Speaking Walking Stick using GPS Interface

Project report submitted in partial fulfillment of the
requirement for the degree of Bachelor of Technology
in
Computer Science and Engineering

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CERTIFICATE

We hereby declare that the work presented in this report entitled **Speaking walking stick using GPS interface** in partial fulfillment of the requirements for the award of the degree of **Bachelor of Technology** in **Computer Science and Engineering** submitted in the department of Computer Science & Engineering and Information Technology**,** Jaypee University of Information Technology Waknaghat is an authentic record of our own work carried out over a period from August 2016 to May 2017 under the supervision of **Dr. Vivek Sehgal,** (Associate Professor, Department of Computer Science and Information Technology).

The matter embodied in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidates is true to the best of my knowledge.

Dr. Vivek Sehgal
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Dated:

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Our appreciation also goes to our respective family members who have been supporting me all these months in accomplishing the first half of our final year project. Thanks for their encouragement, loves and support that they had given.

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LIST OF ABBREVIATION AND SYMBOLS

GPS	Global Positioning System
RFID	Radio Frequency Identification
TTS	Text To Speech
GIS	Geographic Information System
KHz	Kilo Hertz
V	Voltage
cm	Centimeter
M	Meter
µS	Microsecond
µ/S	Micropersecond

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ABSTRACT

Human beings are blessed with the perfect creation of body. Despite that, some people are not as fortunate as others are , since they suffer from natural disabilities or disabilities caused by accidents. Visual impairment is categorized as one of the most common disabilities. Luckily, there are various assistive technology that help in neutralizing their in ability to see . For years, visionless people have chosen to use the simple wooden stick as a tool for aiding their daily walking or life. The stick has been very useful to the blinds in assisting their movements in the various activities they perform throughout the day. Although the walking cane is able to guide the blind people in broad terms still thereare several weaknesses that can be enhanced to make the design better so that it is able to guide the blind in a more effective manner. One of the major weaknesses of the walking stick is that, it can only detect obstructions that come within the range of the length of the stick. Person comes to know about the obstruction only when the stick comes in direct contact with the obstruction. The main purpose of this project is to develop a smart speaking walking stick for the blind which detects the obstacle that is within the range of 400cm without touching it. By using a microcontroller and Raspberry Pi(a single board computer that contains SoC), a specific output is programmed for a specific range of distance between the user and the obstructions. The walking stick will speak to the user to warn him of any obstruction in its path.

CHAPTER 1

INTRODUCTION

Vision is the most significant a part of human physiology as 83% of knowledge person gets from the surroundings is via sight. The count of visually impaired individuals rises each year. The 2011 statistics by the World Health Organization (WHO) estimates that there square measure 285 billion individuals in world with visual defect, thirty-nine billion of that number are blind and 246 with low vision. In existence they bear drawback of navigation to go from one place to a different safely and timely. They usually rely on external help which may be provided by humans, trained dogs, or special electronic devices as support systems for deciding. The foremost necessary drawbacks of those aids consists of necessary skills and coaching part, range of motion and extremely very little information sent. With the fast advances of contemporary technology, each in hardware and software package front have brought potential to produce intelligent navigation capabilities. this technique presents an inspiration to produce a wise electronic aid for blind individuals, each publicly and personally. The system is meant to produce overall measures artificial vision and object detection, real time help via global positioning system (GPS). In this system embedded system plays a serious role. we are implementing ultrasonic sensor , GPS receiver, GSM module, accelerometer, microcontrollers and speaker.

Smart walking stick is specially designed to find obstacles which can facilitate the blind to navigate freely. The audio messages keeps the user alert and significantly scale down accidents. A voice enabled automatic switch is additionally incorporated to assist them in house also. This blind guidance device use ultrasound attributable to its immunity to the environmental noise. another excuse why ultrasonic is standard is that the technology is comparatively cheap, and sufficiently little to be carried without the requirement for complicated circuit.

1.1 Background of Project

Among different forms of disability, blindness is one of the most suffering that can happen to people of all ages and it affects the victim's life severely. Nowadays, a number of researches have been conducted in designing and developing tools that may protect the blind persons from dangerous accidents. Most of the visually challenged people today still use simple sticks as the tool to help their movements especially when they are moving in outdoor spaces. Major developments and advancements in IoT technology can assist the blind person to walk around more comfortably and easily.

There are many research papers that are related to this invention of speaking walking stick in which different design implementation such as infrared sensor, radio signal and ultrasonic sensor detection, vibration detection for various applications.

1.2 Problem Statement

There are a number of blind people who use the simple walking stick to assist them in their daily movement. The stick helps them to detect obstacles in their path and to avoid them from dangerous situations.

The common walking stick used by blind persons can implement simple functions only. So, the development of a new smart walking stick, that can detect any object near the person before the user collides with it with the bottom of the stick, is needed.

1.3 Objectives

The main objective of this project is to build a smart speaking walking stick that can detect obstacles in front of visually challenged people. This smart stick will be able to calculate different distances between the person and the objects for up to 300 *cm* long and to be able to help more the stick will speak the distance of the nearest object to the blind person. This stick will also be able to detect the fall of the stick using accelerometer. If the person will not pick up the stick for 30 seconds then it will be assumed that the person is in problem and needs immediate help. In order to receive help, the loctaion of the person will be detected using GPS module which will be sent via twitter feed to the guardians of the blind person. In addition, the objective of this project is also to assist motion activities of blind person in their daily routine. Nonetheless, this project also aims to build a low cost, fast, durable and robust speaking walking aid for blind.

1.4 Scope

There are two major parts involved in this project, namely hardware and software modules. The hardware part involves the physical development of the walking stick, an accelerometer, an arduino, raspberry pi, GPS and GSM module, an ultrasonic sensor, earphones and a switch.

The software part includes the programming of the sensors. The software used to program Arduino is Arduino 1.0.6 and to program Raspberry Pi is Python on Raspbian operating system. Accelerometer sensor, GPS and GSM module has been configured with Arduino using Arduino programming language. The ultrasonic sensor has been configured with raspberry pi using python. Text to speech module and messaging module have been implemented using python on Raspbian operating system installed on raspberry pi.

1.5 Thesis Outline

The first chapter starts with transient introduction of the project. This chapter describes the background of the project, the problem statement, objectives and hence the scope of the project. It also provides the brief thesis outline of the project. The second chapter is regarding the literature survey that we have done regarding the field of the project. It also discusses the basic concept and working principle of Ultrasonic sensor , text to speech module, Accelerometer, GPS and GSM module, Raspberry Pi and arduino, messaging module.

Chapter three discusses the system development of the project which consists of programming of Arduino Uno microcontroller using Arduino software system, installation of Raspbian on Raspberry Pi, the characteristics and programming of different modules and hence overall development of the walking stick.

Chapter four presents the results obtained after the integration of all modules ans some discussion of the results. It also does the performance analysis of different sensors in different situations.

Chapter Five concludes the overall findings of the project and discusses about the recommendations along with future scope.

Chapter six wraps up with the overall planning of the project using Gantt Charts and time scheduling. Finally it estimation of cost incurred during the construction of “Speaking Walking Stick For Blind Using GPS Interface” .

CHAPTER 2

LITERATURE SURVEY

This chapter describes the past and current researches that have been carried out and the papers that have been published which are related to the project. This review investigates from various aspects of sensors, microcontrollers, indicators and the overall working system of the related projects.

2.1 Application of Ultrasonic Sensor in Arduino Mobility Cane

Jayant, Pratik and Mita have suggested the application of ultrasonic sensor in the walking stick to detect the obstacles. The overall project is discussed as below.

2.1.1 Working Principle

The basic function of ultrasonic sensor is to calculate the distance of an object. In this project, an ultrasonic sensor is used to measure the distance between the nearest obstacles and the blind person. The sensor is able to warn the blind when facing any dangerous situations.

The ultrasonic sensor works on the principle of generating high frequency sound waves from the echo pin and evaluates the echo which is received back by the receiver of the sensor . The sensor determines the time interval between sending of the signal and receiving of the echo to calculate the distance of the nearest obstacle. The calculated distance is sent to the Raspberry Pi microcontroller and it speaks the distance of the nearest object to the blind person.

2.1.2 Characteristic of Ultrasonic Sensor

The ultrasonic sensor model used in this project is SRH-04. It was developed to be as easy to use as the Polaroid sonar. This ultrasonic sensor can calculate the distance of obstacles in maximum range of 300 cm.

This sensor consists of 4 terminals, namely the power terminal, the ground terminal, trigger pulse terminal and echo pulse terminal. An analog voltage signal is generated as output which is directly proportional to the distance of the nearest object. The current consumption for the sensor is about 2.5A during the sonic burst and the power required to turn start the sensor is $5V$.

To start the ranging, the sensor needs to supply a short 10μS pulse to the trigger input. After which the sensor will generate out an 8 cycle burst of ultrasound at 40kHz and hence its echo line is raised high. The module is compact enough to fit into small system like ours. Figure 2.1 shows the SRH-04 ultrasonic sensor.

Figure 2.1 HC-SR04 Sensor

2.1.3 Hardware Part

The five main components in the system that is described in the research are GPS module, Ultrasonic Sensor, Accelerometer, Arduino microcontroller and a control unit.

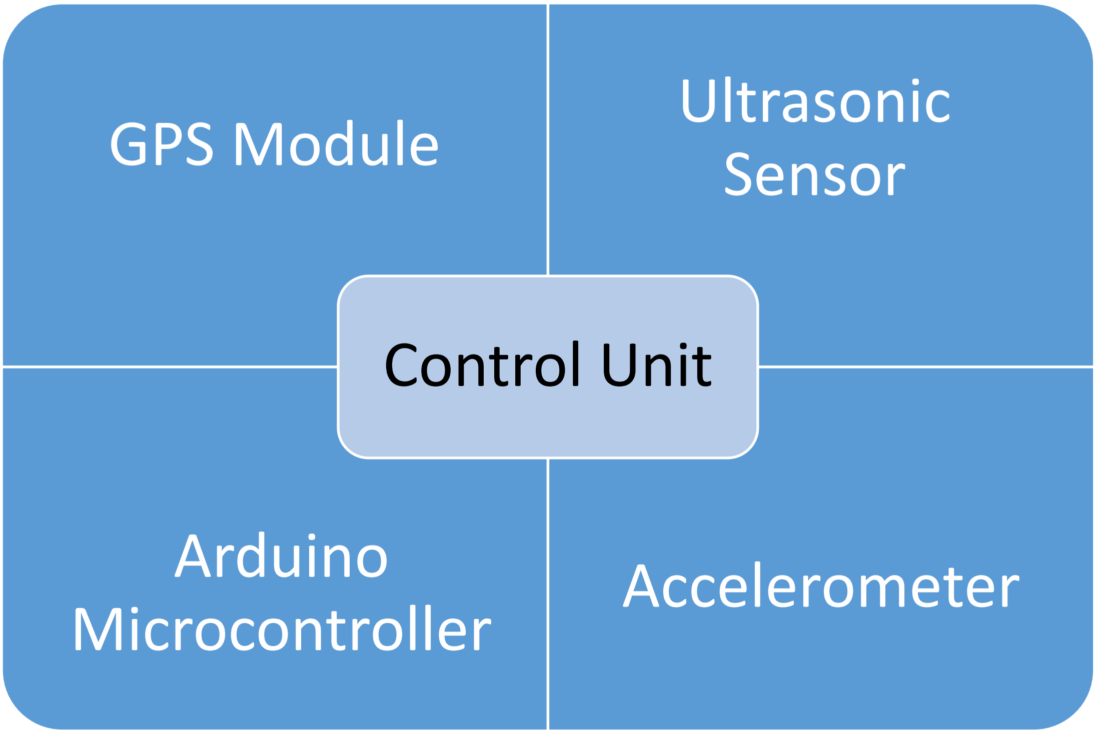

Figure 2.2 Block Diagram of the Components

Referring to the above figure (Figure 2.2), ultrasonic sensor will send ultrasonic waves, which will bounce back when they will strike with an object or an obstacle in the path of the visually Impaired person. The signal which is received back will be sent to the control unit which consists of a microprocessor, Arduino Uno. Arduino will do the calculation and then it triggers the text to speech module as the indicators to warn the blind person of the obstacle.

2.2 Application of Infrared (IR) Sensor in Electronic Guiding Stick

K. Divya, P. Dhivya, R. Gayathri and P. Govindaraj have proposed the use of infrared (IR) sensor in developing and designing of the Electronic Guiding Stick for the blind people. The stick is used as a tool for guiding their movement of the blind people. Based on this project, the sensors will be able to detect the presence of obstacles that present along the path of the blind person.

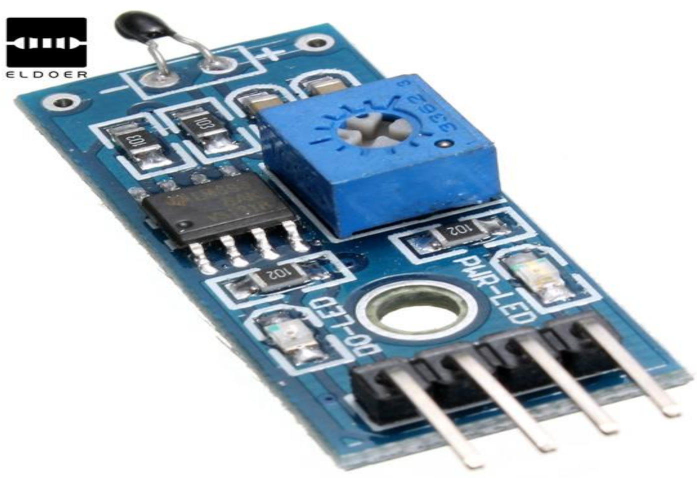

Figure 2.3 Infrared Sensor

2.2.1 Basic Concept

The basic concept of the infra red sensor is used to detect obstruction around the blind person. Depending upon configuration of the sensor, it is also able to differentiate between various colors.

One major disadvantage of this project is that it will not be able to detect obstacles towards extreme right or left of the user. However, the main focus of this project is to design the system that will be able to detect the obstacles in front of blind people for longer distances unlike the current available systems. The block diagram of the above discussed project is shown below in Figure 2.4.

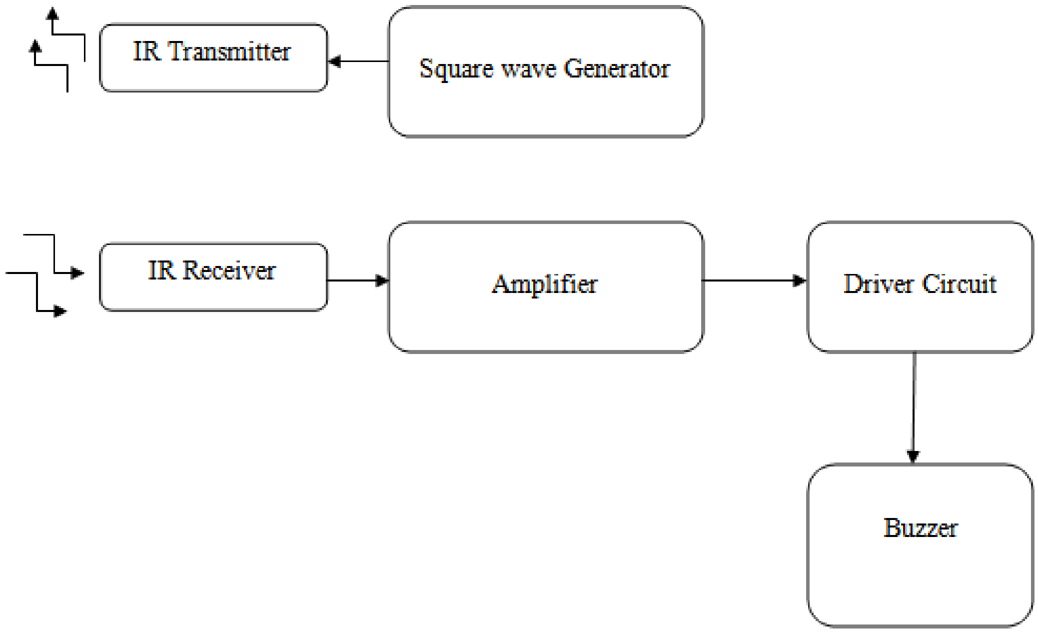

Figure 2.4 Block Diagram of the Components using Infrared Sensor

2.2.2 Working Principle

The basic concept of this project is to design a smart electronic guiding stick with obstacle avoidance system by using Infra Red sensor. The designed smart electronic stick is integrated with Infra Red sensor to measure the distance in range of approximately 100-550 *cm* .

The Infra Red consists of a transmitter and a receiver which are combined with each other. The Infra Red beam is transmitted from Infra Red LED(Light Emitting Diode) transmitter which is the range of 100 to 550 *cm* .

The transmitted beam detects the obstructions and is reflected back to photodiode receiver end. Then, the microcontroller(Arduino Uno) processes the signal and active a vibrator or a buzzer as output indicators that are attached with the handle of the guiding stick.

2.3 Application of Radio Frequency Identification in Blind Navigation System

Bin Ding, Haitao Yuan, Li Jiang and Xiaoning Zang proposed the application of Radio Frequency Identification (RFID) to be implemented in a Blind Navigation System.

2.3.1 Basic Concept

The project has been designed and developed to be conveniently used to solve the requirement and difficulties faced by blind people on their trip to the outside world. We have used wireless and mobile communications technologiesin this project. Radio Frequency Identification (RFID) technology is a non-contact automatic identification technology. It has many qualities, some of which are its large capacity, long performance life and long reading distance.

2.3.2 Working Principle

This system consists of RFID reader, an antenna, RFID tags, mobile terminal, call center, route server and tag information database as shown below (Figure 2.5).

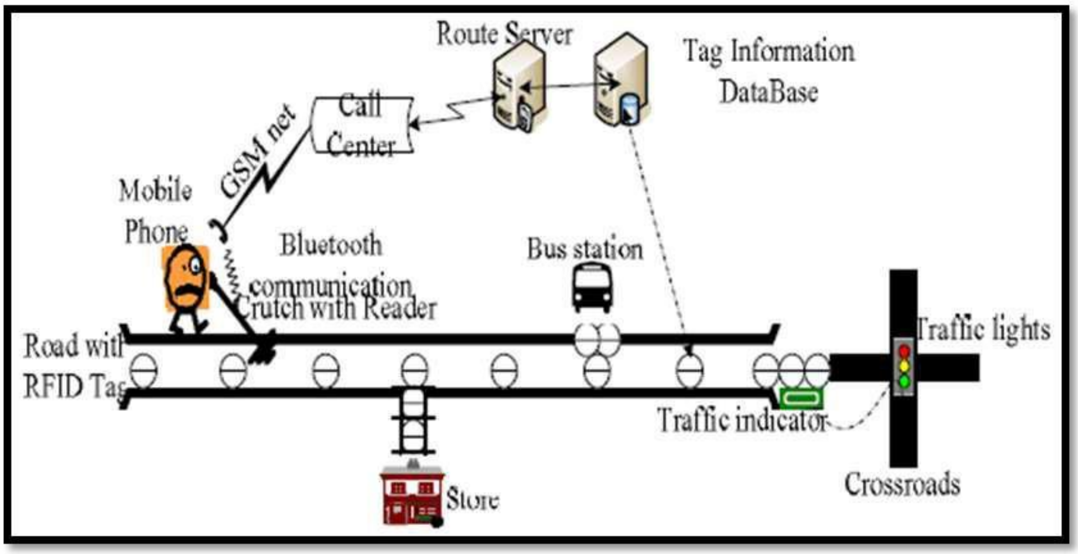

Figure 2.5 Frame of Blind Navigation System

The blind person will have to tell the call center about his destination by his mobile phone and then the mobile phone will send the person's location information back to the call center. The RFID reader will read the road tag near the blind person and it will connect with the mobile phone using Bluetooth interface and will send the tag information to the mobile phone.

After this, the call center will input the information about the destination and location to the route server. The route server will look up for the necessary data from the tag information database. The tag information database will send the data to the route server and it will use route arithmetic to produce an optimal route and send the route to the call center.

2.3.3 Indicator

The output at the call center will send the optimal route to the blind person's mobile phone. Instead of using a mobile phone, audio signal can also be the output option which can assist blind people in walking and finding their way in various situations along their journey.

2.4 Microcontroller

Microcontroller is a compact microcomputer which is designed to regulate the operation of embedded systems in robots, office machines, motor vehicles and various other devices. An embedded system is a very sophisticated system that requires minimum memory and small program lengths. No operating system is required and less software complexity is there.

2.4.1 Arduino Uno Microcontroller

The Arduino Uno is a microcontroller board, which is based on the ATMEGA328. It is an open source single board microcontroller, heir of the open source-wiring platform; hence, it helps in designing of various electronic projects very easily. Arduino has to be programmed in order to perform the designed function. The software that is used for the programming of Arduino Uno is Arduino software.

It has 14 digital input/output pins. Some of which can be used as PWM outputs, 6 of them can be used for analog inputs, a USB connection, a power jack, a 16MHz crystal oscillator, ICSP header, and a reset button. It has everything that is needed to support a microcontroller.

2.5 An Ultrasonic Navigation System For Blind People

The proposed system will detect the nearest obstructions via stereoscopic sonar system and will send back a vibro-tactile feedback to alert the blind person about the immediate obstruction. The sonar system is based on an ultrasonic sensors; which consists of two parts, the transmitter will emit an ultrasonic wave and the receiver will measure the echo.

2.5.1 Basic Concept

This project is implemented on a microcontroller which has synthetic speech output. It gives information to the user (blind person) about urban walking way thereby helping him to make various decisions. Pulse from the microcontroller activates the speech synthesizer . The output shows the different actions that are to be taken.

2.5.2 Working Principle

The system consists of a microcontroller, an hexadecimal keypad, an accelerometer, a speech synthesizer, a footswitch, two ultrasonic sensors, a mode switch, two vibrators, a buzzer and a power switch a power switch. The block diagram of the described system is shown in the Figure 2.6.

It sends out a pulse of ultrasound which is reflected by an object in the path of the user and is sent to the microcontroller(Arduino Uno). The vibration in the stick will increase as the distance between the user and the obstacles will decrease.

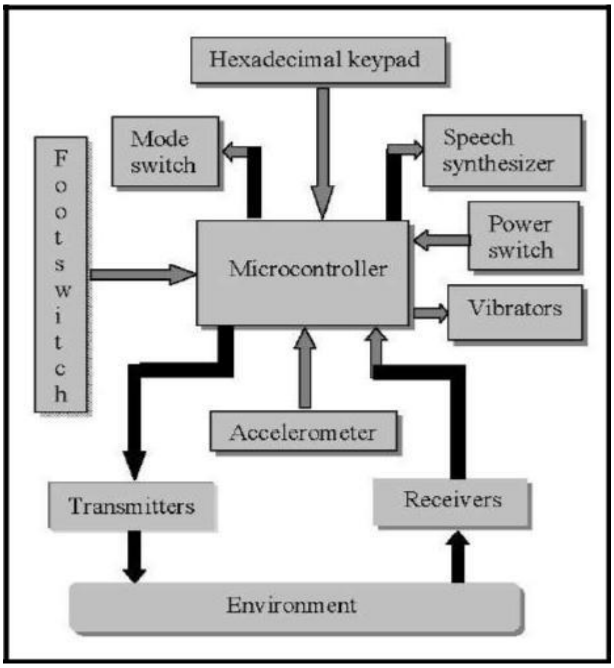

Figure 2.6 Block Diagram of the System

The two modes of operation of the system are record and playback. In the record mode, the blind person will walk on the path of his choice in, and the stick will measure the distance travelled by the person. When the blind will reach at a point where he will have to make a decision, for example, should he take a left turn he press a key on the stick which is coded with a left turn instruction. In the playback mode, the stick will again measure the distance travelled by the blind person. If it is equal to that distance which is already stored in the memory of the microcontroller, a corresponding decision word which will generated by the synthesizer will given to the blind. The system can store many routes and each and every route is numbered, and is to be selected using the same set of keys as for the decisions.

2.6 GPS-Location Tracking Technology

GPS is a technology that is used in large number of applications in today's world. One of all the applications is tracking a device and monitoring them regularly This tracking system can tell you about the location and route travelled by a vehicle, and that information can be seen from any other remote location. It also can be integrated with various web applications that can provide us the exact location of the target. In this project also we have used GPS technology for the same use. Since a lot of mishappenings occur on roads everyday, therefore the need of tracking a blind person is even more. Since it will be even more difficult for him to handle the situation without the gift of sight. Using the GPS module the track of the blind person can be kept by his guardians. Also in case the blind person is in problem he will be able to communicate the details about his position with his near ones.

Figure 2.7 GPS module

2.6.1 Characteristics Of The Module

GPS system is made up of three parts which are satellites, ground stations, and receivers. Satellites are like the stars in various constellations—we know where they are located at any given point of time

The ground stations use radar system which make sure that the satellites are actually located there where we think they are.

A receiver, like we might find in our phones or in our cars, is constantly listening for a signal from these satellites. The receiver finds out how far away they are from some of them. Once the receiver has calculated its distance from four or more satellites, it tells us exactly where we are.

They can determine where we are within a few yards of our actual location. More high-tech and advanced receivers, though, can find out where we are to within a few inches.

2.6.2 Working Of The Module

Calculating Position

A GPS receiver computes its position at any time using a technique called satellite ranging. It this technique measuring of the distance between the GPS satellites it is tracking and the GPS receiver is done. The range (the range a receiver computes is more of a pseudo range, or an estimate of range rather than a true and precise range) or distance, is measured as the elapsed transit time. The position of each and every satellite is *known to us* , and the satellites transmit their positions as part of the "messages" that are sent by them via radio waves. The GPS receiver located on the ground is the *unknown* point, and it must calculate its position using the information that it receives from the satellites.

Measuring Distance to Satellites

The first step to measure the distance between a GPS satellite and the GPS receiver requires measuring the *time* that it takes for the signal to propagate from the satellite to the receiver. Once the receiver has the knowledge of the time that has been elapsed, it multiplies the travelling time of the signal times the *speed of light* (because the satellite signals always travel at the same speed as that of the light, that is approximately 186,000 miles per second) to calculate the distance. Distance measurements of four satellites are required to calculate a 3-dimensional (that is latitude, longitude and altitude) position of the person.

To measure the travelling time of the satellite signal, the receiver will have to know the exact time when the signal left the satellite and when the signal reached the receiver. Knowing the latter part that is when the signal reaches the receiver is easy, the GPS receiver just has to "check" its internal clock when the signal arrives to calculate what time it is. But how will it be able to "know" when exactly the signal left the satellite? All the GPS receivers are synchronized with the satellites and thus the same digital code is generated at the same time. When the GPS receiver receives a code from a particular satellite, it can look back in its memory bank and "remember" when it transmitted the same code. This smart "trick" allows the GPS receiver to determine when exactly the signal left the satellite.

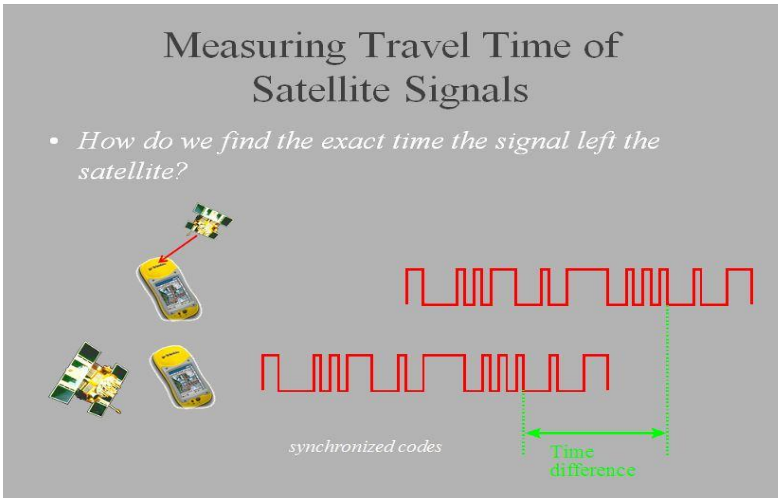

Figure 2.8 Time Signal in GPS

Using the Distance Measurements to Calculate a Position

Once the receiver has calculated the distance measurements, then it basically becomes a problem of geometry. If it "knows" where the four satellites are, and how far it is from each satellite, it calculate its location by trilateration. Here is a detailed explanation of how it works.

The GPS receiver "locks on" to one satellite and calculates its range to be 12,000 miles. This fact helps to narrow the receiver location down, but it tells us only that we are somewhere on a sphere which is centered on the satellite and has a 12,000 mile radius, we can be anywhere on this 12,000 mile radius. Many of the locations on that sphere are not present on earth, but out in the space.

After this , consider that the receiver picks up a signal from a second satellite and calculates the range between the receiver and the satellite to be approximately 11,000 miles. This means we are also somewhere on a sphere within the radius of 11,000 mile with the second satellite at the center. Therefore we must , be somewhere where these two spheres intersect. When these two spheres intersect, a circle is formed, hence we must be somewhere on that circle.

If the receiver picks up some other satellite, let it be at a distance which is 11,5000 miles away, another sphere is formed, and there are only two points where all these three spheres intersect. In practice the receiver can discard one of the last two points because it is nowhere near the earth. So, we are left with one point which is the exact location of the GPS receiver.

GPS Error

There are many sources of possible errors which can degrade the accuracy of positions calculated by a GPS receiver. The time taken in travelling of GPS satellite signals can be altered by atmospheric effects; when a GPS signal passes through the ionosphere and troposphere layers of atmosphere it is refracted, which causes the speed of the signal to be different from the speed of a GPS signal in free space. Sunspot activity can also cause interference with GPS signals. Another source of error is noise measurement, or distortion of the signal caused by electrical interference or errors which are inherent in the GPS receiver itself. Errors in the ephemeris data (the information about satellite orbits) will definitely cause errors in computed positions, because the satellites weren't really at the positions where the GPS receiver "thought" they were (based on the information it received) when it computed their positions. Small variations in the atomic clocks (clock drift) on board the satellites can give rise to large position errors; a clock error of 1 nanosecond can translate to 1 foot or .32 meters user error on the ground. Multipath effects can arise when signals transmitted from the satellites strikes on a reflective surface before getting to the receiver antenna. When this happens, the receiver can get the signal in straight line path as well as delayed path that is multiple paths. The effectis almost same as a ghost or double image on a TV set.

2.7 Text Processing for Text-to-Speech Systems

AnandArokia Raj , TanujaSarkar , SatishChandra Pammi, SanthoshYuvaraj have proposed to build a natural sounding speech synthesis system, it is important that the text processing component produce a very appropriate Sequence of phonemic units that corresponds to an arbitrary input text. In the paper they discuss their efforts in addressing the issues they faced some of which are Font-to-Akshara mapping, pronunciation rules for Aksharas, text normalization in the context of building text-to-speech systems in Indian languages.

2.7.1 Working

Speech synthesis is an artificial production of human speech. The computer used for this purpose is called a speech computer or a speech synthesizer. This system can be implemented in both software as well as hardware products. "The text-to-speech (TTS) module's work is to convert normal human language text into speech that is voice based output; other systems also can reproduce symbolic linguistic representations like phonetic transcriptions into speech".

During the creation of the database, all recorded speech is divided into some or all of the following: diphones, syllables, morphemes, words, phrases, and sentences. To do its work that is to produce words from a written text, the module starts by doing a complex linguistic analysis that converts written text into phonetic text.

2.8 Activity recognition using Accelerometers

Zohra Aziz Ali Manjiyani, Renju Thomas Jacob, Keerthan Kumar R, Babu Varghes proposed the recognition of activity using cell phone accelerometers.

An accelerometer sensor is an electromechanical device that is used to measure the acceleration forces. These forces can be static, like the continuous force of gravity or, similar is the case with many mobile devices, dynamic to sense movement or vibrations. Acceleration is the measurement of the change in velocity, or speed with respect to time. They can typically be used in one of three modes:

- As an inertial measurement of velocity and location;
- As a sensor of inclination, tilt, or orientation in 2 or 3 dimensions, that is referenced from the acceleration of gravity (1 g = 9.8m/s2);
- As a vibration or impact (shock) sensor.

2.8.1 Principles of Operation

Mostly all accelerometers are Micro-Electro-Mechanical Sensors (MEMS). The basic principle of operation behind the MEMS (Micro-Electro-Mechanical Sensors) accelerometer is the displacement of a small proof mass etched into the silicon surface of the integrated circuit and suspended by very small beams. In accordance with Newton's second law of motion (**F = ma**), as an acceleration is applied to the device, a force is developed which displaces the mass. The support beams act same as that a spring does spring, and the fluid (usually air) trapped inside the internal circuit acts as a damper, hence resulting in a second order lumped physical system. “This is the source of very limited operational bandwidth and also the source of non-uniform frequency response of accelerometers”.

2.9 An RFID Based Electronic Stick for Navigation Assistance

This project consists of a system named Smart Vision which is able to help a blind person to move around an unfamiliar environment, it can be indoor or outdoor, through a geographical information using RFID technology.

2.9.1 Basic Concept

The project is based on a navigation system that uses Radio Frequency Identification (RFID) as the main technology. The RFID tags are kept along the various streets where the visually impaired people may pass by and RFID reader is located inside the smart walking stick.

2.9.2 Working Principle

The goal of this Smart Vision project is to assist the blind person in navigating himself in indoor and outdoor environments. This project has used a typical stereo vision system, Radio Frequency Identification (RFID) tags, GPS (Global Positioning System) is used for outdoor positioning and GIS is used for indoor positioning. After obtaining the present position, through GPS (Global Positioning System) or Radio Frequency Identification (RFID), the system gives the blind person the applicable information with the help of the GIS server, using Text to Speech module that converts text that is stored in a database into audio signs.

The tag reader of RFID (Radio Frequency Identification) is pasted at the bottom of the wooden stick. The stick uses USB to establish communication with the processing unit. After this , the RFID (Radio Frequency Identification) tag reader unit sends data using Buletooth technology. The function of vibrator near handle is to alert the blind person each time a tag is detected by the sensor and hence the user can judge its position relative to the tag.

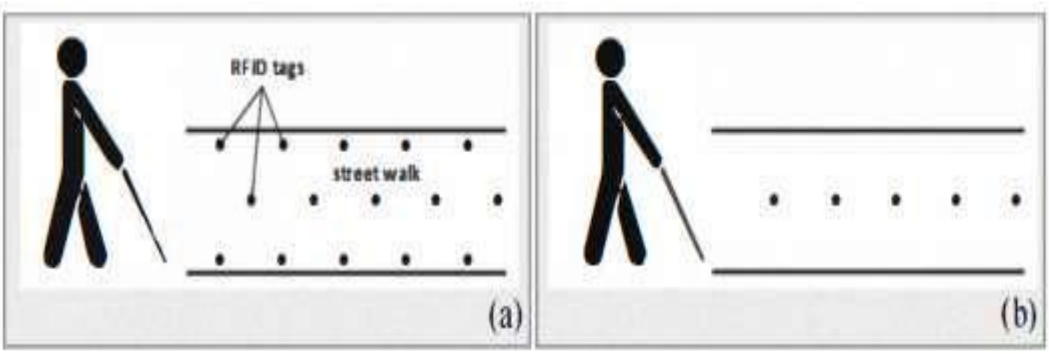

Figure 2.9 RFID Tags Position

CHAPTER 3

SYSTEM DEVELOPMENT

This chapter discusses the overall project development and integration of different modules. It consists of four parts, namely the physical development, project overview, circuit design and software development.

3.1 General Construction

The walking cane used in this project is a ready-made stick readily available in the market. The walking stick with a handle is selected due to several factors such as easy to hold, maintain and operate. It is a wooden stick. Figure 3.1 shows the stick to be used in developing the Speaking walking stick for blind. The walking stick is about 80 *cm* in length which is suitable enough for average human height.

Figure 3.1 Wooden Walking Stick

3.2 Project Overview

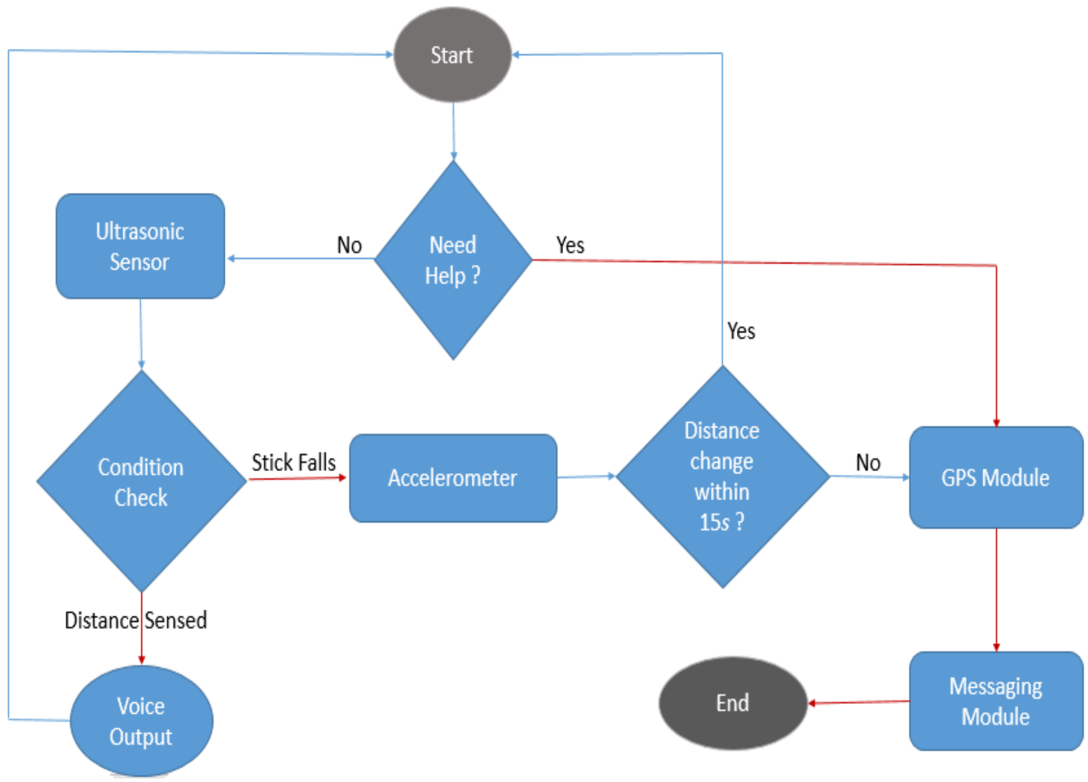

Figure 3.2 Project Flow Chart

Figure 3.2 represents the flow chart of the overall stick. The system has an ultrasonic sensor which function simultaneously to calculate the distance of the nearest obstacle in the user's path. The output of the sensor will be propagated to the microcontroller.

Raspberry Pi receives the output signal from the ultrasonic sensor and processes it. If the output signal is within the programmed distance range, the calculated distance will be spoken by the stick using text to speech module. The falling of the stick will be detected by accelerometer and if the stick is not picked up by the person within 30 seconds, it will show that the person is in problem and needs immediate help. After which the GPS

Module will start working and detect the position the person and it will be sent to the guardians of the person via tweeter feed.

If the stick is not fallen and still the blind person needs help, in that case he can press the button and then too the GPS module will start working and the locations of the person will be sent to his guardians. They can find the exact location by clicking on the coordinates sent in the link, as it would be directed to the google maps.

3.3 Electrical Design

The electrical circuit design of the system includes the ultrasonic sensor, the accelerometer, GPS and GSM module, a button, Arduino Uno microcontroller and Raspberry Pi 2 as shown in Figure 3.3.

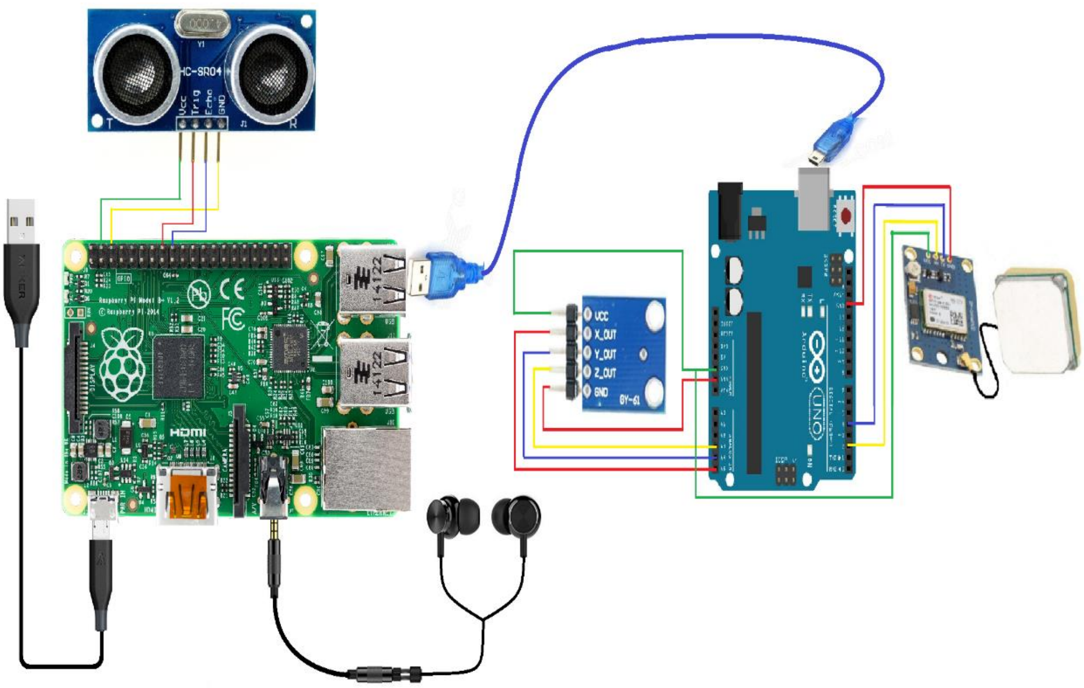

Figure 3.3 View of the Main Circuit

3.3.1 Raspberry Pi

The main brain of the stick is Raspberry Pi. It is a small affordable single board computer. These computers are approximately of the size of a credit-card and represent the standard mainline form-facto. There are several generations of pi that has been released till now. All models have a system on chip (SoC), which has ARM(Advanced RISC Machine) compatible central processing unit(CPU) and on chip graphics processing unit. The model used in the stick is "Raspberry Pi 2 Model B". It has a 900MHz quad-core ARM Cortex-A7 CPU with a RAM of 1 Gb.

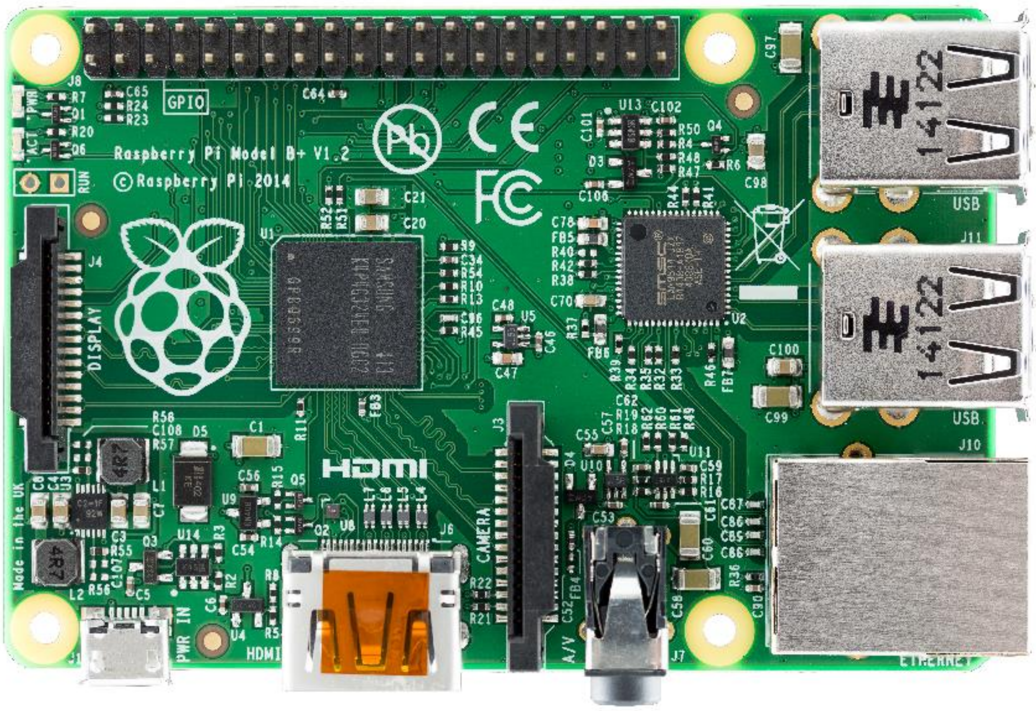

Figure 3.4 Raspberry Pi 2

It also has 4 USB Ports, 40 GPIO pins, full HDMI Port, Ethernet Port, 3.5mm audio jack and composite video, camera interface(CSI), display interface(DI), micro SD card slot. We have installed Raspbian operating system on the pi.

3.3.2 Microcontroller Design

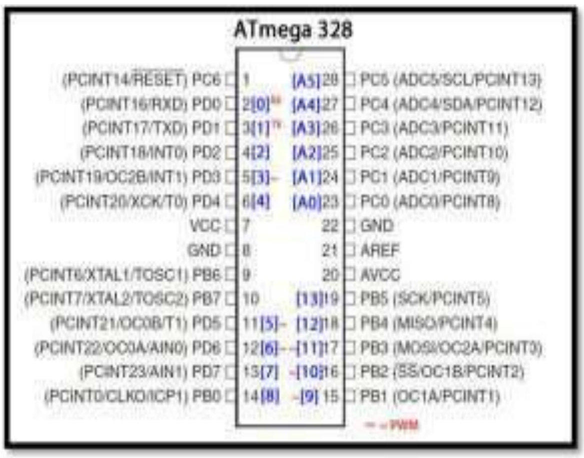

Figure 3.5 Microcontroller Pin Diagram

The brain of the entire system is Raspberry Pi which serially communicates with Arduino Uno microcontroller where most part of the data management is done. We are using Raspberry Pi 2 model B in which we have installed Raspbian operating system. It has 2 Gb RAM and we have put a micro SD card of 8 Gb in it. The microcontroller that we have used in this project is Arduino Uno R3, as illustrated in Figure 3.5. Arduino Uno has an ATMEGA328P microcontroller embedded in it. It has 32 KB of flash memory of storing the program code. It also consists of 2 KB of SRAM and 1 KB of EEPROM. The detail features of the microcontroller are discussed in Appendix E.

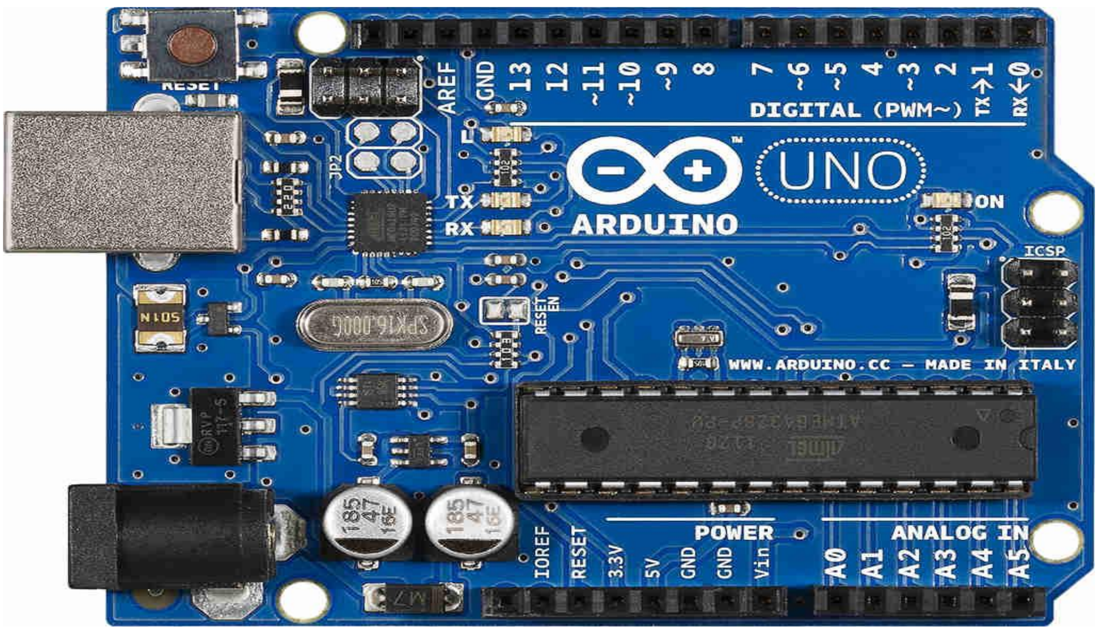

Figure 3.6 Arduino Uno R3

The Raspberry Pi processor receive signals from the sensors and perform data processing. It calculates the signals received and if needed further modules are activated by the processor to assist the blind person.

3.3.3 Ultrasonic Range Sensor

The ultrasonic range sensor is used to compute the distance between the user and the objects for near-knee positions. The model of the sensor used is HC-SR04. Figure 3.6 below illustrates the image of the ultrasonic sensor used in this project.

Ultrasonic waves are generated from the trigger pin of the module and is able to detect obstructions using echo pin within the range of 2cm – 400cm.

Figure 3.7 HC-SR04 Sensor

The consumption current for the sensor is 15mA and the operating voltage is 5V. The time interval between sending signal and receiving echo signal is computed using the following formula :

Time = High Level Time * Velocity (342μ/S)/2

3.3.4 Raspberry Pi interface with Ultrasonic Sensor

Ultrasonic sensor has been interfaced with Raspberry Pi in our stick. Four pins of ultrasonic sensor are connected to the Raspberry Pi in the following way. Vcc has been attached to 5V, Ground Pin to GND, Trigger pin to GPIO 23 and echo with GPIO 24 on the Pi.

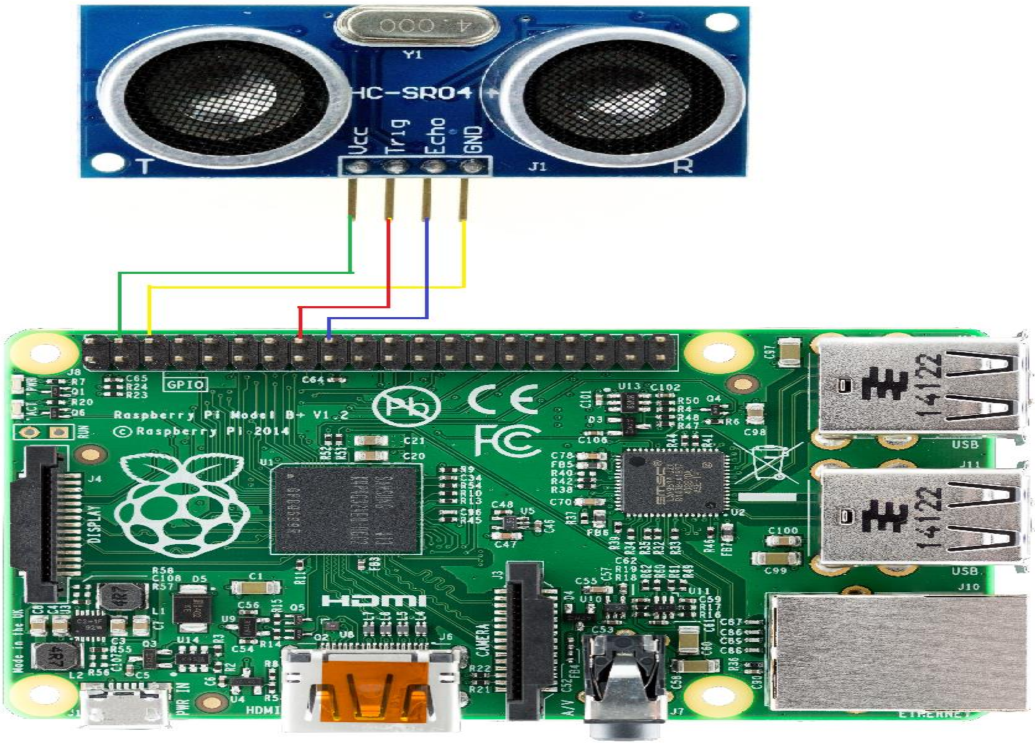

Figure 3.8 Ultrasonic Sensor and Raspberry Pi Interfacing

3.3.5 Accelerometer

An accelerometer sensor is an electromechanical device that is used to measure the acceleration forces. These forces can be static, like the continuous force of gravity or, similar is the case with many mobile devices, dynamic to sense movement or vibrations. Acceleration is the measurement of the change in velocity, or speed with respect to time.

It consists of five pins Vcc, GND,X_Out,Y_out,Z_Out.

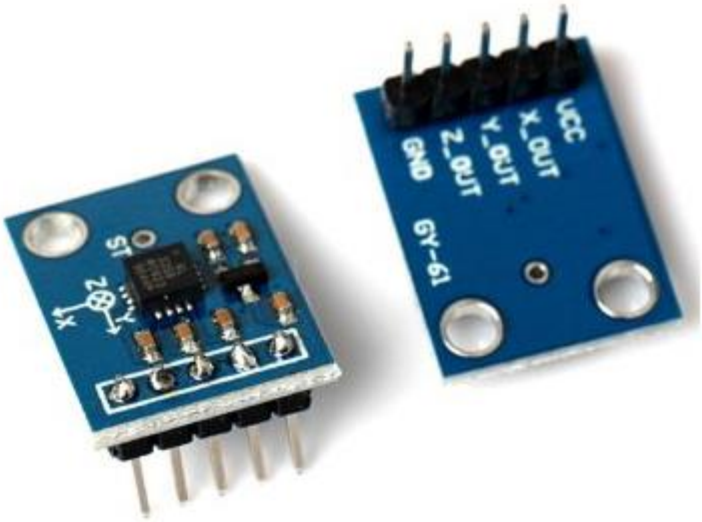

Figure 3.9 An Accelerometer

Here accelerometer calculates the value of its three axis at any point of time and it the value of any two axis changes then that will mean that the position of the sensor has been changed or falling of the stick in our case.

3.3.6 Accelerometer interface with Arduino Board

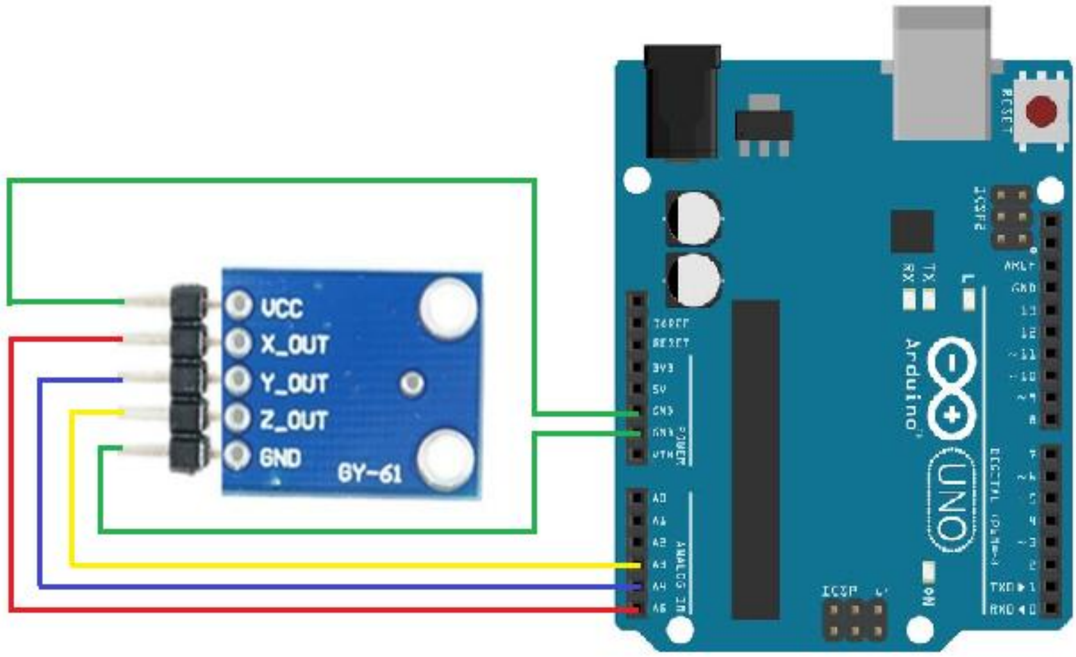

Figure 3.10 Accelerometer and Arduino Interfacing

We have interfaced the accelerometer with Arduino board . 5 pins of accelerometer have been connected to Arduino Board in the following manner. Vcc Pin of Accelerometer is connected to 5V,Ground to GND X_out to A5,Y_out to A4 and Z_out to A3. We have interfaced Accelerometer with arduino rather than Raspberry Pi because it is easy to implement.

3.3.7 GPS Module

Global positioning System tells the accurate position and velocity information at any given point of time anywhere in the world. These sensors consists of receivers with antennas which use a satellite-based navigation system that has a network of 24 satellites that orbit around the earth to provide information about position, velocity, and time.

We have used ublox neo 6m-0-001 model. It has 4 pins Vcc,GND,Rx and Tx.

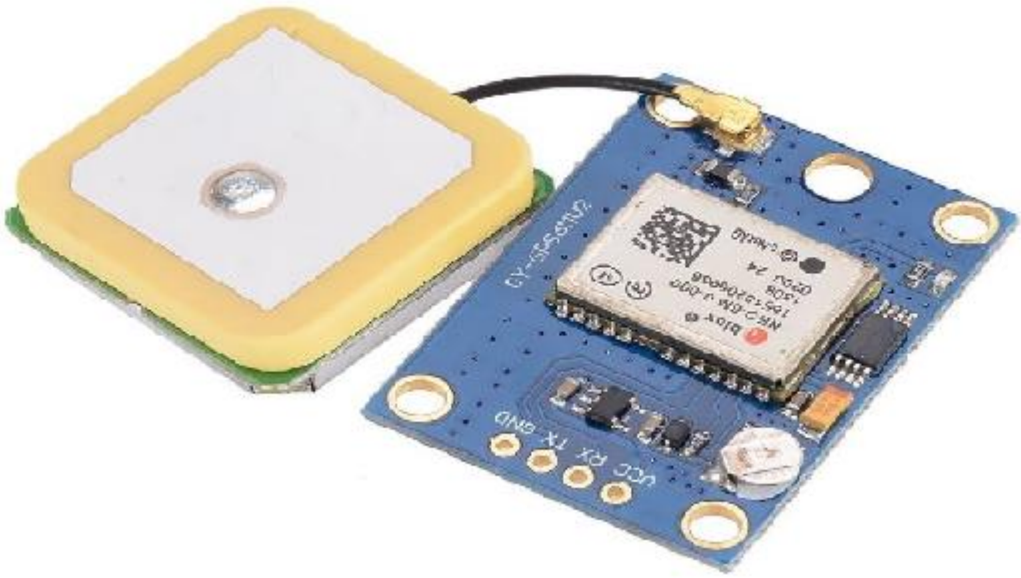

Figure 3.11 GPS and GSM Module

In our project the GPS sensor will detect the position of the stick on its activation and this positions will be sent to the guardians of the person via twitter feed.

3.3.8 GPS Module Interface With Arduino Board

The GPS module in our stick has been interfaced with Arduino Board because interfacing it with Raspberry Pi would have led to the complex code and other problems may have risen due to this. 4 pins of the module have been connected with Arduino board in the following manner. Vcc is connected to 5V, Rx to pin 2 , Tx to pin 4, and ground to GND of Arduino board.

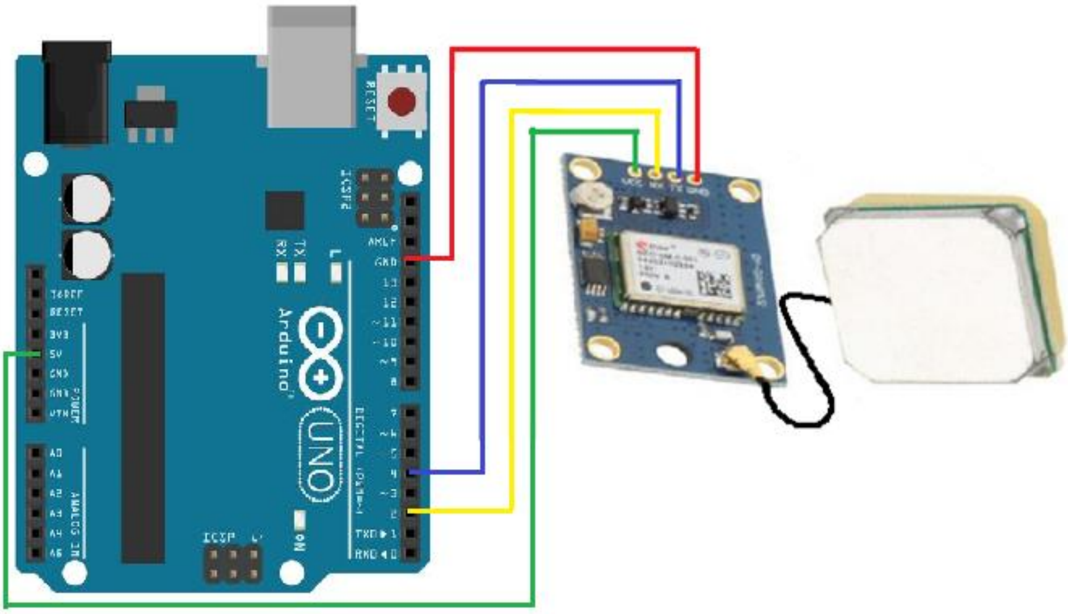

Figure 3.12 GPS and Raspberry Pi Interfacing

3.3.9 Communication between Arduino and Raspberry Pi

Since we need the output of GPS module on Raspberry Pi in order to further send it to the guardians of the blind person using twitter feed so it has been transmitted to the Raspberry Pi by establishing serial communication between Arduino and Raspberry Pi. It has been achieved by connecting Arduino Power cable to USB of Raspberry Pi.

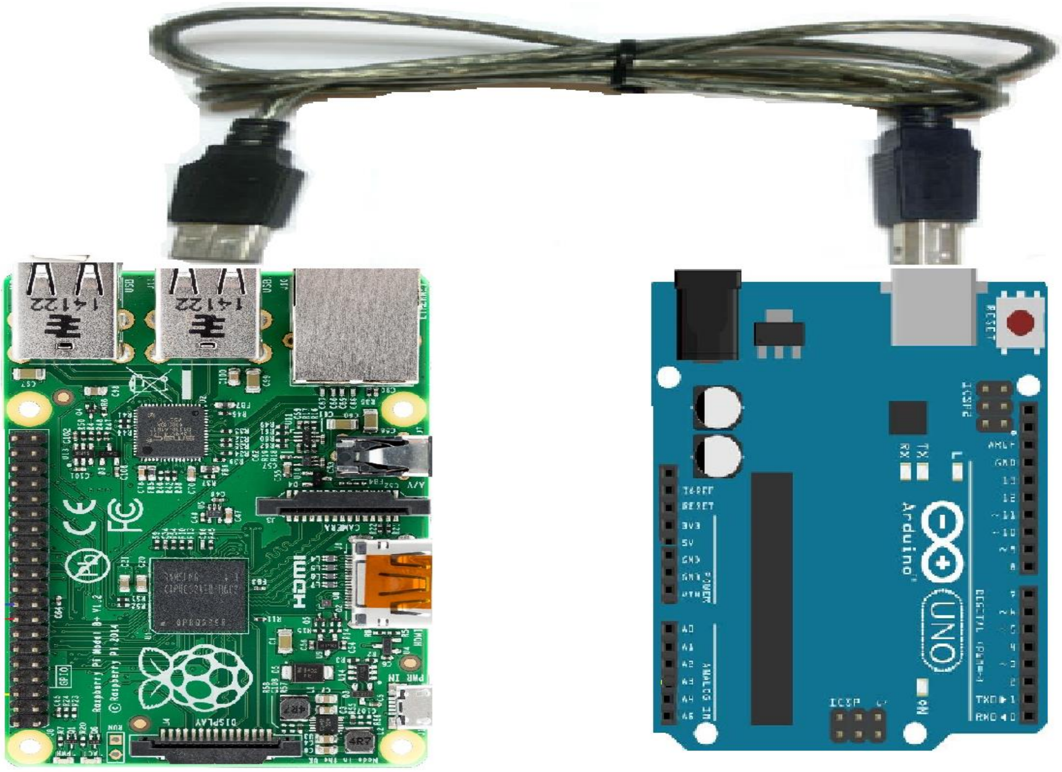

Figure 3.13 Serial Communication between Raspberry Pi and Arduino

3.3.10 Text To Speech Module

A Text to Speech (TTS) module converts simple text into speech. Since the stick is for blind person it will speak about the distance of the nearest object to the blind person. Distance as discussed above is calculated by ultrasonic sensor and this distance is used as

Figure 3.14 Device to obtain Voice Output

the input for text to speech module which will convert the written text into voice output. We have used earphones to hear the voice output. The earphones are connected to the raspberry pi through 3.5mm jack available on the Pi.

3.3.11 Messaging Module

If the person is in problem then the he can call his relatives by sending a twitter feed with a click of a button. Also the location computed by GPS module are sent to the guardians. The message will contain a link that will tell the latitude and longitudinal position of the stick. By clicking on the link google maps will tell about the position of the person in more readable format.

3.3.12 Slide Switch

The switch used in this project is a push button. It consists of 2 terminals which are easy to do the connection. A user needs to push the button to send the GPS location of the stick to guardian of the blind person via twitter feed. It may help the person to communicate with his/her guardian in case of any emergency.

Figure 3.15 Slide Switch

3.4 Software Development

Software development is the most important part which ensures proper and smooth functioning of the stick. It includes the programming of the ultrasonic sensor, accelerometer, GPS and GSM module serial communication between Raspberry Pi and Arduino Uno, Text to speech conversion and messaging module.

3.4.1 Programming of the Sensor and Indicators

The ultrasonic sensor, the accelerometer, the GPS and GSM module must be declared in the coding. The ultrasonic sensor is programmed to calculate the distance measurement algorithm and the accelerometer has been programmed with fall detection algorithm. The GPS module sends the coordinates of the stick to the guardians as shown in Figure 3.14 below.

```
const int trigPin = 7;
const int echoPinRight = 5;
const int echoPinLeft = 6;
const int ledPin = 13;
const int buzzerPin = 8;
const int vibratorPin = 9;
int sound = 250;
```

Figure 3.16 Coding for Sensor and Indicators

3.4.2 Distance Calculation

After the processor receives signal from the ultrasonic sensors, it does the processing of the data to compute the actual distance travelled by the sound wave using the formula as shown in figure below.

```
durationRight = pulseIn(echoPinRight, HIGH);
cmRight = (durationRight/2) / 29.1;
```

Figure 3.17 Distance Formula

3.4.3 Schematic Diagram

The schematic diagrams for different modules of this project are done using Paint software. The whole circuit consists of an ultrasonic sensor, the accelerometer, GPS and GSM module, a slide switch, Raspberry Pi and Arduino Uno microcontroller. The schematic diagrams are shown below.

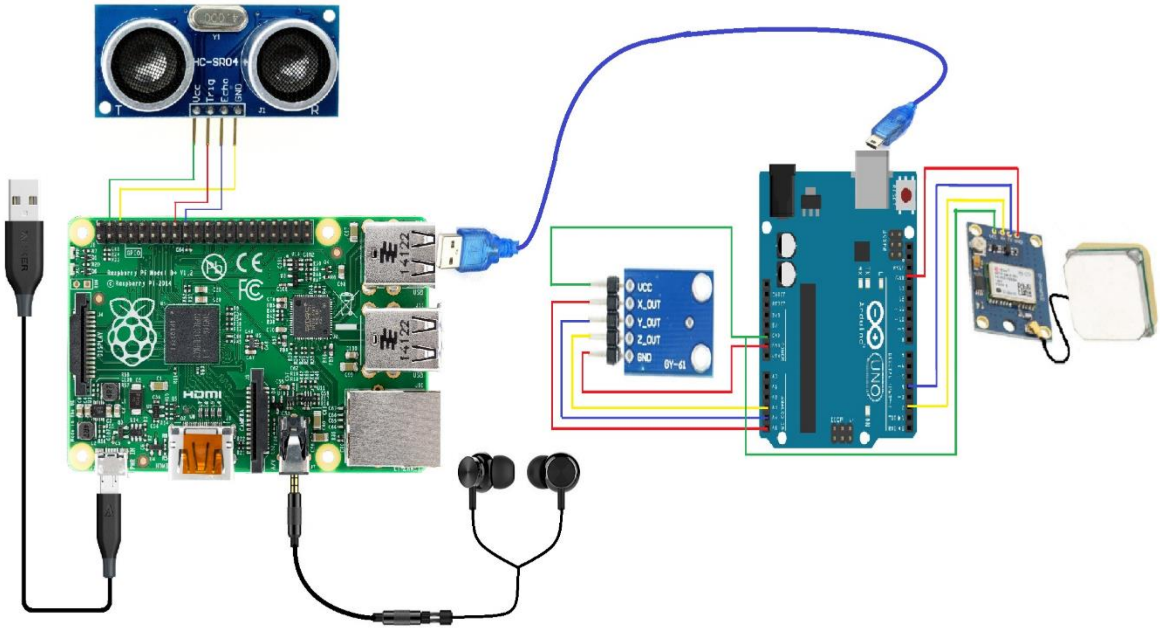

Figure 3.18 Schematic Diagram of the Stick

CHAPTER 4

PERFORMANCE ANALYSIS

This chapter discusses the results that were obtained from experiments performed during the configuration of different modules to check the robustness of the stick.

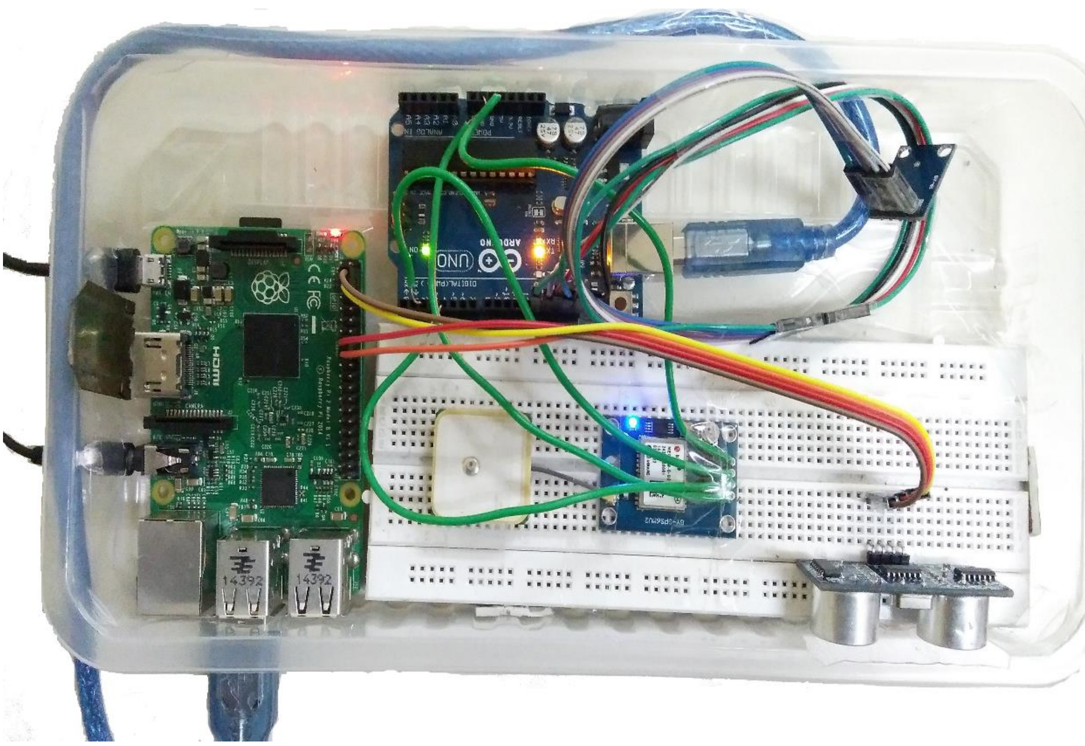

Figure 4.1 Circuit Design of Stick

4.1 Ultrasonic Sensor

Following figure shows an image of the output of the ultrasonic sensor. This output is further used as an input to text to speech module so that blind person is able to hear the distance of the nearest object and act accordingly.

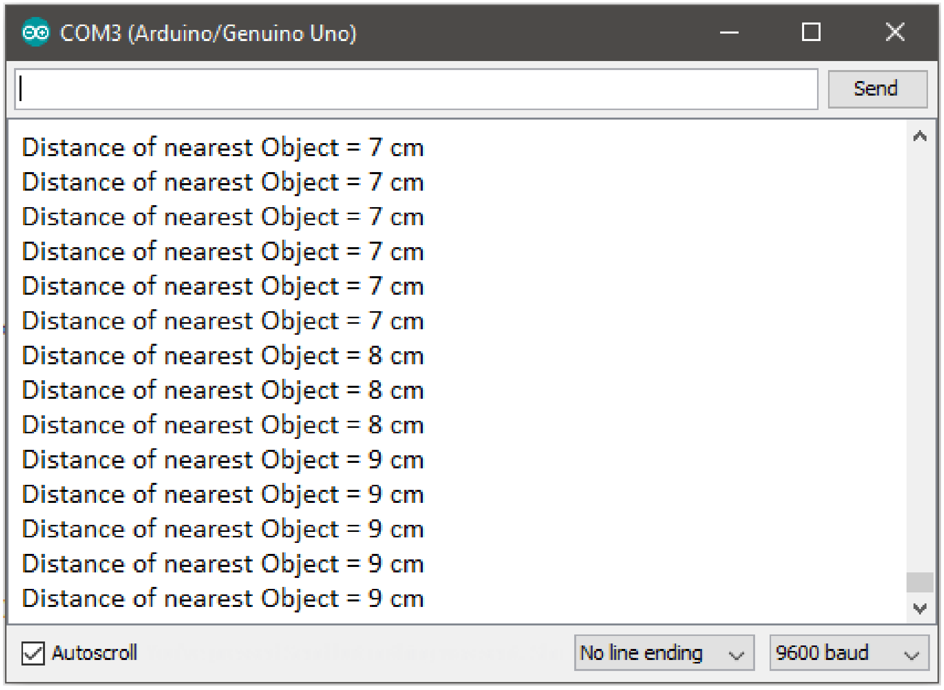

Figure 4.2 Ultrasonic Sensor Results

4.2 GPS Module

Following figure shows an image of the output of the GPS module. These locations are sent to the guardians of the blind person via twitter. It shows the obtained latitude and longitude coordinates, which are then converted into a hyperlink.

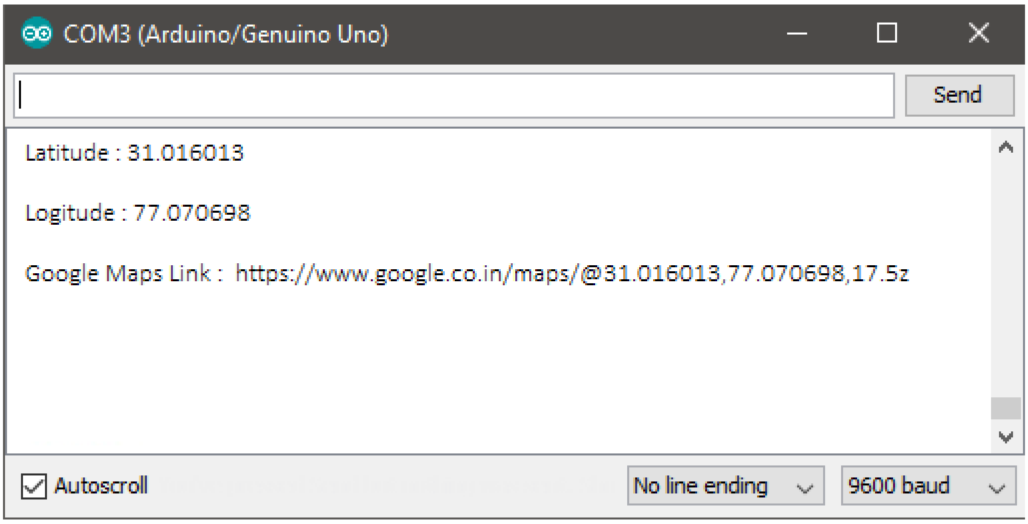

Figure 4.3 GPS Module Results

4.3 Messaging Module

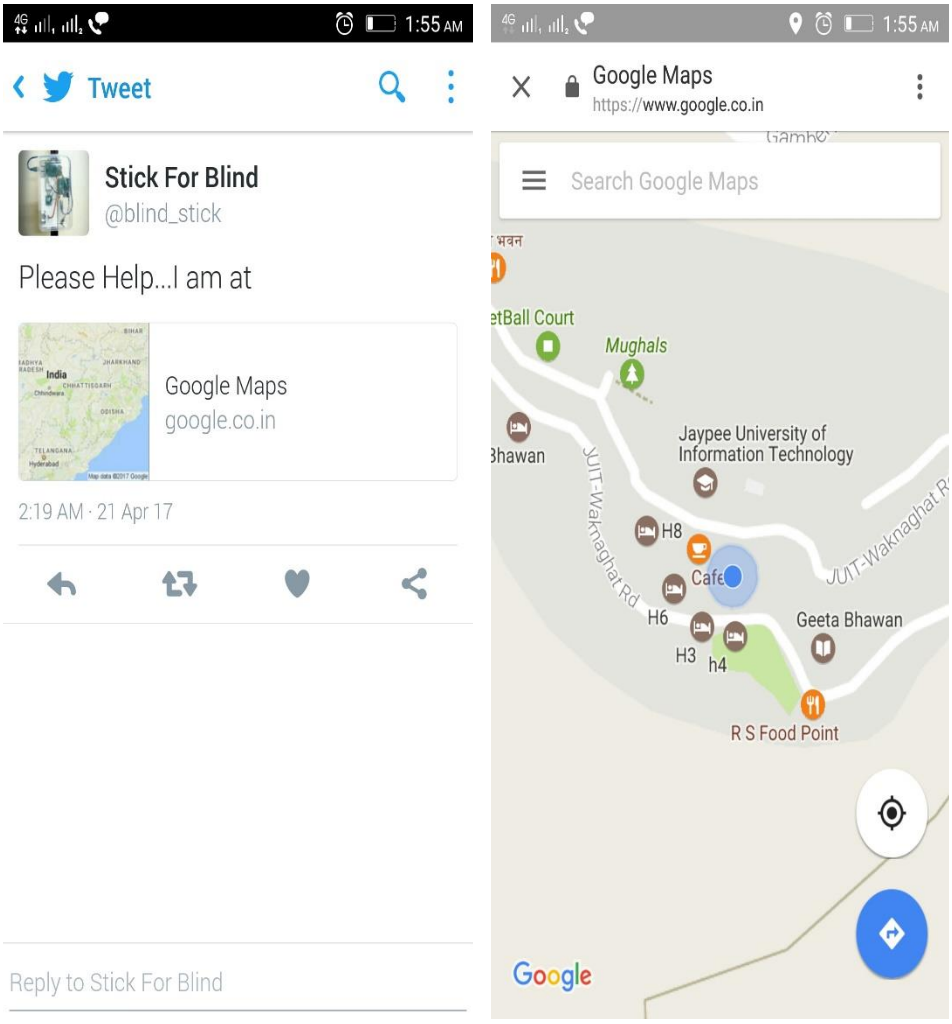

Figure 4.4 Messaging Module Results

The output of messaging module is taken through the twitter handle. The latitude and longitude coordinates converted into hyperlink by GPS module are used here. This hyperlink redirects us to the google maps, where guardians can see the exact position of the blind person.

4.4 Response of Stick for Various Obstacles

A number of experiments were conducted by us for performance evaluation purpose. The ultrasonic sensor used tells us about the distance of the nearest object within a specific range of 300cm. The circuit has been designed and developed to verify the response of the sensor for various obstacles in *cm* . The detection range for 4 types of obstacles in shown by Table 4.1.

Table 4.1 Detection Range for Various Objects

Obstacle	Test 1	Test 2	Test 3
Wall	198	210	203
Human Body	100	114	122
Plastic	115	124	145
Metal	210	199	215

4.5 Performance Analysis of Ultrasonic Sensor

The sensor generates very high frequency of ultrasonic waves and responds by giving an analog value at the output. The sensor is able to find objects which are at distance that ranges between 2-300 *cm* long. The performance analysis of ultrasonic sensor for obstacle detection is shown by Table 4.2.

Table 4.2 Performance Analysis of Ultrasonic Sensor

Range (cm)	Measured (mV)
5	46
10	95
15	144
20	196
25	247
30	296

There is a very little difference between the values obtained by sensor and observed as in the table. It implies that the sensor is capable of showing the approximate distance of the nearest object. The performance analysis of ultrasonic sensor is represented in the form of graph shown below in Figure 4.5 below. The variation of different values lead the graph in almost linear fashion.

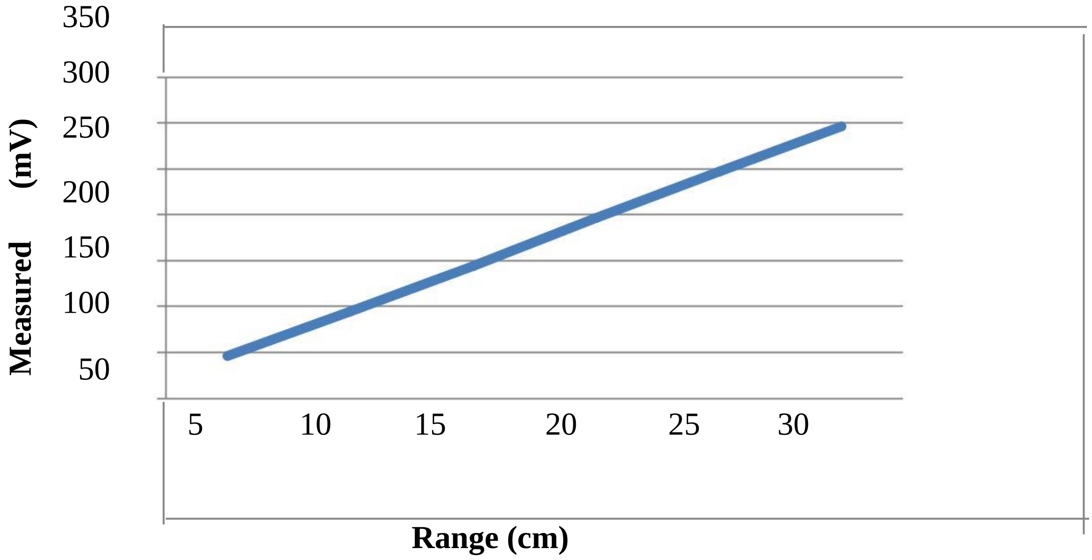

Figure 4.5 Graph Performance

4.6 Sensor Detection Analysis

After analyzing the performance, the ultrasonic sensor was tested with the text to speech module. The range for both positions of the sensor is partitioned into 2 different parts as illustrated in the Figure 4.6.

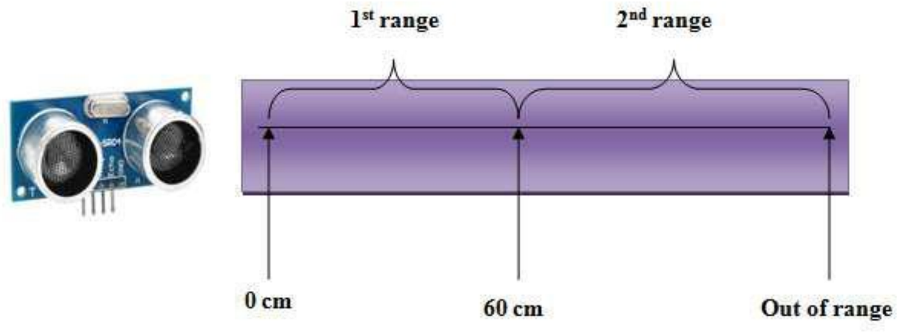

Figure 4.6 Range detection

We have set the distance to vary from 0 for first operational range. The second operational range is set from 61 *cm* until it is out of range.

Table 4.3 Description of Sensor Detection

No	Range (cm)	Output
1	0-60	Buzzer and vibrator ON
2	61-Out of Range	No sound and vibrate

Both positions of the ultrasonic sensor results in same output from the text to speech module. The output for the first operational range which is between 0 *cm* – 60 *cm* generates continuous sound which indicates that the user is close to the obstructions.

For the second operational range, which is set to be from 61 *cm* until it is out of range, the text to speech module will convey a message that path is clear. It represents that it is safe to continue walking along that path for the blind person.

4.7 Logic Algorithm

The flowchart in Figure 4.7 represents the algorithmic flow of object detection by the sensor and the system repeats this procedure continuously. The outputs are set to speech module for different distance ranges.

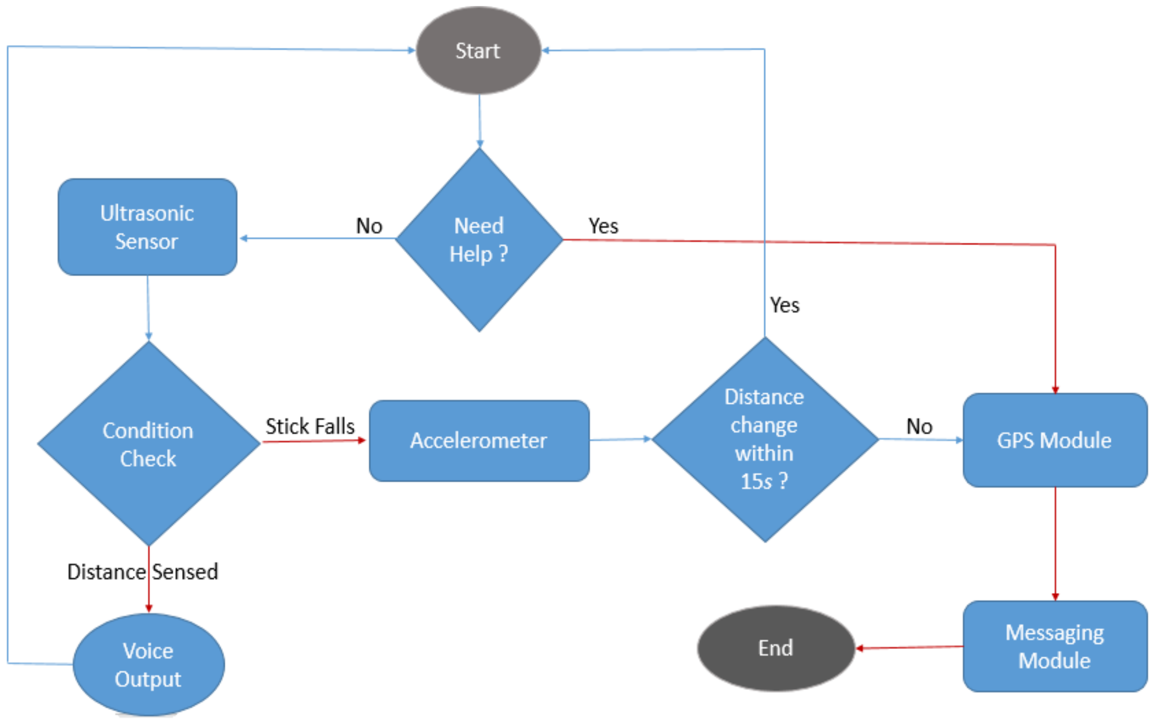

Figure 4.7 Flowchart of the stick

4.8 Walking Stick

The walking stick is made from wood and has a length of 100 cm. Figure 4.8 shows the front view of our smart walking cane. The transparent plastic box contains the main circuit of the system.

.

The front view of the stick is shown in Figure 4.8. It has one ultrasonic sensors, accelerometer, GPS and GSM module. We get the voice output from the earphones which are attached to the walking cane. Figure 4.9 shows the full image of the complete walking stick.

Figure 4.8 Full Image View

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

This Chapter concludes the overall findings of the project and discusses about the recommendations along with future scope.

5.1 Conclusion

The advance development of smart walking sticks for the blind can be implemented using several ways of distance measurement and conveying of message to the blind. Ultrasonic sensor and infrared sensor are examples of sensors that can be used in this system. However, ultrasonic range sensor is much more suitable as it is easy to configure with microcontroller and processor.

We have used ultrasonic range sensor in this project since it is compact, light in weight and requires less power compared to infrared sensor. Generally nature or colour of the object affects no or very less. Moreover, sunlight and dark materials can affect infrared sensor performance easily. Also, it is highly capable of detecting obstacles within 300 cm .

Using the Arduino Uno as the microcontroller and Raspberry Pi as the processor for the smart walking stick has improved the overall functioning of the stick. The sensor and text to speech module are easy to be programmed and easy to be implemented with the processor. In conclusion, the project is successfully implemented and the objectives of the project are fully achieved.

5.2 Recommendations

Some improvements can be implemented to enhance the performance of equired for enhancement of the smart stick for blind. In order to improve it, more ultrasonic sensors can be used to detect any obstacles towards extreme right and left side. Alternatively, the servo motor can be added at the ultrasonic sensor so that it can rotate and tells the direction of the obstacles.

More ultrasonic sensors can be applied along the length of the stick which can tell us about the size of the object in front of the stick. It will increase the reliability of the stick.

In addition, buzzer and vibrator can be used to detect the fall of the stick. In this case voice indicator will amplify its sound output so that it works even in noisy environments. A water and pit and staircase detection algorithms can also be added to the walking stick.

We can replace the ultrasonic range sensor with infrared sensor for larger range of obstacles detection. The battery selection also has a scope for improvement. The battery should be easy to install, remove and recharge.

The stick can also be embedded with high range, more precise and powerful GPS module to get the real time location of the blind person by the guardians. It should be able to communicate very fast with the microcontroller and the processor. We can modify the program and integrate google maps with the code so that we can trace the path of the person using advanced algorithms .

CHAPTER 6

PROJECT MANAGEMENT

This chapter wraps up with the overall planning of the project using Gantt Charts and time scheduling. Finally it estimation of cost incurred during the construction of "Speaking Walking Stick For Blind Using GPS Interface".

6.1 Planning

Table 6.1 shows the gantt chart for the whole project. In order to complete the project, all of the following steps have been taken.

Table 6.1 Gantt Chart for Semester One

Weeks / Activities	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Understanding project's title and brief idea	■	■	■											
Literature review				■	■	■	■	■	■	■	■	■		
List down all components needed							■	■	■	■	■			
Find the circuit									■	■	■	■		
Report preparation										■	■	■	■	■
Presentation													■	

Table 6.2 Gantt Chart for Semester Two

Activities \ Weeks	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Programming development	■	■	■															
Circuit development			■	■	■	■												
Circuit installation to walking stick						■	■	■										
Testing and troubleshooting							■	■	■	■	■							
Presentation												■						
Report preparation												■	■	■	■	■	■	
Report Submission																		■

6.2 Software model

The incremental build model method of software development is the method where product's is designing, implementation and testing is done in an incremental manner that is a little more is added every time until the finishing of the product. It consists of both development as well as maintenance. The product is considered as finished only when all its requirements have been satisfied. This model combines two models. The elements of the waterfall model are brought together with the iterative method of prototyping.

We have decomposed the making of the stick into a number of components and every component is designed and built separately (termed as builds). Each component was tested when it was complete. Had it been a real time project this would have allowed the partial utilization of the stick and hence avoiding a long development time. We collected the sensors and other components part by part and not alI together so it avoided a large initial capital outlay and subsequent long waiting period. This model of development also helped in easing the traumatic effect of introducing a completely new system all at once because there were mistakes that were done in the beginning were also corrected in the beginning.

Characteristics of Incremental Model Of Development

1. System is broken down into many mini projects.
2. Partial systems are built repeatedly to get to the final system.
3. First highest priority requirements are tackled.

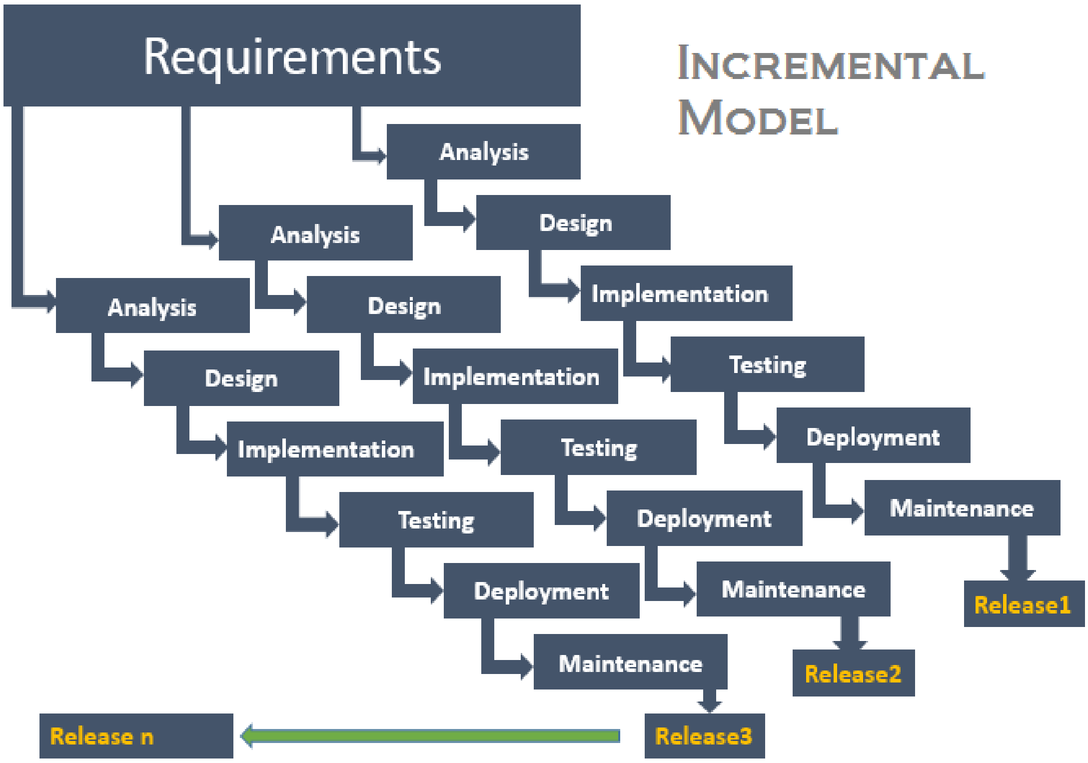

Figure 6.1 Incremental Software Model

Advantages Of Using Incremental Model of Development

After each and every iteration, vigorous testing should be done. During the testing, faulty elements of the software are quickly identified because only few changes are made within any single iteration and hence the problem after a particular iteration should lie in those few changes only.

2. Testing and debugging in this method is easier because the product is tested after every iteration and only small changes are made during each iteration so finding the errors in is easy.
3. Initial product delivery is more fast and costs lesser than others.

Disadvantages

1. There is a possibility that the resulting cost of the project might exceed the cost of the organization.
2. With addition of more functionality to the product, problems related to system architecture can arise which were not visible in earlier prototypes.

Increments of the stick

The development of the stick was done according to this model. We had divided the project into various modules and as each module was developed it was integrated with the whole project.

We started with building the distance measurement module in which we used ultrasonic sensor which was configured using Raspberry pi. Then next we made text to speech module and integrated it with the previous module of ultrasonic. The stick could now measure the distance of the nearest obstacle and tell it to the user. This was our first deliverable model as now it was of some use to the blind person.

Next we moved on to the accelerometer sensor which detected the fall of the stick. Next we moved to GPS module which was able to tell us the position of the stick at any particular time. Then we moved on to build a message module. We used twitter to send message to the guardians of the person. This module was integrated with the GPS module and then both these modules were integrated to the whole system.

6.2 Cost Estimation

Table 6.3 shows the cost estimation according to different modules for the whole project.

Table 6.3 Cost Estimation

Items	Quantity	Price(₹)/Unit	Total(₹)
Arduino Uno Starter Kit	1	1000.00	1000.00
Raspberry Pi	1	2600.00	2600.00
Ultrasonic Ranging Sensor	1	200.00	200.00
Earphone	1	350.00	350.00
Slide Switch	1	50.00	50.00
Accelerometer	1	300.00	300.00
Walking Stick	1	300.00	300.00
Jumper Wire	3 sets	150.00	450.00
GPS and GSM	1	1000.00	1000.00
USB Cable	1	250.00	250.00
TOTAL			**₹ 6500.00**

Based on the table above, the cost estimation for the walking stick for the blind is approximately ₹**6500.00**. It is affordable to buy compared to other electronic walking stick.

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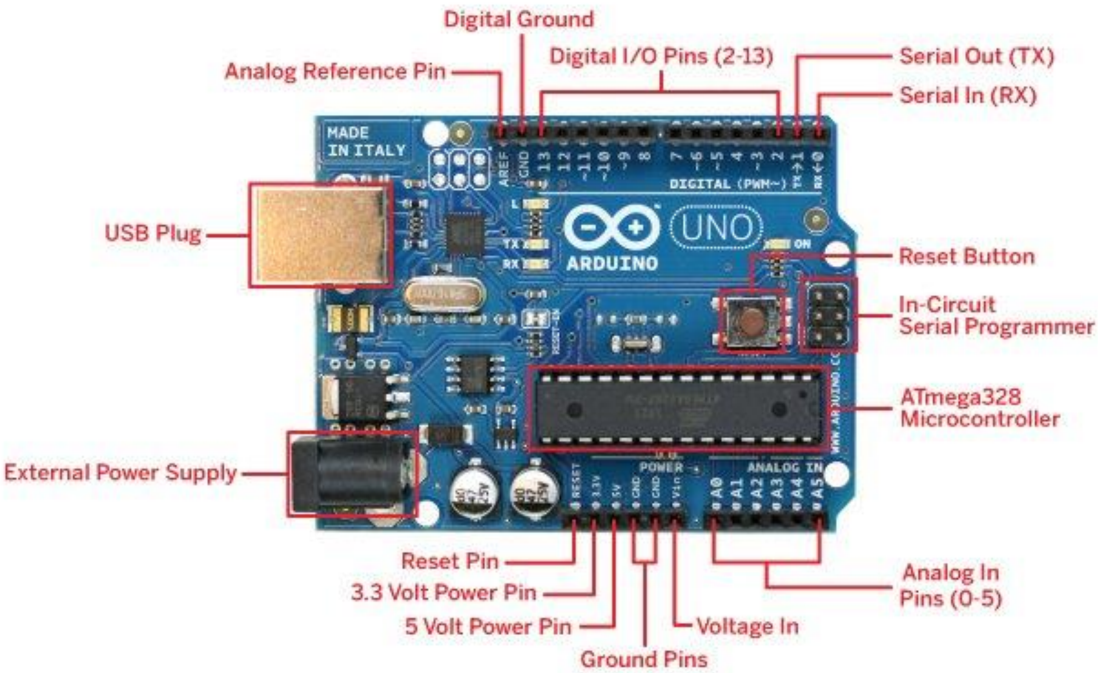
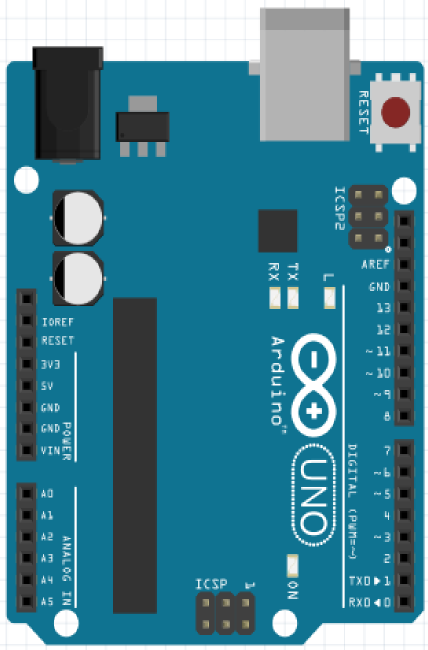
[7] Krishna Kumar (2014). *Development of Walk Safe Cane For The Rehabilition Of Blind People*, Bachelor Degree National Institute Of Technology Rourkella.

APPENDIX A

Appendix A : Arduino Uno Pinout Diagram

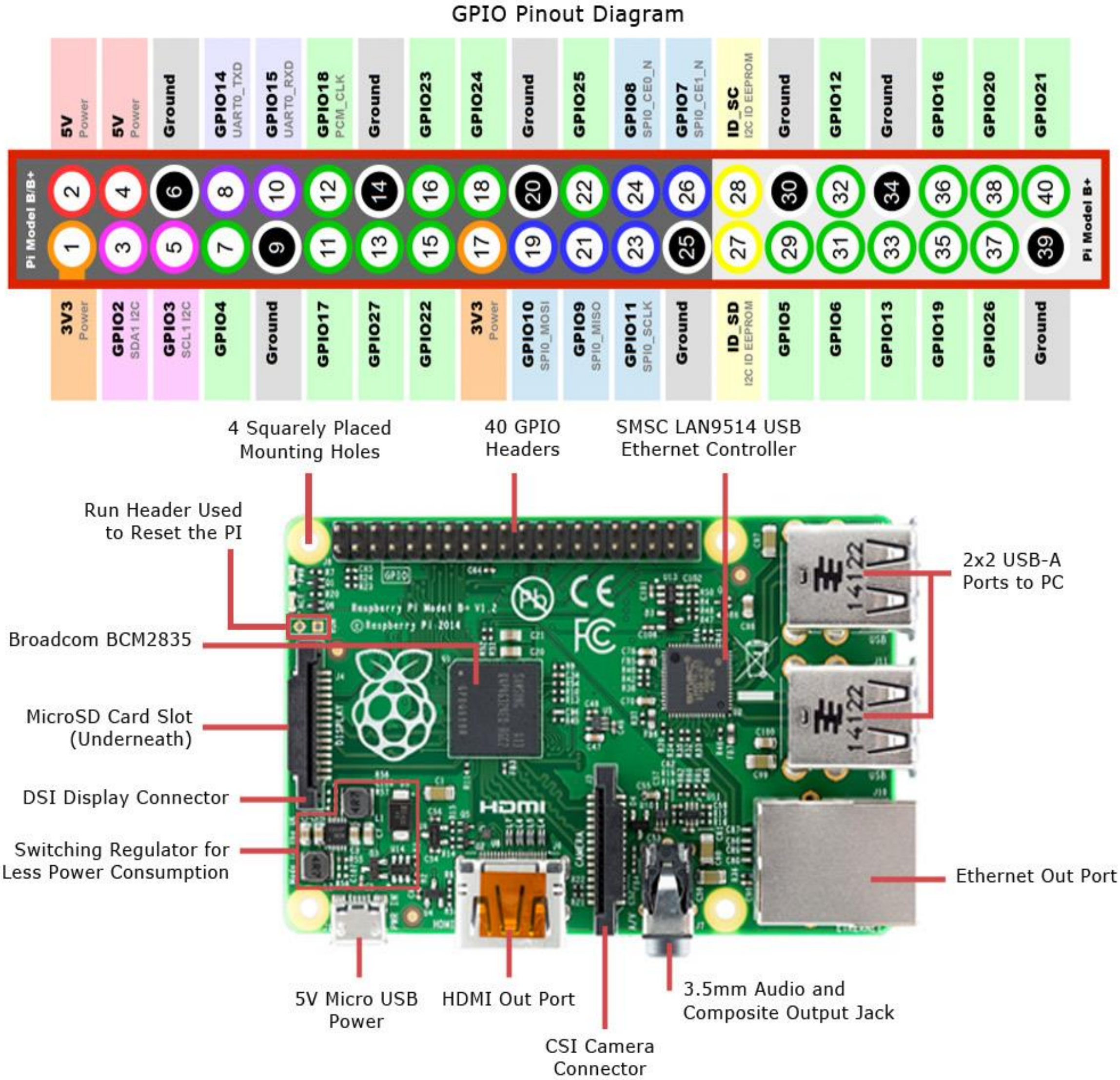


MCU : Atmega 328
Input voltage : 7V-12V
Operating voltage : 5V
CPU Speed : 16MHZ
Analog In/Out : 6/0
Digital IO/PWM :14/6
EEPROM : 1KB
SRAM : 2KB
Flash : 32KB
UART : 1
USB : Regular



ARDUINO PIN		MICROCONTROLLER PIN
0	-	PD0(RXD)
1	-	PD1(TXD)
2	-	PD2(INT0)
3	-	PD3(INT1)
4	-	PD4
5	-	PD5
6	-	PD6
7	-	PD7
8	-	PB0
9	-	PB1
10	-	PB2(SS')
11	-	PB3(MOSI)
12	-	PB4(MISO)
13	-	PB5(SCK)
A0	-	PC0
A1	-	PC1
A2	-	PC2
A3	-	PC3
A4	-	PC4(SDA)
A5	-	PC5(SCL)

Appendix B: Raspberry Pi 2 Model B Pinout Diagram



Appendix C : Installation instructions of OS on Raspberry Pi

This resource explains how to install a Raspberry Pi operating system image on an SD card. You will need another computer with an SD card reader to install the image.

We recommend most users download NOOBS, which is designed to be very easy to use. However, more advanced users looking to install a particular image should use this guide.

Download The Image

Official images for recommended operating systems are available to download from the Raspberry Pi website (https://raspberrypi.org) Downloads page.

Alternative distributions are available from third-party vendors.

If you're not using Etcher (see below), you'll need to unzip .zip downloads to get the image file (.img) to write to your SD card.

Note: The Raspbian with PIXEL image contained in the ZIP archive is over 4GB in size and uses the ZIP64 format. To uncompress the archive, a unzip tool that supports ZIP64 is required. The following zip tools support ZIP64:

- 7-Zip (Windows)
- The Unarchiver (Mac)
- Unzip (Linux)

Writing An Image To The Sd Card

You will need to use an image writing tool to install the image you have downloaded on your SD card.

Etcher is a graphical SD card writing tool that works on Mac OS, Linux and Windows, and is the easiest option for most users. Etcher also supports writing images directly from the zip file, without any unzipping required. To write your image with Etcher:

- Download Etcher and install it.
- Connect an SD card reader with the SD card inside.
- Open Etcher and select from your hard drive the Raspberry Pi .img or .zip file you wish to write to the SD card.
- Select the SD card you wish to write your image to.
- Review your selections and click 'Flash!' to begin writing data to the SD card.

Installing Operating System Images Using Windows

WIN32DISKIMAGER

- Insert the SD card into your SD card reader. You can use the SD card slot if you have one, or an SD adapter in a USB port. Note the drive letter assigned to the SD card. You can see the drive letter in the left hand column of Windows Explorer, for example **G:**
- Download the Win32DiskImager utility from the [Sourceforge Project page]() as an installer file, and run it to install the software.
- Run the `Win32DiskImager` utility from your desktop or menu.
- Select the image file you extracted earlier.
- In the device box, select the drive letter of the SD card. Be careful to select the correct drive: if you choose the wrong drive you could destroy the data on your computer's hard disk! If you are using an SD card slot in your computer, and can't see the drive in the Win32DiskImager window, try using an external SD adapter.
- Click 'Write' and wait for the write to complete.
- Exit the imager and eject the SD card.

Installing Operating System Images On Linux

DISCOVERING THE SD CARD MOUNTPOINT AND UNMOUNTING IT

- Run `df -h` to see which devices are currently mounted.
- If your computer has a slot for SD cards, insert the card. If not, insert the card into an SD card reader, then connect the reader to your computer.
- Run `df -h` again. The new device that has appeared is your SD card. If no device appears, then your system is not automounting devices. In this case, you will need to search for the device name using another method. The `dmesg | tail` command will display the most recent system messages, which should contain information on the naming of the SD card device. The naming of the device will follow the format described in the next paragraph. Note that if the SD card was not automounted, you do not need to unmount later.

- The left column of the results from `df -h` command gives the device name of your SD card. It will be listed as something like `/dev/mmcblk0p1` or `/dev/sdX1`, where X is a lower case letter indicating the device. The last part (`p1` or `1` respectively) is the partition number. You want to write to the whole SD card, not just one partition. You therefore need to remove that section from the name. You should see something like `/dev/mmcblk0` or `/dev/sdX` as the device name for the whole SD card. Note that the SD card can show up more than once in the output of `df`. It will do this if you have previously written a Raspberry Pi image to this SD card, because the Raspberry Pi SD images have more than one partition.
- Now you have noted the device name, you need to unmount it so that files can't be read or written to the SD card while you are copying over the SD image.
- Run `umount /dev/sdX1`, replacing `sdX1` with whatever your SD card's device name is, including the partition number.
- If your SD card shows up more than once in the output of `df`, this shows that the card has multiple partitions. You should unmount all of these partitions.

Copying The Image To The Sd Card

In a terminal window, write the image to the card with the command below, making sure you replace the input file `if=` argument with the path to your `.img` file, and the `/dev/sdX` in the output file `of=` argument with the correct device name. This is very important, as you will lose all the data on the hard drive if you provide the wrong device name. Make sure the device name is the name of the whole SD card as described above, not just a partition. For example: `sdd`, not `sdds1` or `sddp1`, and `mmcblk0`, not `mmcblk0p1`.

```
dd bs=4M if=2017-04-10-raspbian-jessie.img of=/dev/sdX
```

- Please note that block size set to `4M` will work most of the time. If not, try `1M`, although this will take considerably longer.
- Also note that if you are not logged in as root you will need to prefix this with `sudo`.
-

Copying A Zipped Image To The Sd Card

In Linux it is possible to combine the unzip and SD copying process into one command, which avoids any issues that might occur when the unzipped image is larger than 4GB. This can happen on certain filesystems that do not support files larger than 4GB (e.g. FAT), although it should be noted that most Linux installsations do not use FAT and therefore do not have this limitation.

The following command unzips the zip file (replace 2017-04-10-raspbian-jessie.zip with the appropriate zip filename), and pipes the output directly to the dd command. This in turn copies it to the SD card, as described in the previous section.

```
unzip -p 2017-04-10-raspbian-jessie.zip | sudo dd of=/dev/sdX
bs=4096
```

Checking Whether The Image Was Correctly Written To The Sd Card

- After `dd` has finished copying, you can check what has been written to the SD card by `dd`-ing from the card back to another image on your hard disk; truncating the new image to the same size as the original; and then running `diff` (or `md5sum`) on those two images.
- If the SD card is bigger than the original image size, `dd` will make a copy of the whole card. We must therefore truncate the new image to the size of the original image. Make sure you replace the input file `if=` argument with the correct device name. `diff` should report that the files are identical.

```
• dd bs=4M if=/dev/sdX of=from-sd-card.img
• truncate --reference 2017-04-10-raspbian-jessie.img from-sd-
  card.img
```

```
diff -s from-sd-card.img 2017-04-10-raspbian-jessie.img
```

- Run `sync`. This will ensure the write cache is flushed and that it is safe to unmount your SD card.
- Remove the SD card from the card reader.