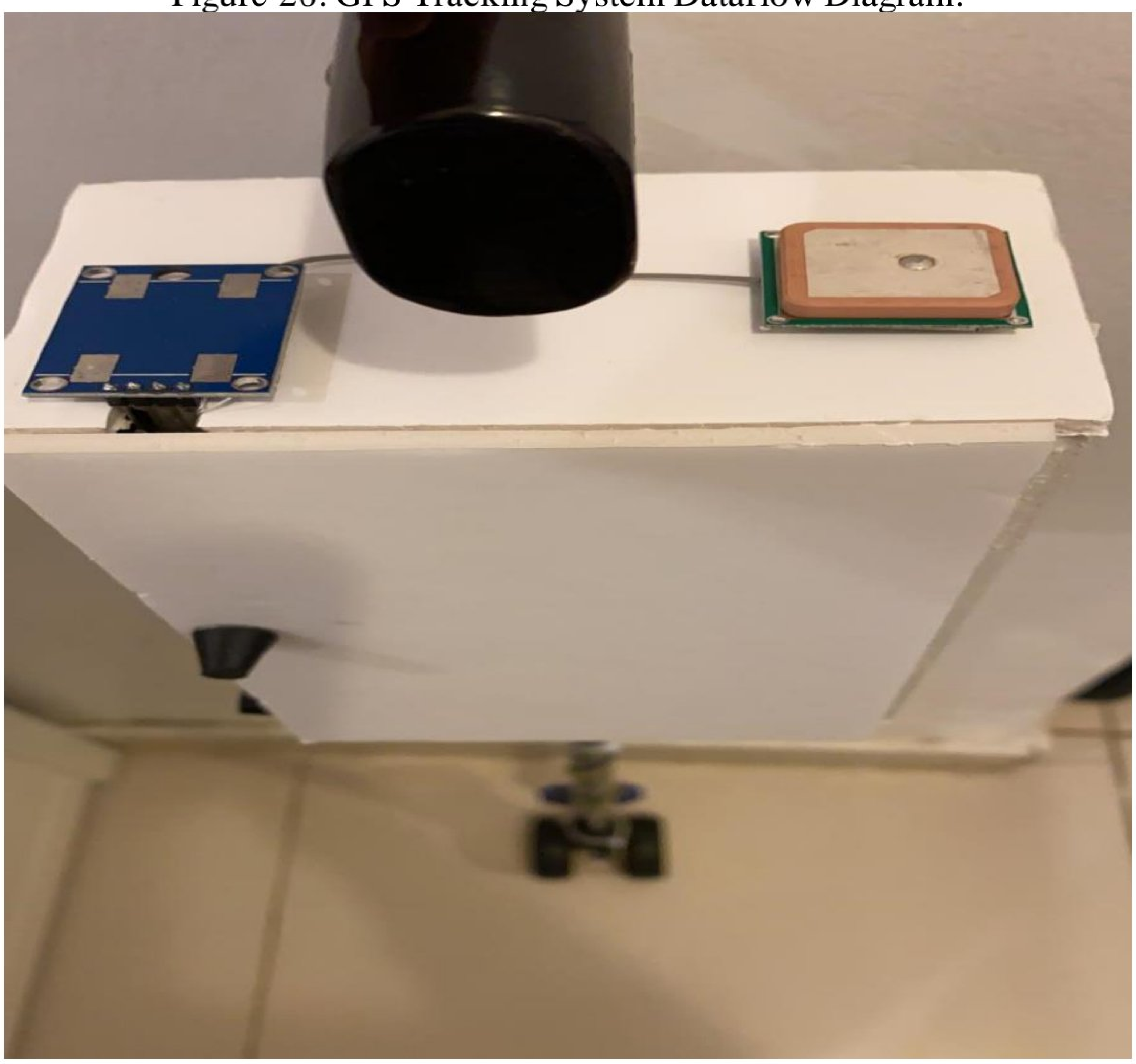

Figure 27: GPS module.

4.1.3 Smart Shoe

This section focuses on the developed "Smart Shoe" which will detect the obstacle such as stairs and alert the user through the usage of a buzzer. This subsystem is composed of 4 very important components. These components are 1) 9V battery 2) Arduino UNO 3) Ultrasonic Sensor 4) Buzzer. The system works in the sense that the ultrasonic sensor will detect an obstacle/object within its prescribed range in the program code (explained in section 4.2.2). The data of the object's distance is sent to the Arduino Uno which is being supplied power from a 9V battery. The pins connected from ultrasonic sensor to the Arduino are the "echo" and "trig" pins. The Vcc pin of sensor is also connected to the Arduino's 5V pin on the analog side. The digital Vcc 5V pin of Arduino is connected to buzzer to give it power. The buzzer is also connected to ground. So when the ultrasonic sensor detects an object, it will send the data to Arduino which will determine whether to send a signal to buzzer to turn on or stay off depending on the readings of the detected object's distance. If it turns on, the buzzer will start beeping to alert the user otherwise, it will stay off. The following diagram and figure show's how the "Smart Shoe" circuit works and its overall designed prototype:

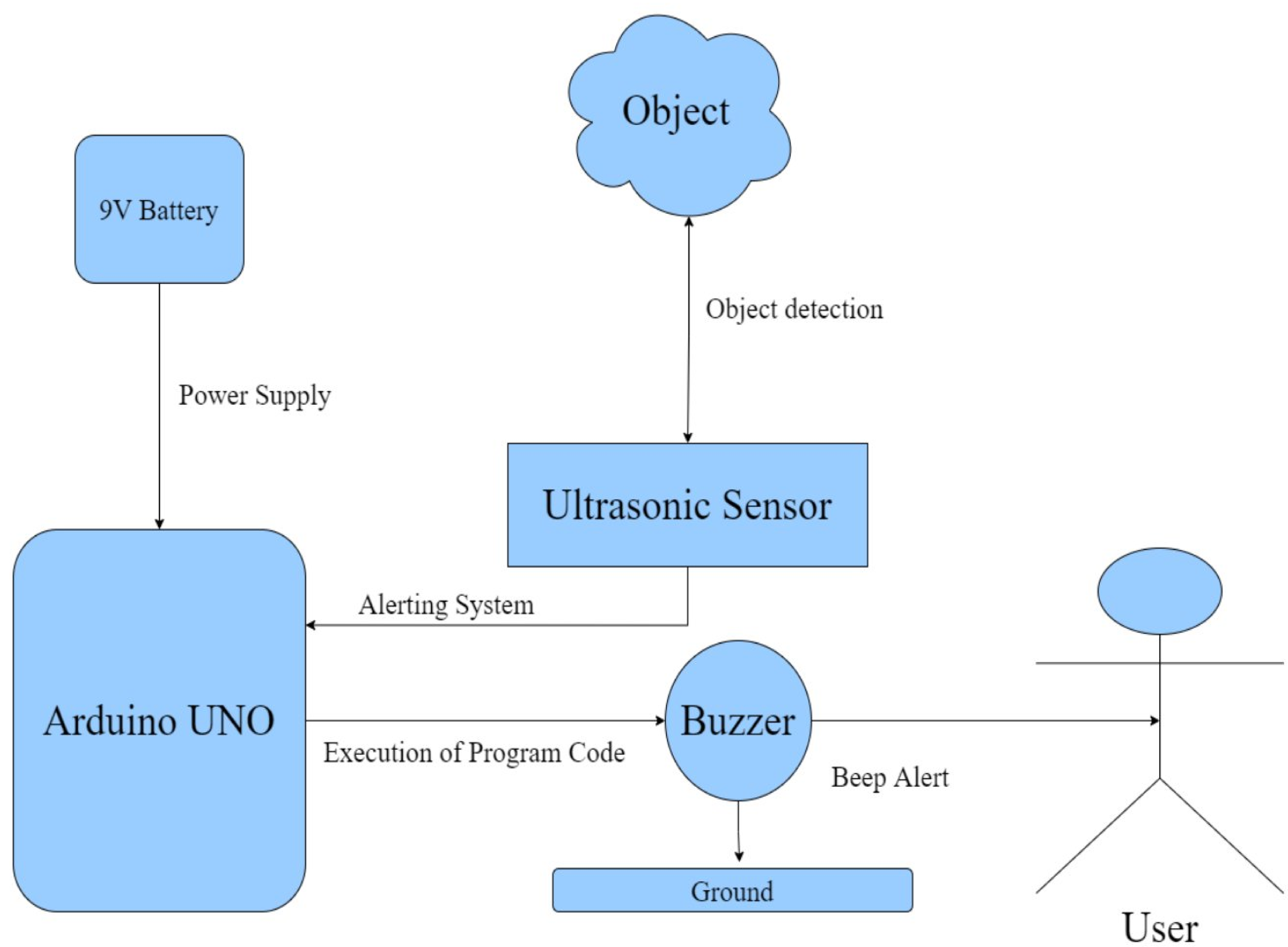

Figure 28: Data-Flow Diagram for Smart Shoe.

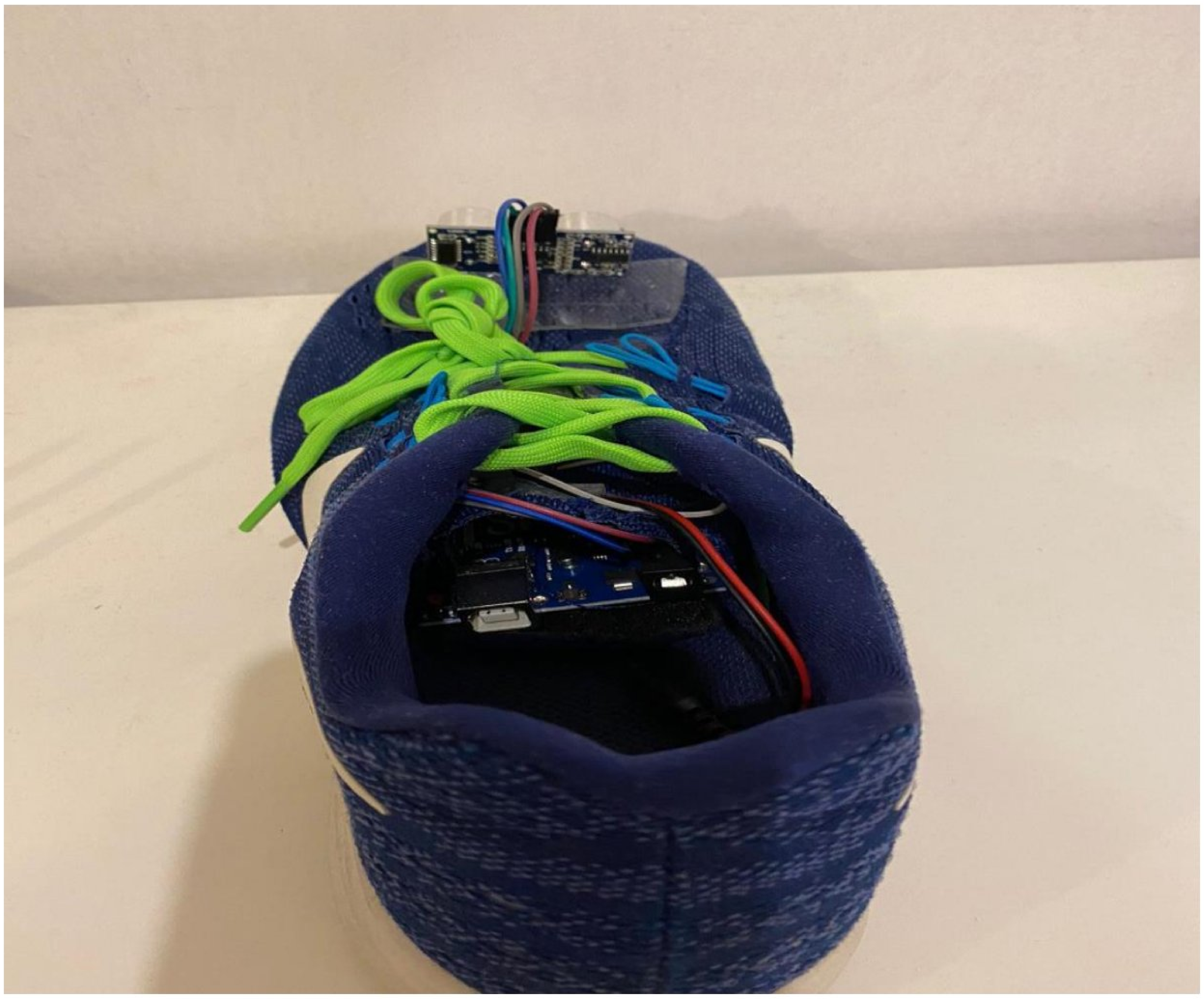

Figure 29: Smart Shoe Prototype.

Figure 30: Smart Shoe Front View.

4.1.4 Smart Helmet

This part is dedicated to the hardware development of "Smart Helmet" which works similarly to "Smart Shoe" but has some extra very useful features. This subsystem of the project consists of 1) Arduino UNO 2) 8ohm Speaker 3) Ultrasonic sensor 4) Breadboard 5) 9V battery and 6) Voice Recording Module (ISD 1820). The Arduino UNO is powered by the 9V battery and contains the program code (explained in section 4.2.3) which needs to be executed. The ultrasonic sensor will detect the range of an object in front of the user and send a signal to Arduino to start executing the program code instructions. Arduino is then connected to a breadboard for 2 specific reasons. Firstly, Arduino's analog 5V pin is connected to breadboard which is then connected to the ultrasonic sensor's Vcc pin. The "trig" and "echo" pins of the sensor are connected to the Voice recording module. Pin "P_E" of voice recording system is connected to Arduino's 5V pin on the digital side to gain power for functioning purposes. The speaker is connected to the recording system. Overall, sensor will detect the obstacle and send signal to Arduino to execute the program which will turn on the voice recording module. This voice recording module will execute the recorded audio in it through the speaker so that the user of the product can change his/her direction to avoid colliding with an obstacle. The following figures show the diagram and prototype of the helmet:

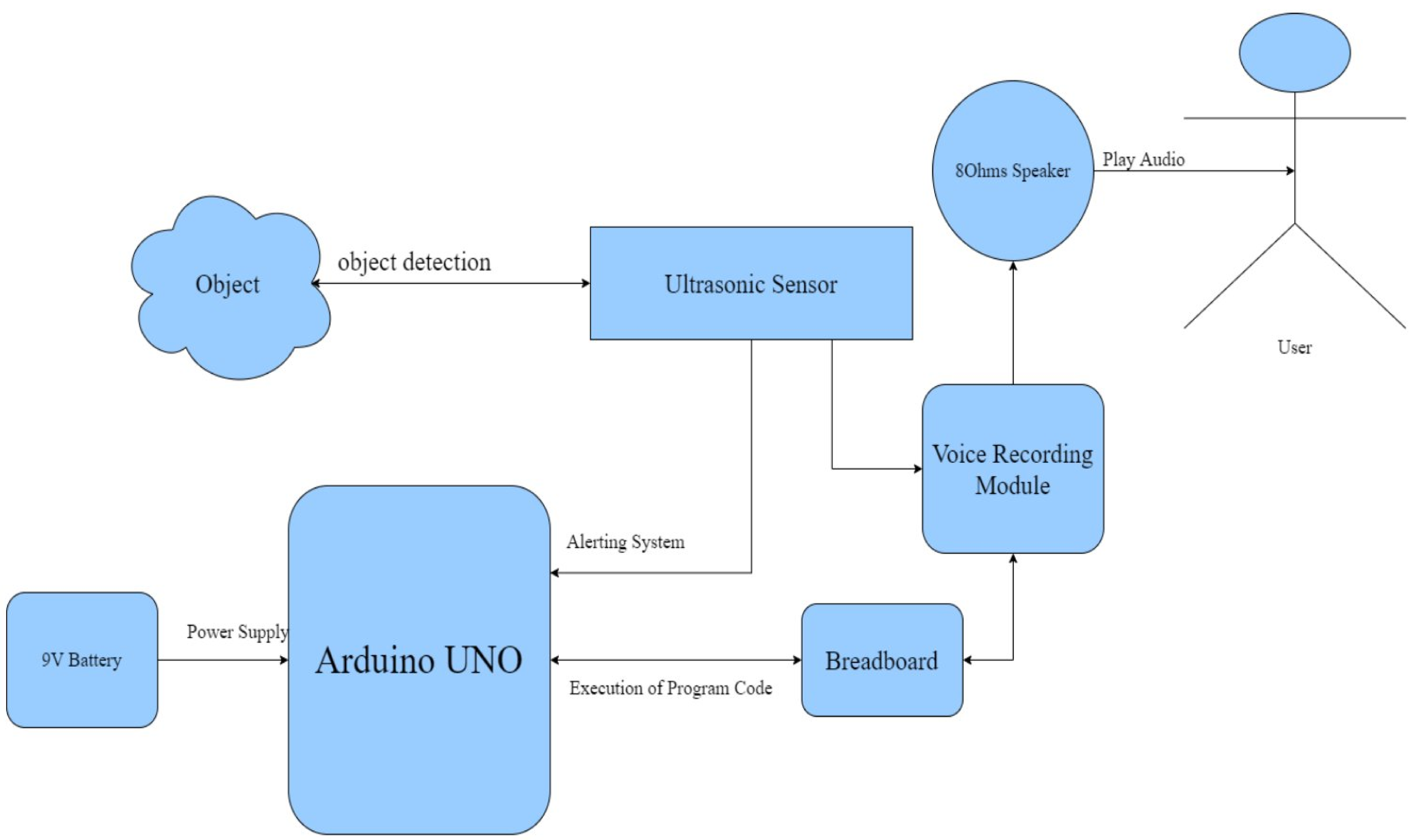

Figure 31: Data-Flow Diagram for Smart Helmet.

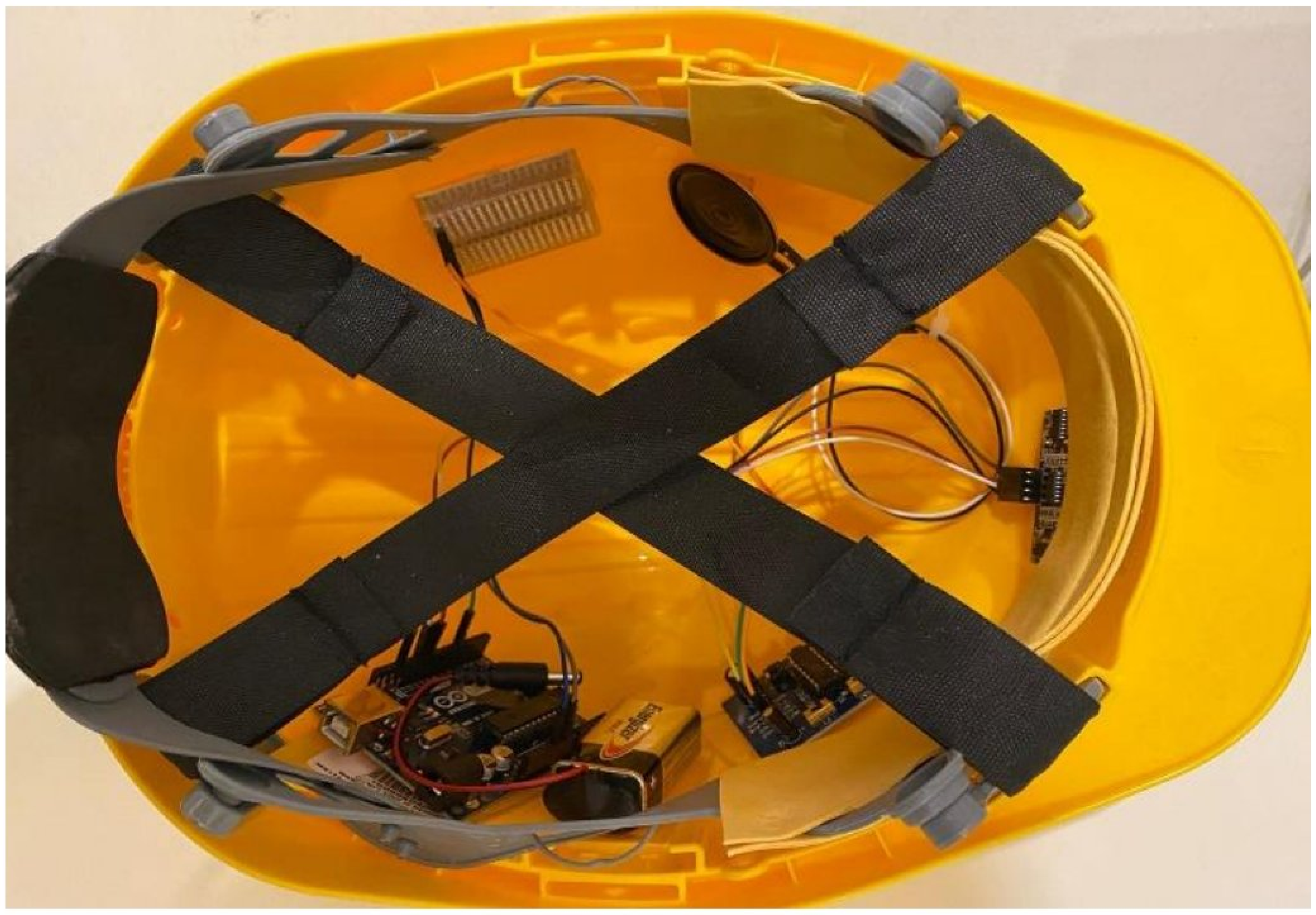

Figure 32: Smart Helmet Prototype Interior.

Figure 33: Smart Helmet Prototype Exterior.

4.2 Software Implementation

The Software program used for all 3 developed subsystems were conducted on the Arduino IDE program. although there are 3 subsystems, we developed 4 different types of code for complete project system where it consisted of many subsystems named 1) Smart Stick circuit 2) Smart Shoe circuit 3) Smart Helmet circuit and 4) Smart Stick's GPS Tracking circuit as provided below:

4.2.1 Smart Stick:

Smart_Stick | Arduino 1.8.13

File Edit Sketch Tools Help

Smart_Stick

```
const int trigPin = 9;
const int echoPin = 10;
const int buzzer = 11;
const int VR = 6;

// defines variables
long duration;
int distance;
int safetyDistance;


void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
pinMode(buzzer, OUTPUT);
pinMode(VR,OUTPUT);
Serial.begin(9600); // Starts the serial communication
}


void loop() {
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);

// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);

// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);

// Calculating the distance
distance= duration*0.034/2;

safetyDistance = distance;
if (safetyDistance <= 10)   // You can change safe distance from here changing value Ex. 20 , 40 , 60 , 80 , 100, all in cm
{
  tone(buzzer, 4000);
   digitalWrite(VR,HIGH);//turn the VR on
```

Done compiling.

Figure 34: Arduino IDE Program Code for Smart Stick Circuit.

This code is designed to work in such a way that the if the ultrasonic sensor detects an obstacle within the range of 10cm. As visible in the if statement, the obstacle detected within 10cm will trigger the buzzer but any obstacle outside the range meaning above 10cm will not trigger the buzzer. To avoid any overlapping of processes, we added delays in the code. The Buzzer is set 4000 tone meaning that the buzzer is loud enough to alert the user. The complete code can be found in Appendix A.

4.2.2 Smart Shoe:

Smart_Shoes | Arduino 1.8.13

File Edit Sketch Tools Help

Verify

Smart_Shoes

```
// defines pins numbers
const int trigPin = 9;
const int echoPin = 8;
const int buzzer = 10;

                            //  Project by - Be innovative with Prasad
                                    //   title - ultrasonic sensor project with buzzer and Arduino
// defines variables
long duration;
int distance;
int safetyDistance;


void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
pinMode(buzzer, OUTPUT);
Serial.begin(9600); // Starts the serial communication
}


void loop() {
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);

// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);

// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);

// Calculating the distance
distance= duration*0.034/2;

safetyDistance = distance;
if (safetyDistance <= 20)   // You can change safe distance from here changing value Ex. 20 , 40 , 60 , 80 , 100, all in cm
{
  digitalWrite(buzzer, HIGH);
```

Done compiling.

```
Sketch uses 3022 bytes (9%) of program storage space. Maximum is 32256 bytes.
Global variables use 200 bytes (9%) of dynamic memory, leaving 1848 bytes for local variables. Maximum is 2048 bytes.
```

Figure 35: Arduino IDE Code for Smart Shoe Circuit.

As visible in the provided code in the figure above, the code calculates the distance of the shoe from the obstacle. If the obstacle is within 20cm range, the user will be alert through the buzzer while if the obstacle is outside the 20cm range, the buzzer will stay off meaning the user is safe distance from any obstacle that might be in his/her path. The complete code can be obtained from Appendix B.

4.2.3 Smart Helmet:

Smart_Helmet | Arduino 1.8.13

File Edit Sketch Tools Help

Smart_Helmet

```
int P_E = 5;
const int trigPin = 9;
const int echoPin = 10;
long duration;
int distance;
int safetyDistance;

void setup() {
  Serial.begin(9600);
pinMode(P_E, INPUT_PULLUP);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);


}

void loop() {
digitalWrite(trigPin, LOW);
delayMicroseconds(10);


digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);


duration = pulseIn(echoPin, HIGH);

distance= duration*0.034/2;

safetyDistance = distance;
if (safetyDistance <= 10)
{
 digitalWrite(P_E, HIGH);
}
else{
  digitalWrite(P_E, LOW);
}

Serial.print("Distance: ");
Serial.println(distance);
```

Done compiling.

Figure 36: Arduino IDE code for Smart Helmet Circuit.

The helmet is designed the same way as “Smart Stick” with barely any difference. The only difference between them is that helmet is designed to provide the user with navigation incase he/she have an obstacle or any object in front of them. The helmet is mainly designed to detect obstacles that are on eye-level and above such as tree branches. The program code is processed to detect any object in front of it within 10cm range where the program will automatically play an audio “Change Direction” to alert the user that there is an obstacle in his/her path. If the obstacle is outside the pre-set range in the code then the audio system will stay off. There is a delay applied in the circuit of 10microseconds to avoid any overlaps of the processes of detecting obstacle and playing audio. The overall code for this subsystem can be found in Appendix C.

4.2.4 Smart Stick GPS Tracking System:

GPS_GSM_SYSTEM | Arduino 1.8.13

File Edit Sketch Tools Help

GPS_GSM_SYSTEM

```
#include <SoftwareSerial.h>

#include "TinyGPS++.h"

SoftwareSerial serial_connection(10, 11);

TinyGPSPlus gps;

int state = 0;

const int pin = 2;

void setup()

{

//Set Exact Baud rate of the GSM/GPRS Module.

Serial.begin(9600);

Serial.begin(9600);//This opens up communications to the Serial monitor in the Arduino IDE

serial_connection.begin(9600);//This opens up communications to the GPS

Serial.println("GPS Start");//Just show to the monitor that the sketch has started


delay(100);


Serial.println(gps.location.lat(),6);


Serial.println(gps.location.lng(),6);

pinMode(4,INPUT_PULLUP);

}

void loop()
```

Done compiling.

Figure 37: Arduino IDE Program Code for Smart Stick GPS Tracking System.

This program is designed as to address special needs for the user. The code is designed in such a way that when the user will press button, an emergency SMS will be sent to his/her caretaker or guardian to provide them with the user's location along with accurate coordinates to get them the help needed. The program code is embedded with the phone number of the caretaker and the overall circuit uses a normal Sim Card to function. The GSM module is sending a signal to the satellite with info about the user's current location, but this happens only in an outdoor open environment. The signal sent goes through the satellite to the phone number. It is very important that the Sim used in this Subsystem-section has credit in it to send the emergency messages. Just like the previously discussed subsystems, this section is part of the "Smart Stick" subsystem. The complete code can be found in Appendix D.

4.3 IEEE Standards

IEEE Standards are very important for engineers as for every project we develop, we need to adhere to these standards to make sure that technology used does not have a negative affect in any sense. The following shows the list of IEEE Standards that we adhered to [11]:

1. To hold paramount the safety, health, and welfare of the public, to strive to comply with ethical design and sustainable development practices, and to disclose promptly factors that might endanger the public or the environment.
2. To be honest and realistic in stating claims or estimates based on available data.
3. To reject bribery in all its forms.
4. To seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others.
5. To avoid injuring others, their property, reputation, or employment by false or malicious action.
6. To maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations.
7. To assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

CHAPTER 5: EVALUATION

The evaluation section should show an evidence of qualitative analysis and technical assessment of the project. The relationship between the project and its area of application is taken into consideration. Business, economic, marketing, ethical, social, environmental, and other related aspects are also included in the evaluation and given dedicated sections. A core requirement of this chapter is presenting a comparison with related works using a scientific approach.

5.1 Introduction

Chapter 5 is dedicated to focusing on evaluating the idea of the whole project. The evaluation of the project helps in seeing the feature that are mentioned in the previously provided chapters. This project was developed in the form of waterfall model and therefor everything was done 1 by 1 without needing to conduct interviews or survey's. This chapter will discuss the target market and the different fields of impacts concerning the project.

5.2 Target Users

Main targeted users for "Smart Stick for blind people" as mentioned in the name itself is the visually impaired community who have trouble navigation their way through their surroundings. The project is designed to be flexible and can be used anywhere at any moment of time. For example, the visually impaired people in Kuwait can use it to navigate their path on the walking tracks next to the Beaches or the Parks without facing much trouble. This means that the majority of the stakeholders in this project will be visually impaired people who need this type of navigational help.

5.3 Impacts

There are many impacts that we need to think about when we are developing this project. These impacts can vary from economic to medical and from social to environmental. These impacts are further discussed in detail's below.

5.3.1 Economic

This project has a huge marketing/business capability as it will be able to get the focus of people from all over the globe who are facing issues related to blindness. This project can be sold to a professional medical organization which will increase their profits dramatically as it is addressed to a specific part medical community's customers (Visually impaired individuals). This project has the ability to attract a lot of organizations in its field that can use the developed product.

5.3.2 Medical

The medical impact is tremendous as it will immediately help to address the medical issue related to vision to a good extent. The number of patients going for medical attention will not be affected by a lot but the important part of this project to medical field is that it will decrease the number of visits needed by visually impaired individuals to the medical centers meaning that the doctor can focus and manage other patient who would be there for different medical purposes.

5.3.3 Social

In today's age, different types of technologies are being developed for different purposes. People are paying attention to this rise and development in technologies much more compared to before. These technologies can vary from robotic to automation and even AI to Nanotechnology. This means that whatever technology makes the daily life of an individual easier and helps them to achieve what they want, they will most probably focus on such technology. This further means this developed project will receive the same attention or maybe even more awareness from the individuals around the world.

5.3.4 Environmental

Understanding the climate change taking place around the globe and environment impact new technologies are having, it was decided that batteries are to be used for the project as these batteries will only consume power that is going to be not as harmful to the environment than the normal emissions that are damaging it such as gas, coal-burning, and smoke.

CHAPTER 6: CONCLUSION AND FUTURE WORK

The conclusions chapter is where all the previous chapters are tied up. Students need to show how their work contributed to meeting the objectives set in the introduction. It is usually appropriate to repeat key points from the review, design, implementation, and evaluation chapters as necessary. A section on future works should be included. Students may also want to reflect upon the work that they have done and whether it could have been done better and, if so, how?

6.1 Conclusion

Overall, “Blind Stick for Blind People” is a project with immense potential. It provides the results that are very favorable to visually impaired people to help them move around with precautionary measures taken incase anything happens. It provides a lot of features which not only make the user comfortable with the product but also provides safety help in form on communication between user and his/her caretaker.

6.2 Future Work

In the future, the focus will be on making the product better visually (eye-pleasing) and light-weighted. Another development to be taken in future will be to integrate a camera system into the helmet so that the camera can take pictures for the user and save as well as post these pictures on social media platforms. The camera system will work in relation with social platforms through the developed mobile app in future. Furthermore, another crucial future development planned is the evolution of dynamo tires to be able to recharge the smart stick batteries through motion of the tires which can be done easily with dedicated time and effort. Lastly, an important work in the future would be to install mini-solar panels on the stick to generate energy which can be used to charge the user’s mobile to avoid running out of batteries/energy for the product.

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APPENDIX A

```
const int trigPin = 9;
const int echoPin = 10;
const int buzzer = 11;
const int VR = 6;
long duration;
int distance;
int safetyDistance;
void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
pinMode(buzzer, OUTPUT);
pinMode(VR,OUTPUT);
Serial.begin(9600); // Starts the serial communication
}
void loop() {
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance= duration*0.034/2;
safetyDistance = distance;
if (safetyDistance <= 10)
{
  tone(buzzer, 4000);
   digitalWrite(VR,HIGH);//turn the VR on
}
else if (safetyDistance <= 20)
{
```

```
  tone(buzzer, 2000);
  digitalWrite(VR,HIGH);//turn the VR on
}
else if (safetyDistance <= 40)
{
  tone(buzzer, 1000);
  digitalWrite(VR,HIGH);//turn the VR on
}
else{
   noTone(buzzer);
   digitalWrite(VR,LOW);
}
Serial.print("Distance: ");
Serial.println(distance);
}
```

APPENDIX B

```
const int trigPin  = 9;
const int echoPin = 8;
const int buzzer = 10;
long duration;
int distance;
int safetyDistance;

void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin  as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
pinMode(buzzer, OUTPUT);
Serial.begin(9600); // Starts the serial communication
}


void loop() {
digitalWrite(trigPin, LOW);
delayMicroseconds(2);

 digitalWrite(trigPin, HIGH);
delayMicroseconds(10);

digitalWrite(trigPin, LOW);

duration = pulseIn(echoPin, HIGH);
 distance= duration*0.034/2;

safetyDistance = distance;

if (safetyDistance <= 20)
```

```
{
  digitalWrite(buzzer, HIGH);
}
else{
  digitalWrite(buzzer, LOW);
}
Serial.print("Distance: ");
Serial.println(distance);
}
```

APPENDIX C

```
int P_E = 5;
const int trigPin  = 9;
const int echoPin = 10;
long duration;
int distance;
int safetyDistance;

void setup() {
  Serial.begin(9600);
pinMode(P_E, INPUT_PULLUP);
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
}

void loop() {
digitalWrite(trigPin,  LOW);
delayMicroseconds(10);

digitalWrite(trigPin,  HIGH);
delayMicroseconds(10);

digitalWrite(trigPin,  LOW);

duration = pulseIn(echoPin, HIGH);
distance= duration*0.034/2;

safetyDistance = distance;
```

```
if (safetyDistance <= 10)
{
 digitalWrite(P_E, HIGH);
}
else{
  digitalWrite(P_E, LOW);
}
Serial.print("Distance: ");
Serial.println(distance);
}
```

APPENDIX D

```
#include <SoftwareSerial.h>
#include "TinyGPS++.h"
SoftwareSerial serial_connection(10, 11);
TinyGPSPlus gps;

int state = 0;
const int pin = 2;

void setup(){
Serial.begin(9600);
Serial.begin(9600);
serial_connection.begin(9600);
Serial.println("GPS Start");
delay(100);

Serial.println(gps.location.lat(),6);
Serial.println(gps.location.lng(),6);
pinMode(4,INPUT_PULLUP);
}

void loop(){
int switch1=digitalRead(4);
 Serial.print("switch = ");
 Serial.println(switch1);

 Serial.println(gps.location.lat(),6);
Serial.println(gps.location.lng(),6);
delay(100);

  if(switch1==LOW){
```

```
    while(serial_connection.available())
{
gps.encode(serial_connection.read());
}
if(gps.location.isUpdated())
{
Serial.println(gps.location.lat(),6);
Serial.println(gps.location.lng(),6);
}
Serial.print("\r");
delay(1000);
Serial.print("AT+CMGF=1\r");
delay(1000);
Serial.print("AT+CMGS=\"+96551704769\"\r");
delay(1000);
//The text of the message to be sent.
Serial.print("EMERGENCY PLEASE CONTACT");
Serial.print("https://www.google.com/maps/?q=");
Serial.println(gps.location.lat(),6);
Serial.println(gps.location.lng(),6);
delay(100);
Serial.println((char)26);// ASCII code of CTRL+Z
delay(5000);
Serial.write(0x1A);
 delay(1000);
delay(1000);
state = 1;
}
}
```