B.A.R.T: AN OCULAR ASSISTING AND TRACKING DEVICE USING ULTRASONIC SENSORS AND A GLOBAL POSITIONING SYSTEM MODULE

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APPROVAL SHEET

*This thesis entitled **"B.A.R.T.: An Ocular Assisting and Navigation Device using Ultrasonic Sensors and a Global Positioning System Module"** presented and submitted by **Allyssa Rianne R. Almalvez, Matthew Ryan C. Carandang, Mauie Marie T. De Guzman, Naomie Vivien V. Diasanta, Julia Isabelle B. Lalusin, Fiona Maria R. Payte** in partial fulfillment of the requirements for the subjects **English 10, Information Technology 10, and Robotics 10** has been examined and is recommended for acceptance and approval for ORAL EXAMINATION.

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Accepted and approved in partial fulfillment of the requirements for the subjects **English 10, Information Technology 10, and Robotics 10** with an **ORAL EXAMINATION RATING** of _____ held this _____ day of March 2020.

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DEDICATION

To the **Visually Impaired** who became a source of their inspiration in the creation of their project,

To their **Beloved Family** who wholeheartedly encouraged them to do their best even in the times that they are devastated,

To their **Teachers** who shared their intelligence and for giving their overflowing support to accomplish the study,

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Chapter 1

THE PROBLEM AND ITS BACKGROUND

Introduction

Blindness is defined as the limited or total impairment of the eye. According to the World Health Organization (2018), there are approximately 1.3 billion people who live with some form of vision impairment. The loss of sight implies the loss of independence of a person to travel and have human contact. This limits the person's mobility. Though treatments for visual impairment are available, those who suffer the condition resort to assistive equipment due to inconsistency and costliness.

People who use vision assistance equipment tend to say that even though it is functional, it is inadequate when it comes to efficiency and durability. Mobility aids like walking sticks and guide dogs are frequently used. However, the advancement of technology enables people to use different types of electronic mobility. Since the population of the blind is increasing, the researchers will delve into making a cost-effective guide to assist them, using ultrasonic sensors as the main component.

The researchers made the device using Arduino, which is a learning platform for beginners that offers wide and easy-to-use software and hardware. One of their products is the HC-SR04, an ultrasonic sensor that uses SONAR (Sound Navigation Ranging), provides an excellent non-contact range detection with high accuracy and readings within 2 cm to 400 cm or 1" to 13 feet. The study by Nils Gageik, Thilo Müller, Sergio

Montenegro stated that ultrasonic sensors make a precise non-contact detection of presence, level, position, and distance.

The device also has a Global Positioning System Module that can provide your location on Earth. It undergoes a process called Trilateration. The receiver figures out how far they are from at least three satellites. Satellites transmit their position and the current time in the form of radio signals towards the Earth.

The researchers used the NEO 6M GPS Module which can provide accurate navigation performance even in difficult locations. According to its datasheet, it can present in real-time what latitude, longitude, altitude, date, satellites, speed OTG and course the module receives. They also used a NodeMcu Wi-Fi Module. It has a combination of a Wi-Fi access point and station as well as a microcontroller. Hence, it is considered as a powerful tool for Wi-Fi Networking. The Module can host a web server or connect to the internet to collect or upload data.

Blynk is an IoT platform that can connect your devices to the cloud, design apps to control them, analyze telemetry data, and manage your deployed products at scale. The researchers used this platform to see the location of the user.

This study looked into providing an assistive device that will allow the visually impaired to measure their distance from the object or person in front of them through the use of ultrasonic sensors.

Statement of the Problem

This study was designed to test the operativity of an ocular assisting device using Arduino Ultrasonic Sensors and Neo-6m. Specifically, it sought to answer the following questions:

1. How accurate will the Ultrasonic Sensors be at detecting objects, especially those that may harm the user?
2. How practical will the device be for the daily use of the visually impaired?
3. How precise will the Global Positioning System (GPS) be in tracking the visually impaired person?
4. How beneficial will the Global Positioning System (GPS) be for the relatives of the visually impaired person?

Hypotheses

1. The device would be accurate at detecting objects that may harm the user with the help of ultrasonic sensors.
2. The device would be easy to use and would cater to the blind's everyday needs.
3. The Global Positioning System (GPS) will be precise in tracking the visually impaired person.
4. The Global Positioning System (GPS) will be beneficial for the relatives of the visually impaired person.

Significance of the Study

This study will be beneficial to the following groups:

Visually Impaired. This study will be for the visually impaired. The device will help them to detect objects that may harm the user. This will also help them navigate more comfortably, and with confidence.

Relatives of the Visually Impaired. The relatives of the blind can benefit from this device by allowing them to locate the user of the device in real-time through the use of the GPS and the Wi-Fi module.

Scope and Delimitation

This research will help provide the needs of visually impaired people by sensing nearby objects that canes and other aiding devices can't detect. Though the device can assist them, there are some limitations. It cannot detect the material of the object being sensed. The device also cannot detect and inform the user if there is a hole in front of him or her. It also cannot guide the user in crossing the road. The GPS Module can detect the real-time location of the person. Additionally, the Wi-Fi Module that can provide the data from the GPS to the mobile app requires Wi-Fi. In instances where there is little to no signal for Wi-Fi, the user will not be located. There is a need for a stable Wi-Fi connection for it to function properly. The device is only water-resistant and not waterproof. As a result, any severe exposure to liquid can damage it. This study is only limited to blind people.

Definition of Terms

Ultrasonic sensors measure distance by using ultrasonic waves. The sensor head emits an ultrasonic wave and receives the wave reflected back from the target. Ultrasonic sensors measure the distance to the target by measuring the time between the emission and reception.

Ultrasonic waves are sound waves transmitted above the human-detectable frequency range, usually above 20,000 Hz. They are used by some animals and in medical or industrial-technological devices.

Proximity sensors are electronic sensors that can detect the presence of objects within their vicinity without any actual physical contact.

Arduino is an open-source electronics platform based on easy-to-use hardware and software. It's intended for anyone making interactive projects.

Blindness is the loss of useful sight. It can be temporary or permanent. Damage to any portion of the eye, the optic nerve, or the area of the brain responsible for vision can lead to blindness.

Visual Impairment is the decreased ability to see properly that causes problems not fixable by usual means like glasses, or contact lenses.

Global Positioning System (GPS) is a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.

Module is each of a set of standardized parts or independent units that can be used to construct a more complex structure, such as an item of furniture or a building.

Ocular refers to anything related to the eye.

Mobility is the ability to move around.

Chapter 2

REVIEW OF RELATED LITERATURE AND STUDIES

In exploration, new information and knowledge can be gained. From these, new gadgets, equipment, or substances can be made that can make a man's life easier. These are the products of the fast-changing and technological world we live in today. Innovations like these prompted the researchers to conduct this study about utilizing ultrasonic sensors and a GPS module for an assisting device as an aid to the visually impaired. This chapter presents a brief review of the literature and studies that are related to this study.

Related Literature

History of Blindness

Blind people are said to be insignificant in society during the beginning of primitive times. Most people thought that they are useless because they cannot fight nor can they hunt for food. Some babies were discarded by their parents. They were either left to die or will be eaten by some wild animals. While some blind men were sold into galley slavery and some blind women were sold into rough trade. The others were used for entertainment, or they live as beggars, or they were kept by their family. Later on, civilized society began believing that they should care for the less fortunate including the blind. In 1829, "New England Asylum for the Blind" was inaugurated and was the first residential school in

America. In 1918, Braille was considered as the national standard for tactile writing and reading for the blind (James Omvig, n.d).

History of White Canes

Canes were used as traveling aids for the visually impaired. Around the Biblical times, Shepherds used a staff for solitary travel and canes were merely used as an instrument for travel. Until around the 20th century, canes were used by blind people to notify others that they are blind. White canes were invented by the photographer, James Briggs of Bristol in 1921 after an incident blinded him. He was threatened by the increase of vehicles in his town so he decided to paint his cane white to make it more visible to passing vehicles (Philip Strong ,2009).

GPS Signal Analysis

The Global Positioning System (GPS) is a global navigation satellite system that determines the location of any target by measuring the propagation delay of the signals from the satellites to the GPS Module. This was originally developed by the US government in the 1970s for military purposes like positioning, navigating and aiming weapons. Before, the DoD (Department of Defense) included a distortion in the signal called Selective Availability (SA) so that they would obtain better precision than others.

How Dangerous are White Canes?

On the other hand, Lily-Grace Hooper, a seven-year-old schoolgirl from Bristol, had been told by her school not to use her white cane because it could trip up teachers and other pupils. Her mother expressed that she was "devastated" but the school's mobility officer had raised health and safety reasons and so the decision was made. Lily-Grace would have to leave her cane at home (2015).

Design and Implementation of Mobility Aid for Blind People

With the scope of electronic advancements increasing day by day, the need for utilizing these advanced technologies to make human lives simpler is becoming more and more necessary. The demand for using these to make lives easier for disabled people is also increasing. This has prompted many new areas of research and one of these is electronic mobility aid for blind people. According to the World Health Organization, approximately 285 million people of all ages are blind. Traditional mobility aids such as white sticks and guide dogs take a lot of time getting used to (Sourab, Chakravarthy, Ranganath, Dsouza, & Sachith, 2015).

Understanding How Ultrasonic Sensors Work

The use of ultrasonic sensors as a mode of detection in aiding people with visual and hearing disabilities is an effective way of using ultrasonic sensors. Ultrasonic sensors are dual-channel sensors with one sending information and one retrieving information. Ultrasonic sensors are mostly used in cars and roads as a way of detection. These sensors can attach to multiple parts of the human body to be able to detect if anything will be obstructing their movement in a certain area of their body. With these ultrasonic sensors, the person can detect forty to one hundred fifty meters from them with two hundred meters of detection with the person extending their arm. And can detect a three-dimensional space around the person (Mahdi Safaa A., Muhsin Asad H., Al-Mosawi Ali I., 2012). Ultrasonic sensors are independent of light, smoke, dust, color, and material (except for soft surfaces, i.e. wool, because the surface absorbs the ultrasonic sound wave and doesn’t reflect sound.) allowing the user to use the sensor indoors and outdoors. (Roderick Burnett, 2019).

Related Studies

Enhanced Tactile Acuity

An increase in tactile acuity is well known in people who are blind. However, their increase in tactile acuity is through adaptation and through extensive use of touch to determine what objects are or to read Braille. Blind people were shown to use the cortical areas usually associated with vision when performing auditory or tactile tasks. There was a 30% increase in the tactile ability of blind people compared to their sighted counterparts of the same age and gender. This was found by asking them all to distinguish the orientation of grooves etched into a surface. The gaps between these grooves became increasingly smaller and blind people were able to tell the orientation when sighted individuals could no longer distinguish between the individual grooves. Blind people, who were not blind from birth, also had improved tactile abilities when distinguishing between 3-dimensional shapes. Therefore, it is theoretically possible for a person to increase their tactile acuity (Deamer, Lieu. et al., 2013).

Blindness Shapes Cortical Representations of Auditory Frequency within Auditory Cortex.

Blind people often are better at performing tasks that rely on distinguishing the location a noise has emanated from in comparison to a person who has their vision. Blind people can also distinguish between different levels of speech and are able to focus their hearing to the stimuli from a specific ear at a much higher level than sighted individuals. These results show that hemispheric reorganization played a role at the sensory and cognitive levels when processing information in blind individuals (Deamer, Lieu, & Lonsdale, 2013). It has long been held that early blindness leads to an enhanced perception of auditory stimuli, and a number of behavioral studies have linked early-onset blindness to superior pitch perception (Gougoux et al., 2004; Wan et al., 2010; Voss and Zatorre, 2012).

Using ultrasonic sensor for blind and deaf persons combines voice alert and vibration properties

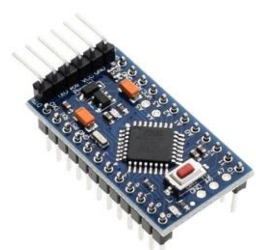
Many solutions are being explored to aid these people in our society today. An example is a white cane. The white cane is a purely mechanical device used to detect uneven ground surfaces, obstacles, and other hazards. Based on a study by Sharma et al. (2018), white canes have two major limitations. First, they can only detect obstacles below the knee-level. They cannot detect obstacles above the knee-level such as tree branches, bars, and the like. Second, white canes can only detect obstacles one meter away from the user. Another aid available is a guide dog. Guide dogs require extensive training and are only helpful for an estimated 5 years. The visually impaired may also find trouble in caring for another being. Lastly, there is an aid that utilizes a voiced based alert system to the surrounding area of the visually impaired person. Though effective, this hinders the user to be able to hear the surroundings around them that may cause major accidents in urban areas (Al-Mosawi, A. et al., 2012).

Chapter 3

METHODOLOGY

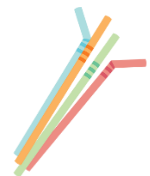
The methodology of this research contains the parts and materials used in building the project, a wiring diagram of the project that shows what the components looked like, and the code that is used for the Ocular Assisting Device and the Global Positioning System (GPS). This chapter outlines the building process which specifies the steps of how the project was built and depicts a flowchart that shows a visual representation of how the program works, a Gantt chart that displays the timeline of the project and the assignment of each member of the group, and the formula and the scale that they used to get and interpret the data gathered.

Parts of the Ocular Assisting Device

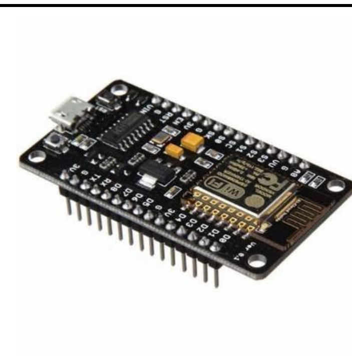
	PART	FUNCTION	FIGURE
1	Arduino Pro Mini	The Arduino Pro Mini is a microcontroller board based on the ATmega328. It is the main processing unit.	

2	Male to Male Jumper Wires	The Male to Male jumper wires are used for the wiring of the device and to connect female headers.	
3	Perfboard	A perfboard is a material used for prototyping electronic circuits.	
4	Piezo/Buzzer	A piezo/buzzer is used to alert the user using sound.	
5	Slide Switch	A slide switch is a mechanical switch using a slider that slides to an open position to the closed position. They allow control over current flow in a circuit without having to manually cut or splice wire.	
6	Rocker Switch	A rocker switch is a type of switch that rocks back and forth, an action where one end is raised and the other is depressed. One side of the switch is on and the other is off; these are usually marked with a "1" for on and "0" for off.	

6	Vibrating Motor	A vibrating motor is used to alert the user without sound.	
7	Female Headers	Female headers are used to connect the Arduino Pro Mini to the perfboard.	
8	Ultrasonic Sensors	An ultrasonic sensor emits sound waves at a very high frequency that humans can't hear. Then, it waits for the sound to be reflected back, calculating distance based on the time required.	
9	AAA 1.5v Battery	The AAA 1.5v battery is used as the power source of the device.	
10	Female to Male Jumper Wires	The Female to Male jumper wires are used to connect the Ultrasonic Sensor to the board.	

11	Cardboard	Cardboard is used to create the casing of the device.	
12	Straws	Straws are used to create protection for the wires.	
13	Velcro	The velcro is used to fasten the parts of the device unto the garments	
14	Vest	A vest is the clothing where the assisting device would be attached.	
15	Knee pads	The knee pads are the garment where the assisting device would be attached.	

Parts of the GPS Device

	PART	FUNCTION	FIGURE
1	GPS Module Neo-6m	It is used to receive information from GPS satellites and then calculate the device's geographical position.	
2	Jumper Wires	The jumper wires are used for the wiring of the device.	
3	NodeMCU Wi-Fi Module	It transmits the data of the GPS module to the Blynk cloud which is displayed using the Blynk app.	
4	470 uf Capacitors	The Capacitors stores electrical energy then gives electrical energy to the circuit if necessary.	

5	lm7805 Voltage Regulator	The voltage regulator outputs +5 volts.	
6	Pocket Wi-Fi	The pocket Wi-Fi connects to the NodeMCU Wi-Fi Module.	
7	AAA 1.5v battery	The AAA 1.5v battery is used as the power source of the device.	
8	Case	The case gives protection to the GPS device.	

Materials Used

	PART	FUNCTION	FIGURE
1	Soldering Iron	A soldering iron is a tool used for soldering. It supplies heat to melt the lead so two workpieces can join together.	
2	Lead	A lead, when heated, is used as a bonding agent that connects different electronic circuits.	
3	Glue Gun	The glue gun, when heated, releases a loaded adhesive that is used as a bonding agent.	
4	Cutter	A cutter is a tool that can be used to cut certain objects.	

5	Long Nose Pliers	Long nose pliers hold and control jumper wires when it is being cut.	
6	Multi-tester	A multi-tester is used to measure the voltage, current, and resistance of a circuit.	
7	Cutting Pliers	Cutting pliers are used to cut jumper wires.	
8	Arduino UNO	The Arduino UNO is a microcontroller based on the ATmega328. It is used to upload the code to the Arduino Pro Mini.	

9	Glue stick	The glue stick is used to attach the slide switch and vibrating motor to the perfboard.	
10	Sewing Materials	Sewing materials are used to stitch and modify the garments.	
11	Electrical Tape	Electrical tape is used to insulate electrical wires that conduct electricity.	

Procedure for the Ocular Assisting Device

1. Using a cutter, cut the width of the 5x7cm perfboard in half for the front and back.

Refer to figure 3.1 for the measurements.

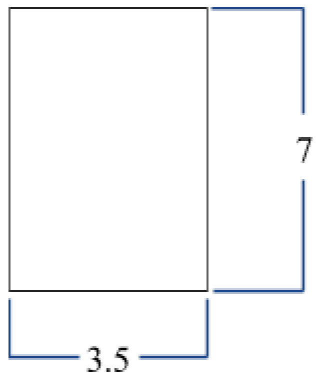


Figure 3.1. The Dimensions of the Perfboard

2. Solder 2 pairs of 12 female headers to the board with 5 circuit spaces in between them.

3. Solder the buzzer to the board.

4. Attach the vibrating motor to the perfboard using mighty bond or glue gun.

5. Solder everything in compliance with the circuit diagram below.

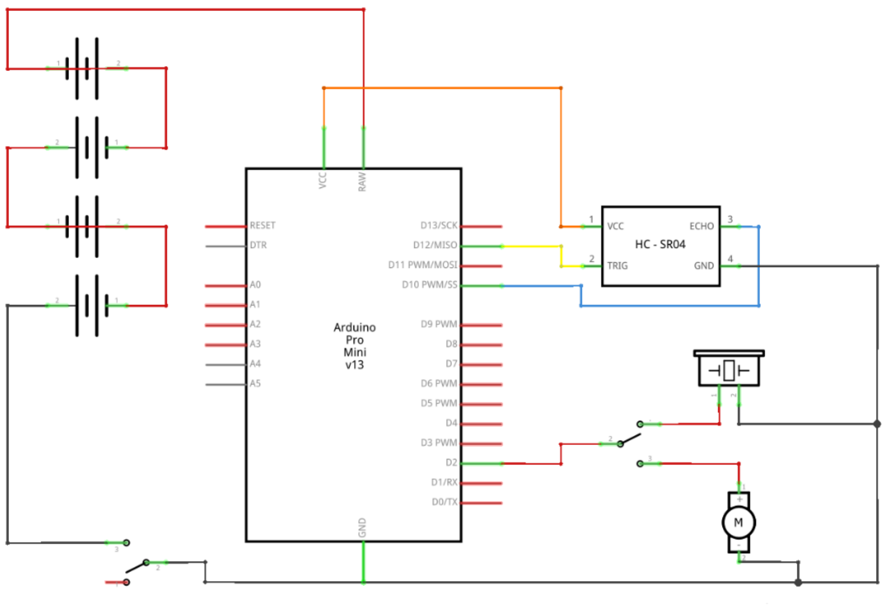


Figure 3.2. Schematic Diagram for the Ultrasonic Sensor and Arduino Pro Mini

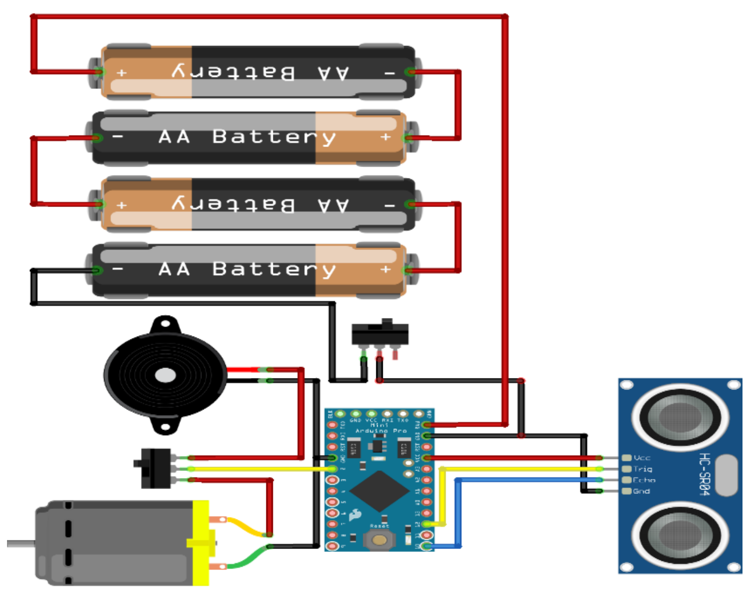


Figure 3.3. Pictorial Diagram for Ultrasonic Sensor and Arduino Pro Mini

6. Use female to male jumper wires to connect the ultrasonic sensor to the Arduino Pro Mini.

7. Solder wires to the VCC, GND, RX, TX and RST pins of the Arduino Pro Mini.

8. Remove the ATmega 328P from the Arduino Uno.

9. Connect the wires from the Arduino Pro Mini to the corresponding pins of the Arduino Uno.

10. Upload the code to the Arduino Uno.

```
int TrigPin = 12; //Trigger connected to PIN 7
int EchoPin = 10; //Echo connected to PIN 8
int buz=2; //Buzzer and Vibrating to PIN 2
void setup() {
Serial.begin(9600);
pinMode(buz, OUTPUT);
pinMode(TrigPin, OUTPUT);
pinMode(EchoPin, INPUT);
}
void loop()
{
long duration, cm;
digitalWrite(TrigPin, LOW);
delayMicroseconds(2);
digitalWrite(TrigPin, HIGH);
delayMicroseconds(5);
digitalWrite(TrigPin, LOW);
duration = pulseIn(EchoPin, HIGH);
cm = (duration/2)/29.1;

if (cm<=17){
 tone(buz, 2000,1000);
 digitalWrite(buz, HIGH);
 Serial.println("VERYY NEAR");
 delay(200);
}

if(cm<=115 && cm>17 )
{
int d= map(cm, 1, 100, 20, 2000);
tone(buz, 2000,1000);
digitalWrite(buz, HIGH);
Serial.println("SOUND ON/VIBRATING");
delay(100);
digitalWrite(buz, LOW);
noTone(buz);
delay(d);
}
Serial.print(cm);
Serial.print("cm");
Serial.println();
delay(100);
}
```

Procedure for the GPS Device

1. Download the latest version of Arduino IDE for no compatibility issues.

2. Install the dedicated board drivers and libraries such as NodeMCU and IT libraries.

3. Download the Blynk app on your phone via Apple or Google Play Store.

4. Startup a new project in the Blynk app and get the authentication code.

5. Paste the authentication code in the Arduino code. This enables the board and the Blynk app to recognize each other.

6. Setup a project in the Blynk app with a widget map and set the virtual pin to 0.

7. Setup 3 value displays with virtual pins 2, 3, and 4 and names them latitude, longitude, and speed respectively.

8. Solder the NodeMCU module to the 9x7cm perfboard.

9. Solder everything according to the circuit diagram below.

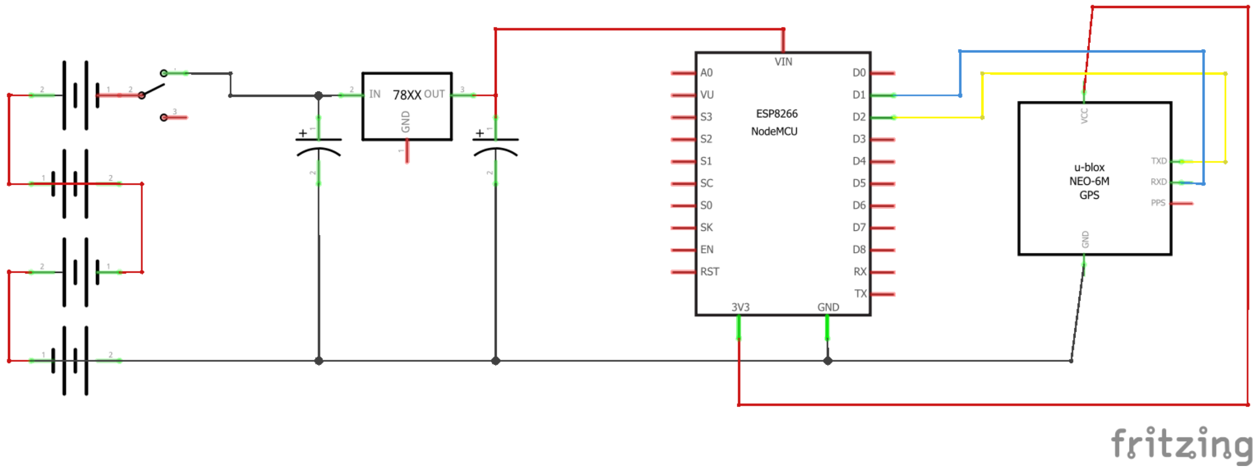


Figure 3.4. Schematic Diagram for the GPS Module

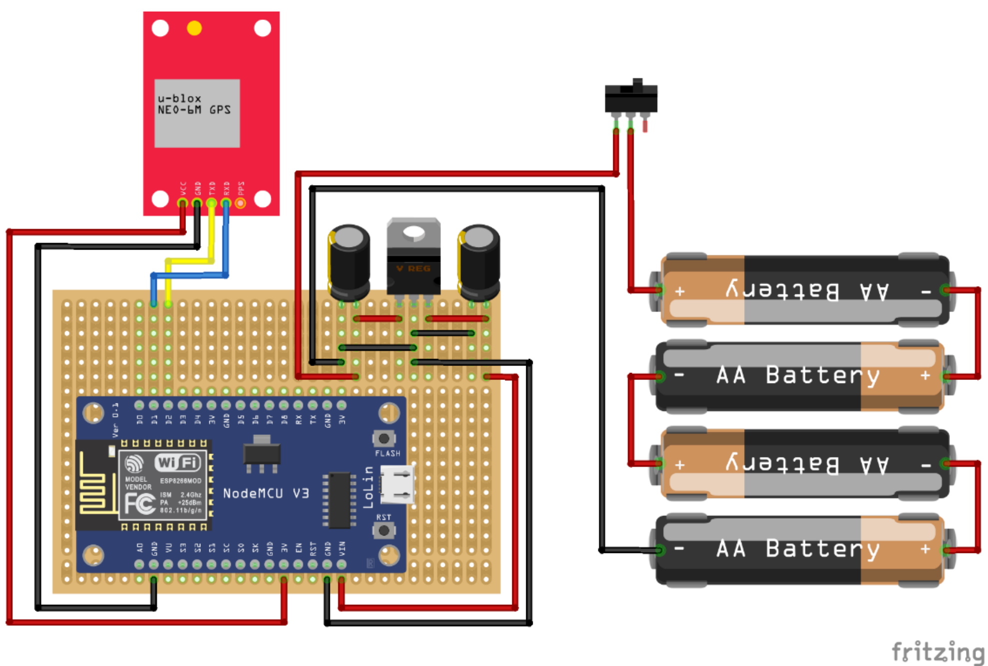


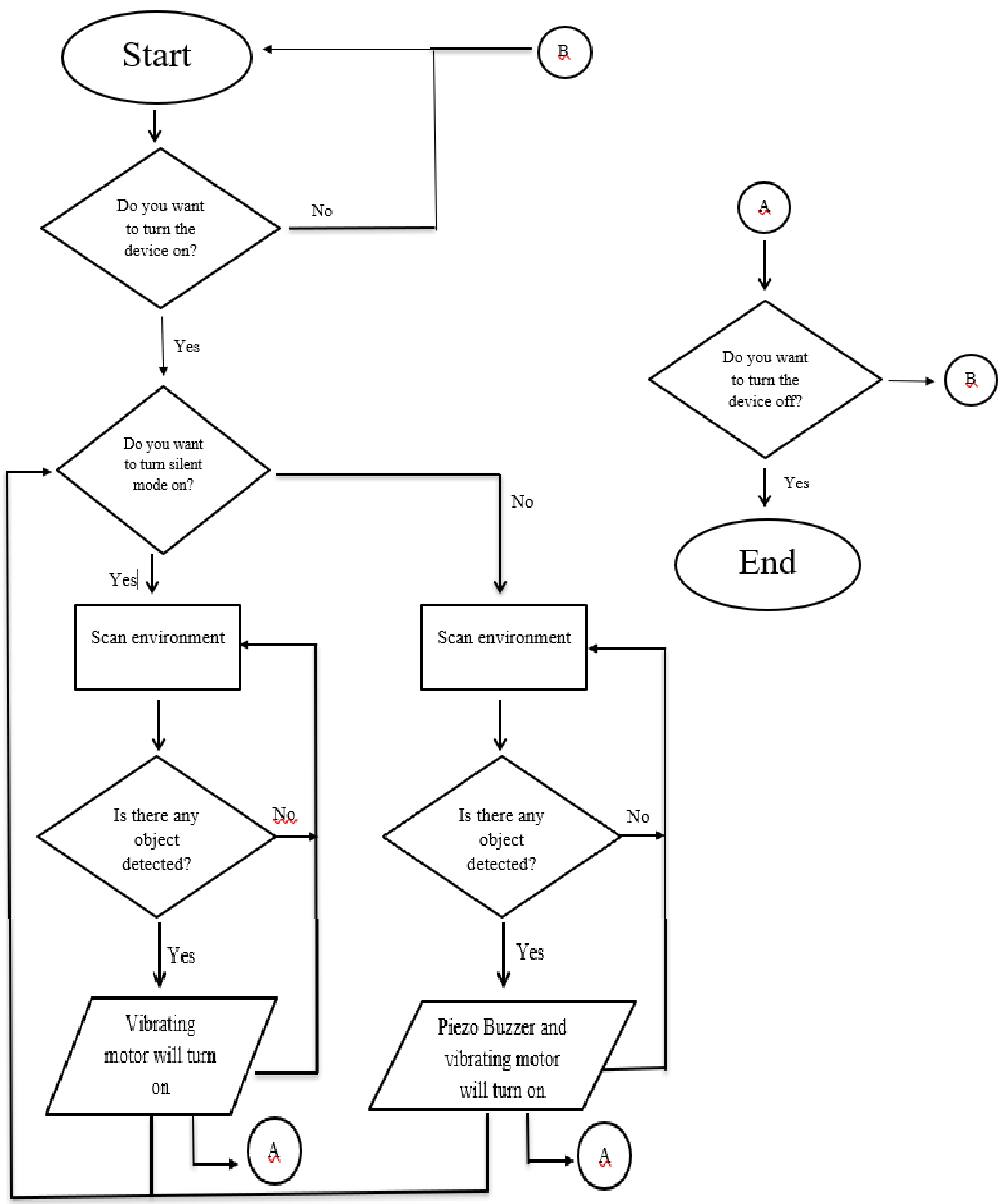
Figure 3.5. Pictorial Diagram for the GPS Module

10. Upload the code using the Arduino software in the NodeMCU via a micro USB cable.

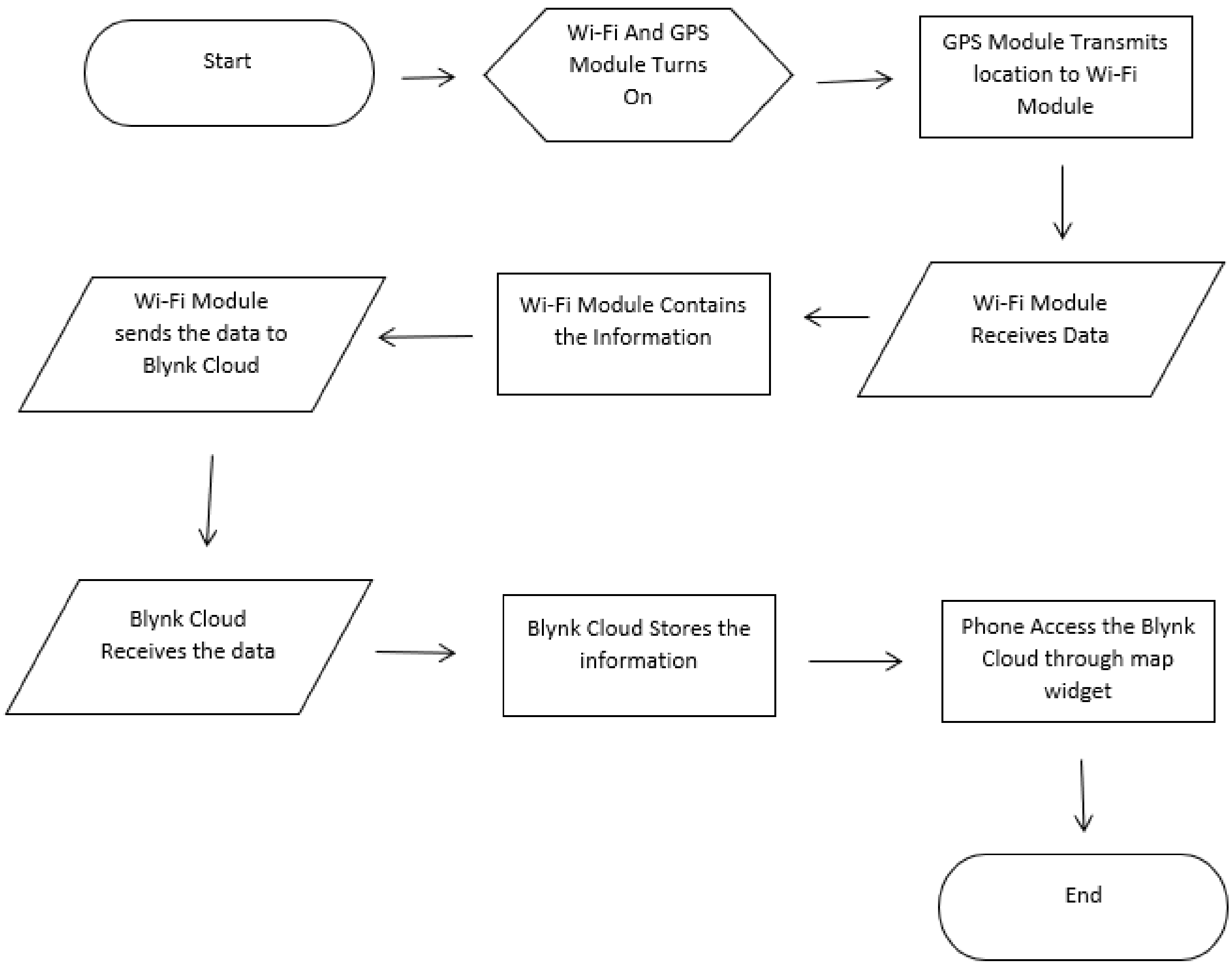
```
#include <TinyGPS++.h>
#include <SoftwareSerial.h>
#define BLYNK_PRINT Serial
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>

static const int RXPin = 4 , TXPin = 5;              //GPIO 4=D2(conneect Tx of GPS) and GPIO 5=D1(Connect Rx of GPS)
static const uint32_t GPSBaud = 9600;

TinyGPSPlus gps;                                     //The TinyGPS++ object
WidgetMap myMap(V0);                                 //V0 for virtual pin of Map Widget

SoftwareSerial ss(RXPin, TXPin);                     //The serial connection to the GPS device

BlynkTimer timer;

float spd;                                           //Variable  to store the speed
float sats;                                          //Variable to store no. of satellites response
String bearing;                                      //Variable to store orientation or direction of GPS

char auth[] = "-cbTHkilpPKP5BuvbdJJRycyqQ_lU28S";   //Your Project authentication key
char ssid[] = "MDG";                                 //Name of your network (HotSpot or Router name)
char pass[] = "hulaanmo";                            //Corresponding Password

unsigned int move_index = 1;                         // fixed location for now

void setup()
{
  Serial.begin(115200);
  Serial.println();
  ss.begin(GPSBaud);
  Blynk.begin(auth, ssid, pass);
  timer.setInterval(5000L, checkGPS);                // every 5s check if GPS is connected, only really needs to be done once
}

void checkGPS(){
  if (gps.charsProcessed() < 10)
  {
    Serial.println(F("No GPS detected: check wiring."));
      Blynk.virtualWrite(V4, "GPS ERROR");           //Value Display widget  on V4 if GPS not detected
  }
}

void loop()
{

    while (ss.available() > 0)
    {
      // sketch displays information every time a new sentence is correctly encoded.
      if (gps.encode(ss.read()))
        displayInfo();
  }
  Blynk.run();
  timer.run();
 }

 void displayInfo()
 {

   if (gps.location.isValid() )
   {

     float latitude = (gps.location.lat());          //Storing the Lat. and Lon.
     float longitude = (gps.location.lng());

     Serial.print("LAT:  ");
     Serial.println(latitude, 6);  // float to x decimal places
     Serial.print("LONG: ");
     Serial.println(longitude, 6);
     Blynk.virtualWrite(V1, String(latitude, 6));
     Blynk.virtualWrite(V2, String(longitude, 6));
     myMap.location(move_index, latitude, longitude, "GPS_Location");
     spd = gps.speed.kmph();                         //get speed
        Blynk.virtualWrite(V3, spd);

        sats = gps.satellites.value();              //get number of satellites
        Blynk.virtualWrite(V4, sats);

        bearing = TinyGPSPlus::cardinal(gps.course.value()); // get the direction
        Blynk.virtualWrite(V5, bearing);


   }


   Serial.println();
 }
```

11. Check the connection on the NodeMCU with the Blynk app then look at the map if the GPS module is detected.

Ocular Assisting Device Flowchart



GPS Flowchart



Weighted Mean

This formula was used to compute for the weight of the answers in the questionnaire given to the respondents. The formula for the weighted mean is shown below:

$$\bar{x} = \frac{\sum fW}{N}$$

Where:

x = Weighted Mean

∑= Summation Symbol

f = Frequency for each option

W = Assigned Weight

N = Total number of frequencies

Likert Scale

This served as the guide for interpreting the data gathered.

Scale	Weighted Means/Equivalent	Corresponding Remarks
5	4.20 - 5.00	Strongly Agree
4	3.40 - 4.19	Agree
3	2.60 - 3.39	Neutral
2	1.80 - 2.59	Disagree
1	1.00 - 1.79	Strongly Disagree

Gantt Chart

TASK	NAME OF TASK	PERSONS	STATUS
1	Discussion with groupmates	Almalvez, Carandang, De Guzman, Diasanta, Lalusin, Payte	100%
2	Coding for the ocular assisting device	Diasanta	100%
3	Coding for the GPS	Carandang	100%
4	Buying of materials	De Guzman, Diasanta	100%
5	Building of prototypes	Almalvez, De Guzman, Diasanta, Lalusin, Payte	100%
6	Designing of prototypes	De Guzman, Diasanta	100%
7	Building of the GPS device	De Guzman	100%
8	Testing of code for the assisting device	Diasanta	100%
9	Testing of the GPS device	Carandang, De Guzman	100%
10	Finalization of the assisting device	Almalvez, Diasanta, De Guzman, Payte	100%
11	Finalization of the GPS device	Carandang, De Guzman	100%
12	Making of schematic and pictorial diagrams	Carandang	100%

Chapter 4

RESULTS AND DISCUSSIONS

This chapter presents the researchers' presentation, analysis, and interpretation of results show the effectiveness of the research project by showing the table of the Likert Scale with the respondents' votes and the weighted mean. In connection to the results that the researchers gathered, this answers the questions under the statement of the problem vis a vis the effectiveness of the device and the accuracy of the hypotheses of the researchers compared to the actual results of their tests.

Presentation of Results

Questions	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Weighted Mean
I find the GPS device helpful.	0	0	0	0	4	5
I find it easy to avoid obstacles using the device.	0	0	0	1	3	4.75
The device is easier to use than what I usually use.	0	0	2	1	1	3.75
If the device was in the market, I would buy it.	0	0	0	2	2	4.5
I would support the development of this device.	0	0	0	0	4	5
TOTAL	0	0	2	4	14	4.6

Table 4.1 Survey Results

The researchers successfully created an assisting and navigating device for the visually impaired. They accomplished it in the form of a vest, glove, and thigh pads including two modes: sound and vibration. The researchers were also able to integrate a global positioning system into the device.

The researchers asked four people with blindness, namely, Raffy Sellon, JR Sellon, Virgie Sellon, and Irene of the Association of Visually Impaired Masseurs for Magnificent Services (AVIMMS), to answer some questions before and after their experience in using the device.

All of them agreed that the blind and the visually impaired have heightened senses, but not all. They also agreed that it is helpful for their relatives to know their location, and they do so by calling them using a cellphone. Two of them use a cane to navigate their surroundings, while the other two do not use anything at all, just their senses. All of them ask for assistance when they are going to cross the road. They told the researchers that they raise their canes as a sign for the drivers that a blind person is going to cross the road. Majority of them generally find it difficult to travel from one place to another. They said that if they know the place and already memorized which is where then it's easy for them to walk around. But if the place they're in is not familiar to them, then it will be difficult for them.

After using the device, the researchers asked them some questions vis a vis their experience using it. All of them strongly agreed that the GPS device is helpful and that they would support the development of the device. Three of them strongly agreed that they find it easy to avoid obstacles using the device, while one of them only agreed. One of them strongly agreed that the device is easier to use than what she normally uses, while one only agreed, and the other two, neutral. Half of them strongly agreed that if the device was in the market, they would buy it, while the other half only agreed. Their only concern in buying the device is the price.

One of them suggested that instead of the device completely replacing the use of white canes, they would be used together, both cane and device. This is due to the limitations of both apparatus and if used together will complement each other.

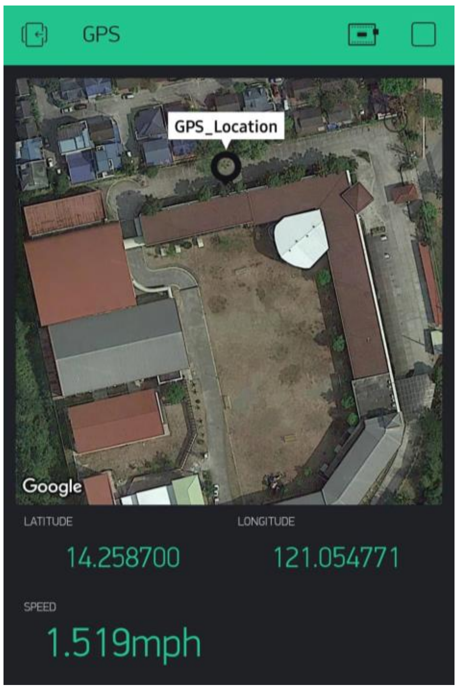


Figure 4.2. Satellite view of Caritas Don Bosco School from Blynk app

The GPS gave the researchers fairly precise and real-time maps through the app called “Blynk.” This app was able to access the data that the GPS module transmits. The passing of data is through the use of a Wi-Fi module. In connection to this, the researchers were able to identify the latitude, longitude, and even the speed of the user.

	GPS Device		Blynk Device	
	Location	Wi-Fi	Location	Wi-Fi
1.	Caritas Don Bosco School	Pocket Wi-Fi (Globe)	Caritas Don Bosco School	Mobile Data (Globe)
2.	Db Audio Balibago	Pocket Wi-Fi (Globe)	Waltermart Balibago	Waltermart Free Wi-Fi
3.	Bel Air 3	Home Wi-Fi	Bel Air 3	Mobile Data (Globe)
4.	Verdana Homes Mamplasan	Pocket Wi-Fi (Globe)	Dita National Highway	Home Wi-Fi

Table 4.3. Global Positioning Device Testing

Analysis of Results

Using the device, it provides the real-time location of the blind. However, the blind can only be navigated if he or she is connected to Wi-Fi. The respondents agree that the device is beneficial for their relatives to track their location.

The researchers had trouble mounting the sensors to the clothing. Once mounted, it became easier to test the devices since it only needed a few tweaks to the sensors. Even though there are visual aids that circulated in the blind community, the researchers provided a more innovative method in detecting obstacles.

Based on the table and computations, the weighted mean is 4.6 (Strongly Agree). Since all of the questions in the questionnaire are positive and getting a 4.6 (Strongly Agree) means that the device was effective and served its purpose to the blind.

Interpretation of Results

In reference to the data gathered by the researchers, the device was more convenient and safer for the users. It is easily accessible and visually impaired-friendly to operate and to use. Its GPS makes it more convenient for the blind’s relatives and family members. Although, some users thought it would be a nice addition to the white cane. Other users felt that it was easier to maneuver than the white cane. Overall, it is able to provide a more innovative aid for those who are visually impaired.

Chapter 5

SUMMARY OF RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

This chapter summarizes the results gained from the trials of the output along with the learnings acquired from the study. This states the conclusion based on the results of the study and the recommendations to future researchers who would like to research about navigating devices for the visually impaired using ultrasonic sensors and GPS and improve the researchers' output.

Summary of Results

The researchers achieved their expected outcome from their test based on their hypotheses. It helped visually impaired people by providing them with assisting devices that are both safe and easy to use. Its friendly interface helped them understand the device easily and clearly. Lastly, it provides convenience for the blind's relatives and family members.

The researchers learned that it is very hard to create a device that can effectively help people with impairments, specifically, the blind. Interviews with members of AVIMMS allowed the researchers a deeper knowledge of the problems encountered by the visually impaired, which led the researchers to gain more information and to somehow help create a solution for them.

Conclusions

1. The researchers conclude that the Blind-Assisting Resource for Travel (B.A.R.T.) effectively helps the blind person to navigate through his or her surroundings.
2. The device detects objects such as walls and is safer to use than a traditional cane.
3. The device also precisely gives the location of the blind, but only with a stable Wi-Fi connection.
4. The device could also be paired with a cane if the user wants to.

Recommendations

1. The researchers would recommend soldering the wires properly so as not to encounter the same problem that they had when putting the prototypes into their cases.
2. The researchers would propose that the future researchers design more comfortable and durable garments that would make the clothes user-friendly.
3. In future studies, the researchers would make a device that can detect holes and stairs, and guide the user in crossing the road.
4. Instead of using regular AAA batteries, the researchers recommend using rechargeable lithium batteries for convenience.
5. Instead of putting the device on a vest, the researchers would opt to put the device on everyday clothing so that it would be more practical for users.

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Appendix A: Survey Questionnaire

This appendix contains a sample of the survey questionnaire that the researchers used.

QUESTIONNAIRE:

NAME: ________________________________ AGE: __________

SEX: ________________ OCCUPATION: ________________

I. EVALUATION

1. Is it true that visually impaired people have heightened senses?

   ☐ YES ☐ NO

2. Do you have any other impairments?

   ☐ YES ☐ NO

3. Do you live on your own?

   ☐ YES ☐ NO, please specify:________

4. If you don't live alone, is it helpful for your relatives to know your location?

   ☐ YES ☐ NO

5. Do you know how to read braille text?

   ☐ YES ☐ NO

6. As a blind person, what do you use to guide yourself navigate in your surroundings?

____

____

7. How do your relatives know or track your location?

____

____

Questions	**1 (Strongly Disagree)**	**2 (Disagree)**	**3 (Neutral)**	**4 (Agree)**	**5 (Strongly Agree)**
8. In general, I find it difficult to travel.					
9. I often ask for assistance when crossing the road.					
10. I find it easy to avoid obstacles using the aid I specified in number 5.					
11. I feel safe using my travel aid.					
12. My relatives find it easy to know my location.					

II. EVALUATION OF DEVICE

Questions	1 (Strongly Disagree)	2 (Disagree)	3 (Neutral)	4 (Agree)	5 (Strongly Agree)
13. I find it easier to travel using the ocular assisting device.					
14. I find the GPS device helpful.					
15. I find it easy to avoid obstacles using the ocular assisting device.					
16. I feel safe using the device.					
17. The device is easier to use than what I usually use.					
18. If the device was in the market, I would buy it.					
19. I would support the development of this device.					

20. Generally, how was your experience using the device?

____

____

Appendix B: Sample Calculations

Questions	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I find the GPS device helpful.	0	0	0	0	4
I find it easy to avoid obstacles using the device.	0	0	0	1	3
The device is easier to use than what I usually use.	0	0	2	1	1
If the device was in the market, I would buy it.	0	0	0	2	2
I would support the development of this device.	0	0	0	0	4

Example calculation for the weighted mean.

$$\bar{x} = \frac{\sum fW}{N} = \frac{14(5) + 4(4) + 2(3)}{20} = 4.6$$

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2007 - 2008	Malitlit Day Care Elementary School

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2018 – 2019	Salesian Youth Movement Secretary – Juventus Sodality
2016 - present	Juventus Sodality Member
2017 – 2019	Basketball Varsity Member
2016 – 2017	Bosconian Click Member
2016 – present	YFC Member

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SEMINAR/FORUM/WORKSHOP

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2019 - present	Head of the Junior High Bosconian Click

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2015 - present	Liturgical Dance Group Member
2016	Class President
2014	Echoes Member
2013 - 2015	Auxilium Sodality Member

SEMINAR/FORUM/WORKSHOP

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2016	Salesian Leaders’ Assembly

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2019 - present	Auxilium Sodality President

2016 - 2017	Class Secretary
2015 - 2016	Echoes President
2014 – 2015	Auxilium Sodality Secretary
2013 - present	Auxilium Sodality Member

SEMINAR/FORUM/WORKSHOP

2019	SYNODO III
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2016	League of Leaders Camp
2015	League of Leaders Camp
2014	Hererra Music Lessons: Violin

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2011 - Present	Caritas Don Bosco School

AFFILIATION

2014 - present	Federation of Choirs and Musicians Member
2013 - 2014	Liturgical Dance Group Member
2012 - 2013	Class Peace Officer
2014 - 2015	Class Peace Officer

SEMINAR/FORUM/WORKSHOP

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AFFILIATION

2019 – present	Class Secretary
2019 – present	Voces Inspirare Member

2018 – 2019	Class Secretary
2018 – 2019	Team Captain (Greywolves Ultimate)
2016 – 2017	Class Secretary
2016 – 2019	Frisbee Varsity Member
2015 – 2016	Class Secretary
2014 – 2015	Class Secretary
2013 – present	Liturgical Dance Group Member
2013 – 2014	Young Earth Savers Movement Member
2012 - 2013	Class Secretary

SEMINAR/FORUM/WORKSHOP

2019	DLSU Math-Sci Challenge Amazing Race: Escape Room
2019	MathSciAKa: Mystery Workshop (Bracket II)
2019	League of Leaders Camp
2018	League of Leaders Camp
2015	League of Leaders Camp