Dedication

I commit this venture to God Almighty my maker, my solid column, my wellspring of motivation, astuteness, information and comprehension. He has been the wellspring of my quality all through this program and on His wings just have I took off. I likewise commit this examination tenderly to My Mum and Father .

Acknowledgements

I have taken lots of effort to finish this dissertation, which I wouldn't have been able to finish without the help I received.

First of all, I would like to thank my supervisor Dr. Ebtihal Haider Gismalla Yousif, for giving information and steady supervision all throughout the journey. Her redirections, inspiration and constructive criticism has helped me extremely.

Furthermore, I might want to demonstrate my appreciation to my family. Their support and consolation have roused me to complete this venture. Also, I might want to thank my folks to be comprehended amid the venture improvement time.

Finally, I would like to acknowledge the great help I received from my companions. Their consultations has helped me to take care of the issues confronted in the venture.

Abstract

This research highlights new innovation and hope for the blind. It demonstrates that we can move on from the simple stick to a more reliable, efficient product. This research develops an Electronic Cane as a mobility aid for the blind (or partial sighted) by using the concept of the ultrasonic waves and Global Positioning System/Global System for Mobile (GPS/GSM) modules. This embedded system mainly has two parts, mobility and navigation system. For the mobility system, it is equipped with an ultrasonic sensor and a vibrating motor. The ultrasonic sensor will send the trigger pulse to detect obstacles. When an obstacle is detected, signals will be sent to the vibrating motor and activate it. For the navigation system, the global positioning system (GPS) is used to get real time coordinates and then will be sending the location information to the Arduino continuously. The Global System for Mobile module is used to transmit the blind location to a preferred mobile number for the blind. Throughout the dissertation, the proposed implementation will be described and the designed prototype will be presented.

Abstract

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List of Abbreviations

API	Application program interface
DC	Direct Current
DDR	Double Data Rate
EEP-ROM	Electrically Erasable Programmable Read Only Memory
GPRS	General Packet Radio Service
GPS	Global Positioning System
GSM	Global System Mobile
ICSP	In-Circuit Serial Programming
INSTICK	intelligent walking stick
LOS	Line Of Sight
NOD	Nottingham Obstacle Detection
PCB	Printed Circuit Board
RISC	reduced instruction set computer
SIM	Subscriber Identity Module (ETSI GSM technical specification)
SMC's	Smart Mobility Cane
SMS	Short Message Service
STMS	Smart Transportation Management system
TTL	Transistor-Transistor Logic
UART	Universal A synchronous Receiver and Transmitter

USART	Universal Synchronous A synchronous Receiver and Transmitter
WHO	the World Health Organization

1 Chapter One: Introduction

1.1 Overview

Out of a number of severe disabilities, blindness is one of them which a person is bound to bear despite of a number of technological advancements. The World Blind Union (WBW), in the year 2009, released a statistics, which shows that number of 160 million blind and partially sighted persons living throughout the globe [1]. Blindness is a type of disability in which the sufferer needs a continuous assistance even for the most basic needs of the life. An individual, how much attentive he may be, some way or the other will fail to attend the blind person at several occasions and therefore rehabilitation for this particular disability has been a challenge and is resistant to the benefits of the limited rehabilitation techniques present . Despite of such challenges there are a large number of people who use the traditional white cane for their assistance. White cane has been in use since decades. White cane has its own limitations. It has a very short range of detection and detects obstacles only below waist height. It also doesn't provide information about the geographical surrounding [1].

1.2 Problem Statement

The traditional white cane lack of intelligent technology to improve the living standard of blind people. Blinds people need some aid to interact with their environment with more security to perform their daily tasks. By designing this smart cane, blind people are able to detect obstacles more efficiently.

1.3 Proposed Solution

This thesis presents a simple concept and design for a travel aid for the visually impaired. A new device is then proposed to enable them to see the world with their senses. The proposed device uses ultrasonic signal in sensing and detecting an object (obstacles). This Design should has reasonable prices as proposed on this work.

1.4 Objectives

1. To build a smart cane contains two part Hardware and software.
2. To create methods to obtain information from the surroundings in order to detect obstacles
3. To implement a navigation system using Global positioning system and Global system for Mobile to increase the mobility of a blind person more safe .
4. To implement the device using a supported rechargeable power supply.

1.5 Methodology

In order to complete this research smoothly, a lot of research work on electronic white cane was required such as going through reference books, journals, internet resources and components datasheets so that will assist in the success of the research. The system consists of hardware and software.The Hardware components which are needed to construct the system are:

1. The Ultrasonic ranging module HC - SR04.
2. GPS Modules .
3. GSM Modules
4. Arduino .
5. Buzzer and Vibrating motor

A portable user friendly device is developed that can identify the obstacles in the path using ultrasonic sensors . Ultrasonic sensors can scan three different directions (at 180 Degree). The buzzer and vibration motor is activated when any obstacle is detected. GPS system provides the information regarding to his current location. SMS system is used by the blind to send SMS message to the saved numbers in the microcontroller in case of emergency. The Software parts subprograms, perform the job, the language selected in this research is Arduino C program because it's easy to use and the instructions are not complex (see Appendix A).

1.6 Thesis organization

This dissertation consists of five Chapters. Chapter one is the introduction to the thesis. Chapter two provides the background and literature review. Chapter three is explains the system implementation . Chapter four presents implementations, simulations and results. Lastly , Chapter five provides conclusions and recommendations

2 Chapter Two: Background and Literature Review

2.1 Background

Globally, the number of people of all ages living with sight loss is estimated to be 285 million, of whom 39 million are blind according to the World Health Organization (WHO) . Among many constraints faced by a blind person, the challenge of independent navigation and mobility is prominent. Generally visually impaired people rely on assistance of sighted persons to find their way or need an accompanying person to follow; at least during a training period. This means that the majority of visually impaired people cannot find their way autonomously in an unknown area. Generally visionless persons use a white cane or walking cane. A white cane is a mechanical device dedicated to detect static obstacles on the ground, holes, uneven surfaces, steps and other hazards via simple tactile-force feedback. Its light weightiness and the capability to be folded into a small piece can be advantageous to carry around when not required. These simply designed canes are only capable of detecting below waistline obstacles like street curves, steps and staircases and simple guidance between distances. Although these canes are capable of detecting obstacles, receiving feedback is very low. Therefore visually impaired individuals still find it difficult to navigate especially in unknown milieu [2].

2.2 Related Work

A huge number of research works are being performed in various institutions across the globe to provide with a cost effective and efficient navigation aid for the blinds. Initially the visually impaired persons were assisted by sighted persons for their basic needs and mobility then came the era of guiding dogs. Guiding dogs are trained dogs and they help the blind person for an assisted mobility. But this solution was not effective. White cane is regarded as world's most widely used navigation aid for blinds. White cane can detect obstacles present on the ground, pits, puddles, uneven surfaces and also steps . White canes are made up of very light materials and provide an ease of carrying it as it is foldable and easily fits into ones pocket . As a result, the initial cost for white cane is very less. But speaking of overall cost, the case is not the same. A user requires a practice session of about 100 hours to get comfortable with the device so that he can walk safely and properly. Now the 100 hours" investment is considered the extra cost which is very high[1] .

In [1], Kumar presented Laser cane : It was introduced in 1973 by Benjamin et al. It is based on optical triangulation by three laser diodes and three photodiodes acting as receivers. These photodiodes are silicon photodiodes. The cane is capable of detecting obstacles at head level, ground level as well as in-front of the user. The device can detect obstacles in between a range of 1.5-3.5 m ahead of the user. There are several disadvantages attached with use of a laser cane. The use of laser cane can be harmful if proper precautions are not taken and can affect the eyes of an individual without any proper eye wear. The photodiodes used at the receiving ends are most likely to respond to various ambient sources, the sun light etc. Moreover, in hot and smoky areas the efficiency of the cane droops drastically . The Mowat sensor and the Nottingham obstacle detector (NOD) both are hand held devices used for obstacle detection. The Mowat sensor uses ultrasonic based distance measurement system whereas the NOD is a sonar device. Mowat sensor requires engaging both hands of the user for an effective scanning for the obstacles. . Another sonic system is Kaspa. It is much complex system consisting of a sweep FM ultrasound emitter and three sensors which are purposefully displaced. The echo signal is rich in obstacle information and when received can be used to extract various properties of the obstacle. The frequency of the obstacle is inversely proportional to the range .

The study in [2] , considered This project aims at the design and development of a detachable unit which is robust, low cost and user friendly, thus, trying to aggrandize the functionality of the existing white cane, to concede above-knee obstacle detection as well as below-knee detection. The designed mobility stick which is low cost, sturdy, and robust can be easily operated uses ultrasound sensors for detecting the obstructions before direct contact. It offers haptic feedback to the user in accordance with the position of the obstacle.

The study in [3], considered electronic travel aid device consist usually available ultrasonic sensor to detect obstacles on the way within a distance of two to three meters. It transmits ultrasound beams at a regular time interval. If any object is present on the way, the emitted ultrasound will be reected back to the sensor. The discrete distance of the object is then measured according to discrete levels of 1, 2 and 3 meter and sensed by tactile vibrators. In addition to this, device is to give information about water pits in the traveling path which is sensed by audio signal. This design is focused on low power consumption, small size, lightweight, and easy manipulation. The main functions of this system are the clear path indication and the environment recognition.

In[4], Moghavvemi presents a simple concept and design for atravel aid for the visually impaired. The proposed device uses ultrasonic signal in sensing and detecting an object (obstacles). The aid can inform the user about the distance of the detected obstacles by means of tactile vibrations. A PIC micro- controller is used to control the transceiver and process the received signal to an audible format through speech synthesizer. The current prototype version of INSTICK has been tested in laboratory conditions and is successful at its major purpose of identifying potential hazards at ranges of one to three meters.

In [5] ,Leduc-Mills etal., presented the design, implementation, and early results of ioCane, a mobility aid for blind cane users that uses detachable cane-mounted ultrasonic sensors connected to a circuit board to send contextual data wirelessly to an Androidphone application. The ioCane, a mobility aid for the blind, is the first system to integrate an ultrasonic sensor array with Android phones. Obstacle avoidance is achieved through haptic and audio feedback that correspond to the distance and height of an approaching object. These also present novel algorithms for dynamically determining the cane angle to the ground, estimating the canes location in space, and calculating the height of interfering objects based on sensor data and the user's height. A user study with blind cane users revealed a 47.3 percent improvement in obstacle avoidance after only 30 minutes of train-

ing time, a fraction of the normal training given to blind cane users.
In [6] , Shi purposed to design a smart cane with ultrasonic sensor and global positioning system for the blind. This embedded system mainly has two parts, mobility and navigation system. For mobility system, it is equipped with ultrasonic sensor, HCSR04 and vibrating motor. Ultrasonic sensor will send the trigger pulse to detect obstacles. When an obstacle is detected, signals will be sent to vibrating motor and activate it. The vibrating motor will vibrate with different strengths according to the distance of the obstacle. For navigation system, the SKM53 global positioning system is used to get real time coordinates. Geocoding is used to convert address into coordinates. The coordinates will be sent to Arduino UNO through Processing and save in the Electrically Erasable Programmable Read Only Memory (EEP- ROM) of Arduino. Way-points technique is used to calculate the distance and direction from location A to location B. The result of navigation in terms of distance and direction will be performed by text to speech on Processing platform.
In [7], Abd Wahab et al., presented to discuss the development work of a cane that could communicate with the users through voice alert and vibration, which is named Smart Cane which involves coding and physical installation. The main purpose of this study is to produce a prototype that can detect objects or obstacles in front of users and feeds warning back, in the forms of voice messages and vibration, to users. This study would recommend that a power supply meter reading can be installed to monitor its power status.
In [8], Ivanchenko et al,.presented to describe a system for guiding blind and visually impaired wheelchair users along a clear path that uses computer vision to sense the presence of obstacles or other terrain features and warn the user accordingly. Since multiple terrain features can be distributed anywhere on the ground, and their locations relative to a moving wheelchair are continually changing, it is challenging to communicate this wealth of spatial information in a way that is rapidly comprehensible to the user. The main contribution of our system is the development of a novel user interface that allows the user to interrogate the environment by sweeping a standard (unmodified) white cane back and forth: the system continuously tracks the cane location and sounds an alert if a terrain feature is detected in the direction the cane is pointing. Experiments are described

demonstrating the feasibility of the approach. One of the few commercial devices targeted at this population is a version of the laser cane by Nurion Inc., which is rigidly mounted on thearm of a wheelchair . The laser's fixed pencil beam severely limits its field of view, while four added ultrasonic sensors detect only large, tall obstacles within one foot. White canes are often used by visually impaired wheelchair riders, who scan the area around the chair while it is moving . The focus of this paper is a novel user interface we have developed for efficiently and intuitively communicating terrain information from a computer vision-based range sensor to a wheelchair user . This interface continuously tracks the location of the user's white cane and sounds an alert if a terrain feature (such as an obstacle, wall or curb) is detected in the direction the cane is pointing. The goal is to provide an intuitive method for extending the "reach" of the cane, without requiring any alterations to the cane or the environment.

In [9], S.Ram and J.Sharf presents Electronic Travel Aids, which transform visual environmental cues into another sensory modality, have been proven to help visually impaired people travel with a greater degree of psychological comfort and independence. The People Sensor is an Electronic Travel Aid designed to address two issues of importance to visually impaired people: inadvertent cane contact with other pedestrians and objects, and speaking to a person who is no longer within hearing range. The device uses pyroelectric and ultrasound sensors to locate and differentiate between animate (human) and inanimate (non-human) obstructions in the detection path. The distance between the user and the obstruction, along with the nature of the obstruction (human or non-human) is transmitted via modulated vibrotactile feedback. Armed with advance knowledge of the presence and location of objects and people in the environment, users of The People Sensor can travel with increased independence, safety and confidence. The device also measures the distance between the user and the obstruction. The user receives this information via vibrotactile actuation. Two types of vibration are used , one to represent a person in the detection field, another to represent an inanimate object. These is hope that The People Sensor will be an effective, low cost solution for reducing travel anxiety for visually impaired users.

In [10] ,Kanagaratnam presents Among many constraints faced by a blind person, the challenge of independent mobility is the paramount. Widely, the white cane is the most popular tool for mobility aid, but it also has constrains too. The Smart Mobility Canes(SMC's) Obstacle Detection division has implemented a cane to detect and measure the distance of any obstacles present in knee-above areas. This is based on an Ultrasonic Range Finder sensor which can acquire range data's between any obstacle and the user within 2.5 meters. Using the LABVIEW (visual programming language), the URF sensor (SRF05) is triggered with minimum 10uS pulse every 250 millisecond to start the range. Simultaneously, data of echo pulse generated from the output of the sensor is acquisitioned to calculate the distance of the obstacle. At the end, the range of distance is numerically displayed in real-time on the LABVIEW block diagram. The distance of the obstacle is then used by SMC's Signal Integration division to alert the user depending on the range. The Smart Mobility Cane is an integration of obstacle detection sensor, heat detection sensor, vibration grip and white cane. It allows blind people to recognize any obstacles or heat objects in the direction where cane is pointed and it allows real-time feedback to the user with the vibration transducers attached on the grip. Using the Ultrasonic Range Finder sensor, the obstacle within 2.5 meters away from the cane is detected.

In [11] ,Kang etal.,presented An intelligent guide stick for the blind was developed. It consists of an ultrasound displacement sensor, two DC motors, and a micro-controller. The total weight is 4.0kg, and the width and the height of the guide stick are 24cm and 85cm, respectively. Computer simulations were performed in order to find the traces of the guide stick at three different paths using an in-house Visual C++ software. Actual experiments were also performed to compare with the computer simulation results. The difference between the actual experiment and the simulation was 1.19cm in the straight path. However, the difference after the first 90o turn was 9.3cm and became 11.9cm after the second 90o turn. Nevertheless, the intelligent guide stick followed the path of the road successfully avoiding the obstacle. The intelligent guide stick will help the blind travel with providing more convenient means of life. The purpose of the present study is to develop a simple robot-type guidance system for the blind which traces the position of the moving guide stick, using an ultrasonic sensor and two encoders, and to determine whether the blind moves safely. An intelligent guide stick for the blind was developed in the present study. This guide-

stick system used the ultrasonic sensor for detecting both back-and-front obstacles and left-and-right obstacles, and applied the artificial intelligence for avoiding the obstacle. Through various experiments, it was shown that this system could be applied in the straight path, the right angle path, and the curved path. At least 1m width was required for the proper management of the guide stick. The adaptation training of the actively controlled guide stick is not needed but the response of the blind is instantaneous.
In [12] ,Sheth etal., presented to provide a simple, affordable yet an efficient solution for the visually impaired. The idea behind the design of the stick was to keep it structurally similar i.e. thin, lightweight and easy to handle, yet give an active feedback to the user regarding hazards in his walking path. The smart white cane uses the ultrasonic sensors arranged in such a way that it detects pits, potholes, downfalls, a staircase (up and down), low lying and knee level obstacles and even those above the waist. The user is notified about the same by the pre-recorded sound messages and a haptic feedback in form of vibrations. This can considerably alleviate the risk of the user injuring himself. The smart white cane is a practically feasible product and convenient to carry around like any other walking stick. Future Scope: A global positioning method will used to find the position of′ the user using the global positioning system (GPS) and guidance to their destination will be given to the user by voice navigation.
In [13] S.Dambhare and A.Sakhare presents a theoretical model and a system concept to provide a smart electronic aid for blind people. The system is intended to provide overall measures Artificial vision and object detection ,real-time assistance via global positioning system(GPS).The system consist of proximity sensors, ultrasonic sensors , gps module, stereo cameras and dual feedback system- auditory as well as vibratory circuit. The aim of the overall system is to provide a low cost and efficient navigation aid for blind which gives a sense of artificial vision by providing information about the environmental scenario of static and dynamic objects around them. Apart from the conventional navigation systems , a blind aid systems can be provided a new dimension of Real-time assistance and Artificial vision alongwith dedicated obstacle detection circuitry. This different units are discussed to implement the design of a 'Smart stick' for blind. The GPS Based blind device with user in put interfacing get alert the blind person when reaches his destination by voice .This consists of microcon-

troller and GPS and one voice module to generate the voice.pic The Micro controller is the heart of the device. It stores the data of the current location which it receives from the GPS system. So that it can make use of the data stored to compare with the destination location of the user. By this it can trace out the distance from the destination and produce an alarm to alert the user in advance. The proposed combination of various working units makes a real-time system that monitors position of the user and provides dual feedback making navigation more safe and secure. The paper proposed the design and architecture ,of a new concept of Smart Electronic Travel Stick for blind people. The advantage of the system lies in the fact that it can prove to be very low cost solution to millions of blind person worldwide. The proposed combination of various working units makes a real-time system that monitors position of the user and provides dual feedback making navigation more safe and secure.

The study in [14], considered the evolution in transportation technologies makes the necessity for increasing road safety. In this context, these propose the implementation of a smart onboard GPS/GPRS system to be attached to vehicles for monitoring and controlling their speed. In case of traffic speed violation, a GPRS message containing information about the vehicle such as location and maximum speed is sent to a hosting server located in an authorized office so that the violated vehicle is ticketed. Moreover, this system can also track the vehicle's current location on a Google Map, which is mostly beneficial when vehicles should follow a specific road and in case of robbery. Also geo-casting can have a major role in this model. Some sensors, such as shock/vibration sensor usually attached to the air-bags in vehicles, are attached to the system that in case of accident, it will send notifications to the nearest hospital, police station and civil defense. Our proposed model can be utilized for different implementations, both in public and private sectors. While similar existing systems in Palestine have focalized just on the tracking aspect of vehicles' monitoring, it would be the first system supporting both ticketing and tracking. In this work, a Smart Transportation Management System (STMS) based on GSM, GPS and large array of smart sensors integration has been developed for enhancing public and private transportation services. The system is composed of an embedded microcontroller based smart board called Smart-Board, a Cloud based web application and Google MAP Services .Our proposed model performs online monitoring, ticketing and tracking. Moreover, our module supports geo-casting features. The geo-casting function is activated if an accident occurs in a certain area, all the vehicles within a range of specific geographical coordinates will receive a message to choose another road trip. So, traffic jamming and unnecessary delays can be avoided and help in saving time and money. GPS receiver is used to determine the position and speed of vehicles. The location is used for tracking, while the measured speed is to be compared with a limited, predetermined value stored in the microcontroller, extracted from legal maps. When the vehicle's speed is approaching the specified limit, alarm will go on to warn the driver. If the driver does not slow down, and the speed is still increasing and exceeding the maximum allowed speed, GPRS packet containing the speed will be sent to the hosting server. The ticket will be registered at the server side. Moreover, SMS will invoice the driver about his ticket. Because, GPS signal requires Line Of Sight (LOS), in case, there is no valid GPS signal , accelerometer is used to measure the vehicle's speed. In [15], Lee etal.,presented an efficient vehicle traking system is design and implemented for traking the movement of any aquipped vehicle from any location at any time . the proposed system made good use of popular technology that combines a Smartphone application with microcontroller. This will be easy to make and inexpensive compared to others.The design in vehicle device works using Global Positioning System (GPS) and Global system for mobile communication / Genral Packet Radio Service(GSM/GPRS) technology that is one of the most common ways for vehicle tracking . The device is embedded inside a vehicle whose position is to be determined and tracked in real time. A microcontroller is used to control the GPS and GSM/GPRS modules.The vehicle tracking system uses the GPS module to get geographic coordinates at regular time intervals. The GSM/GPRS module is used to transmit and update the vehicle location to database .A smartphone application is also developed for continuously monitoring the vechicle location . The Google Maps API is used to display the vechicle on the map in the smartphone application.Thus, users will be able to continuously monitor a moving vehicle on demand using the smartphpone application and determine the estimated distance and time for the vehicle to arrive at a given destination . In orde to show the feasibility and effectiveness of the system , this paper presents experimental results of the vehicle tracking system and some experiences on practical implementation.

2.3 Contributions

The configurations presented in this are as follows modify an white cane to be compatible with recent technology by using ultrasonic sensor , GPS and GSM modules to enable the blind to communicate with the home making his/her navigation more safe and secure.

2.4 Summary

Apart from these a number of other devices were also developed but unfortunately they could not get enough popularity. The An Obstacle-Aware Global Position System /Global System for Mobile Enabled Electronic White Cane uses ultrasonic signal in sensing and detecting an object (obstacles) and also sensed by tactile vibrators. In this proposed system developes a new device by adding GPS module and GSM module . GPS module is used when a blind person wants to determine its location and also allows him to send the coordinates of the location provided by the global positioning system module to any phone in the house by the Global system for mobile communication.

3 Chapter Three: System Implementation

3.1 Introduction

This chapter will focus on the discussion on the project flow and the method to implement this project, Hardware devices will be discussed as well. This embedded system mainly has two parts, mobility and navigation system. For mobility system, it is equipped with ultrasonic sensor, HCSR04 and vibrating motor. Ultrasonic sensor will send the trigger pulse to detect obstacles. When an obstacle is detected, signals will be sent to vibrating motor and activate it. For navigation system, the global positioning system (GPS) is used to get real time coordinates and then will be sending the location information to the Arduino continuously . The Global System for Mobile (GSM) module is used to transmit the blind location to a preferred mobile number for the blind.

3.2 Project Overview

This project mainly consists of two parts, hardware design and software design. Hardware design consists of four parts major : Arduino UNO is used as a microcontroller for embedded system. The ultrasonic sensor is characterized to sense obstacles and send the feedback to vibrating motor , In addition, the proposed system uses GPS and GSM modules to enable the blind to communicate with the home or preferred mobile number during emergency and follow up him/her. The GPS/GSM module is interfaced to the Arduino to detect the blind person location. The GPS recall and sending the location information to the Arduino continuously. The same information will be routed to the GSM modem through the Arduino microcontroller. The GSM will forward this information to a preferred mobile

number for the blind.
Software design is mainly controlled by using Arduino C programming. Processing is used to interface with the Arduino .

Figure 3.1: Overall design flow of An Obstacle-Aware Global Position System /Global System for Mobile Enabled Electronic White Cane

Figure 3.1 shows that the overall system components. The input of the system consists of signal from ultrasonic sensor and address of a location. Arduino UNO will interface with GPS system to get the real time coordinates and then GSM to send message. The signal from ultrasonic sensor will be sent to vibrating motor. The result of navigation system will be sent to smartphone [6].

3.3 Project flow

Figure 3.2 shows the method and design throughout the project. The literature review and documentation will be kept updated throught the project. For hardware and software implementation, testing.

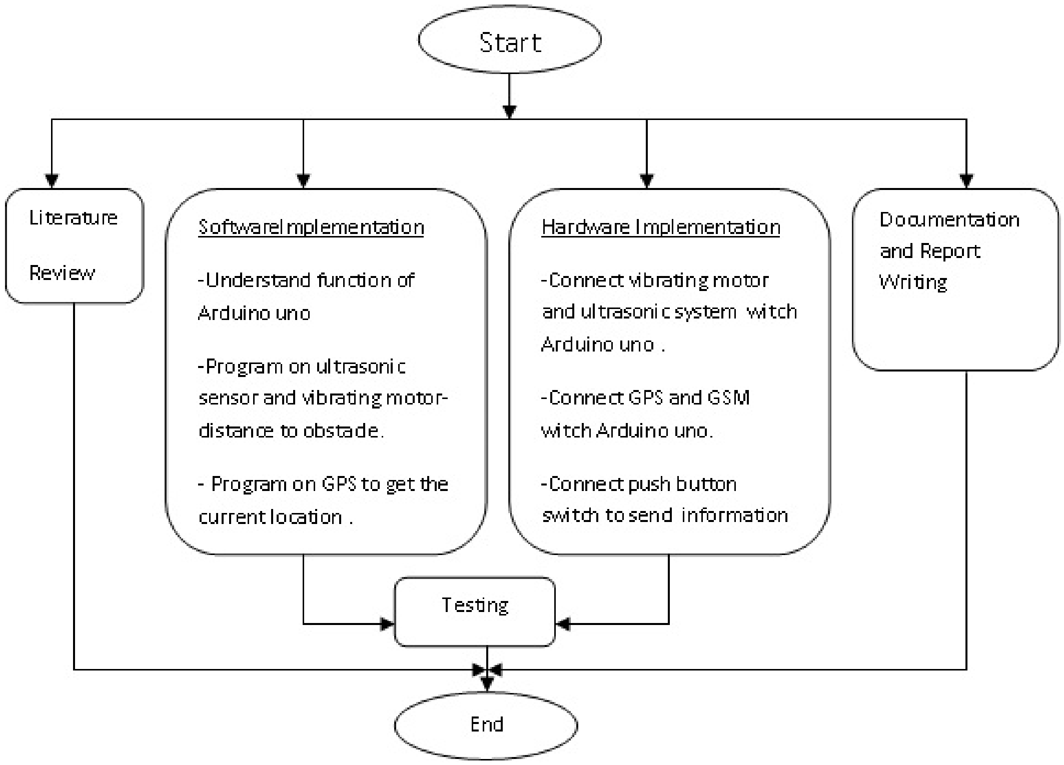

Figure 3.2: Flow of project

3.4 The Proposed System

Our proposed system allows blind and visually impaired people to travel through familiar and unfamiliar environments without the assistance of guides. The block diagram of our proposed system, as shown in figure 3.3, consists of eight blocks: ultrasonic sensors, Arduino uno microcontroller, vibrating motor, GPS/ GSM module, Push button switch, buzzer and power supply. The system gathers data about the environment using the ultrasonic sensors to the microcontroller. The microcontroller extracts the visual information from the data by executing a certain program stored in it. This visual information is then transformed into vibration by the Vibrating motor . The GPS/GSM module is interfaced to the microcontroller to detect the blind person location. The GPS will be sending the location information to the microcontroller continuously. The same information will be routed to the GSM modem through the microcontroller. The GSM will forward this information to a preferred mobile number for the blind when the switch is close and then the microcontroller will be indicator the message have been send by buzzer .

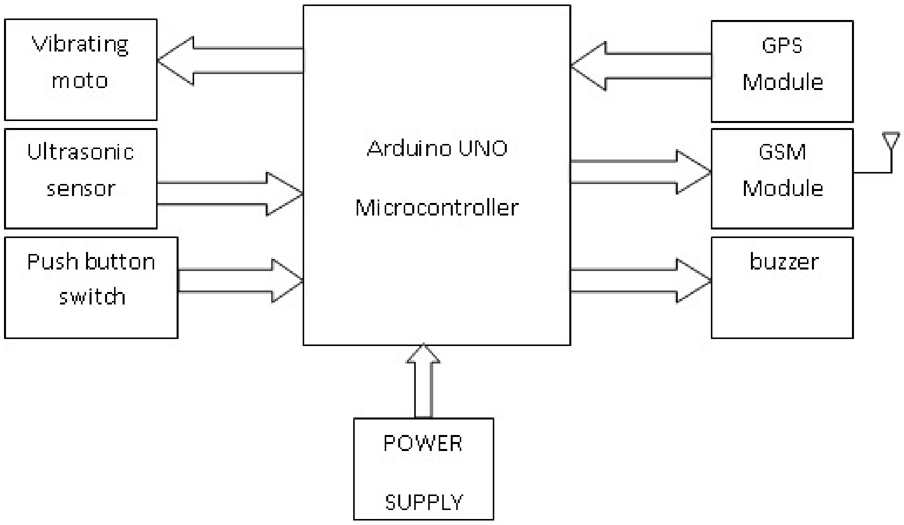

Figure 3.3: System block diagram

3.5 Materials

3.5.1 Microcontroller

Microcontroller is built by a single integrated circuit. It consists of processor core, memory and programmable input and output peripherals. Figure 3.4 shows the overall operation system in a microcontroller [6].

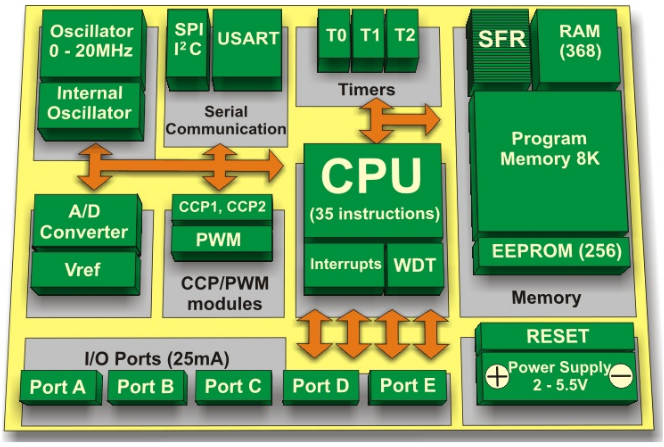

Figure 3.4: Microcontroller architecture [6]

3.5.1.1 Arduino UNO

Arduino UNO is the microcontroller that is used in this project. It is built based on ATmega328 in AVR 8 bit RISC architecture. It has 6 analog inputs, 14 digital input output port, a USB connection, 16MHz ceramic resonator, power jack and an ICSP connector. It consists of 1 KB of EEPROM memory which can be read and writen. Communication in Arduino UNO is using UART TTL serial communication [6].
Figure 3.5 shows the input and output ports and features that are built in the Arduino Uno.

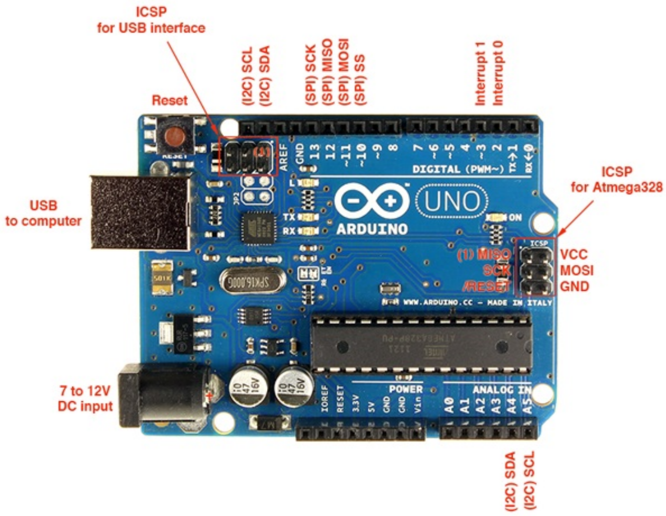

Figure 3.5: Arduino UNO R3 pinouts [6]

3.5.1.2 Port Register

In this project, digital input and output port of Arduino UNO is used to connect to the embedded system. The ports used are Port B and Port D. DDR register in ATmega328 is used to determine the connection of input or output by setting the connection to high or low.Table 3.1 show the Specifications of Arduino UNO .

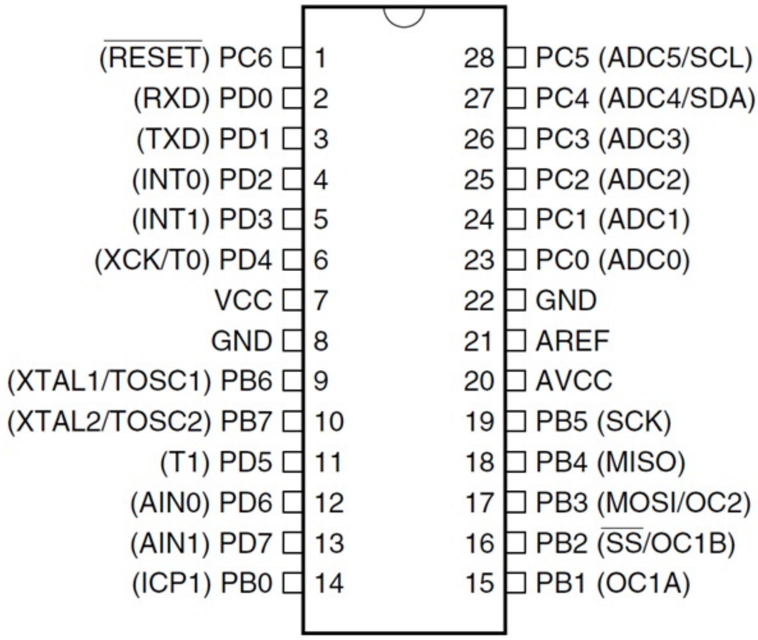

Figure 3.6: ATmega328 ports [6]

Figure 3.6 shows the analog and digital input/output ports that are built in the ATmega328.

Table 3.1: Specifications of Arduino UNO [1]

microcontroller	ATmega328
operating voltage	5V
input voltage (recommended)	7-12 V
input voltage (limits)	6-20 V
Digital I/P Pins	14 (of which 6 provide PWM output)
Anlog input Pins	6
DC Current per I/O Pin	40 mA
DC Current for 3.3 V	50 mA
Flash memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EPROM	1 KB (ATmega328)
clock speed	16 MHZ

3.5.1.3 Arduino Advantages

1. Ready to Use: The biggest advantage of Arduino is its ready to use structure. As Arduino comes in a complete package form which includes the 5V regulator, a burner, an oscillator, a micro-controller, serial communication interface, LED and headers for the connections. You don't have to think about programmer connections for programming or any other interface.

2. Examples of codes:

   Another big advantage of Arduino is its library of examples present inside the software of Arduino.

3. Simple, clear programming environmentOpen source- Simplified and user-friendly programming language- Portable- Low power consumption .

4. Effortless functions:

   During coding of Arduino, you will notice some functions which make the life so easy. Another advantage of Arduino is its automatic unit conversion capability.

5. Large community:

   There are many forums present on the internet in which people are talking about the Arduino. Engineers, hobbyists and professionals are making their projects through Arduino. You can easily find help about everything. Moreover the Arduino website itself explains each and every functions of Arduino.

3.5.1.4 Arduino Disadvantages

1. Structure:

   Yes, the structure of Arduino is its disadvantage as well. During building a project you have to make its size as small as possible. But with the big structures ofArduino we have to stick with big sized PCB's. If you are working on a small micro-controller like ATmega8 you can easily make your PCB as small as possible.

2. Cost:

   The most important factor which you cannot deny is cost. This is the problem which every hobbyist, Engineer or Professional has to face. Now, we must consider that the Arduino is cost effective or not..

3. Open source- Simplified and user-friendly programming language- Portable- Low power consumption .

3.5.2 Obstacle Detection System

The most used active sensors are ultrasonic, laser, and radar. The choice of an active sensor depends on the measurement range of the sensor, , its response time, resolution, recognition reliability and finally the application requirements. A comparative survey is achieved and given in Table 3.2 [16].

Table 3.2: General characteristics of some sensor [16]

	Laser	Radar	Ultrasond
principle	transmission and reception of light wave	transmission and reception of electromagnetic wave	transmission and reception of Ultrasonic waves
Range	About 60 m	About 250 m	From 3 cm to 10 meters
Accuracy	High(about 5 cm)	Medium (few meters)	Very high (5mm)
Price	Very high	high	low

The proposed tool does not require a very large extent, that's why an increase from 0 to 1.5 meters is more than sufficient. In addition, our goal is to offer not only an efficient and reliable cane, but also a low cost one. In this case, the best sensor, which is closest to our needs, is the ultrasound one [16].

3.5.2.1 Ultrasonic Sensor Performance

The ultrasonic sensor used in this project is HC -SR04. It uses sonar to determine the distance to an object. This sensor can detect an object up to 2cm to 400 cm in 30 degrees. Its sensitivity can be up to 3mm [6].

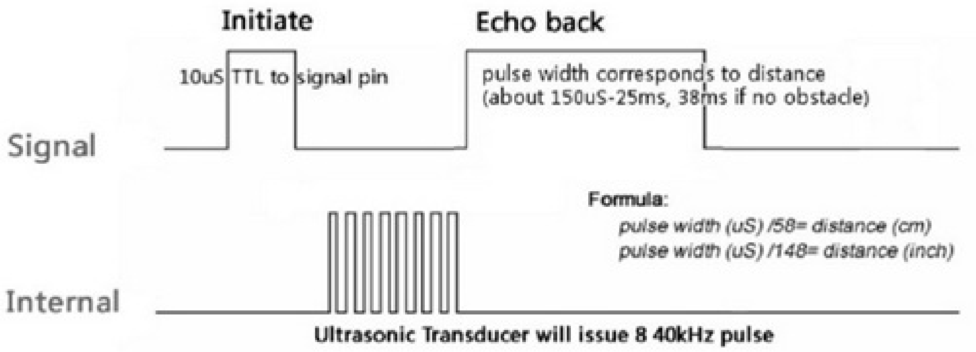

Figure 3.7: Timing diagram [6]

Figure 3.7 shows the timing diagram of HC-SR04. The operation starts when HC-SR04 receives a high pulse and hence initiates the sensor. Every time, eight cycles of ultrasound at 40 kHz is sent to detect the presence of obstacle. Hence the distance in centimeters can be calculated, which is given as distance = time/58.8 [6].

$$\text{Distance} = \frac{1}{2}\,\text{speed of sound} \times \text{time of echo} \tag{3.1}$$

3.5.2.2 Flow of Obstacle Detection Design

Figure 3.8 show flow of ultrasonic sensor on obstacle detection. When there is no obstacles detected in the range, the ultrasonic sensor will keep on detecting and sense for obstacles. When there is an obstacle detected, ultrasonic sensor will send the feedback to vibrating motor [6].Table 3.3 show the Features of HC-SR04(Ultrasonic sensor.

Table 3.3: Features of HC-SR04(Ultrasonic sensor) [1]

power supply	+5 V DC
Quiscent current	< 2 mA
Working current	15 mA
Effectual Angle	15 degree)
Range Distance	2cm to 400 cm
Resoluation	0.3 cm
Measuring Angle	30 degre
Trigger Input Pulse Width	10 microsecond
Dimennsion	45mm × 20mm × 15mm

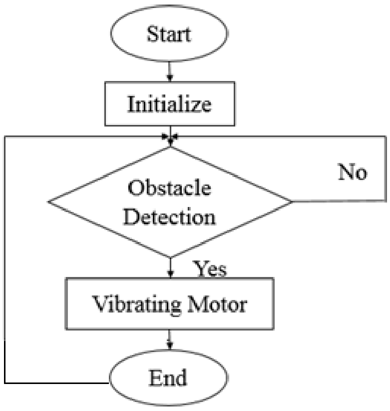

Figure 3.8: Flowchart of obstacle detection [6]

3.5.3 Global Position system (GPS)

Global Positioning System (GPS) is a worldwide radio navigation system formed from the constellation of 24 satellites and their ground stations [14]. Global positioning system (GPS) is a satellite-based navigation system that stands from satellites that orbit in the space. The GPS system is able to provide three dimensional positioning, time and location for navigation purpose. GPS is mainly used in five purposes: navigation, tracking, location, mapping and timing . GPS is able to provide information in all time and all types of weather.
GPS system consists of three main segments. The first segment is satellite segment. The satellite segment is designed to have at least four satellites that function to receive signals at any moment. Hence, the GPS receiver is able to provide graphic information in three dimensions in order to determine the location stated. Those signals are transmitted at very high frequency. Basically, satellite consists of atomic clocks, computer, radio transmission system, solar panels, batteries and other components. Satellite is required to have maintenance from time to time in order to increase the reliability, accessibility, accuracy and security purpose.
The second segment is control segment. Control Segment stands from three main stations, which are Master Control Station, Ground Antenna Station and Monitor Station. Satellites will send the navigation signals to monitor stations and then send to master control station for further processing and ended at ground antenna station. The ground antenna station also functions as routine checking satellites system, updating software and regulate

satellite's orbit.
The third segment is user segment. User segment consists of two categories, military usage and civilian's usage. Civilian can use GPS in order to determine location and timing [6].
Figure 3.9 shows the operation of three main segments in GPS system. GPS

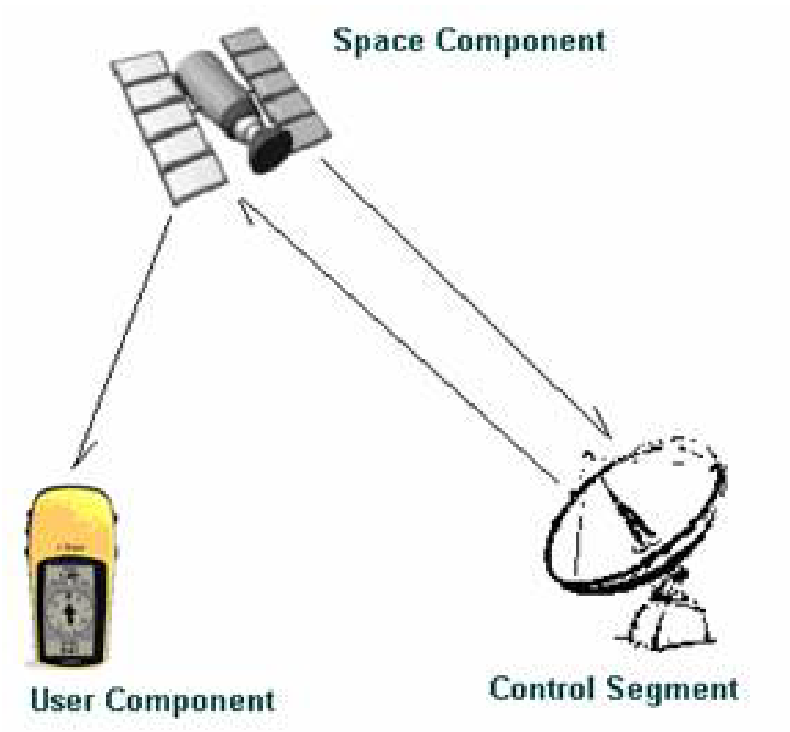

Figure 3.9: Three core segment of GPS system [6]

system works as shown in the Figure 3.10. Information signals are received by antenna and radio-frequency receiver. The digital signal processor, then tracks those signals and adjust parameters of it. Navigation Processor will calculate the position, velocity and time according to signal received and displays it [6].

GPS modules are popularly used for navigation, positioning, time and other purposes. GPS antenna receives the location values from the satellites. GPS gives information about:

1. Message transmission time.
2. Position at that time [17].

The NEO-6 module series is a family of stand-alone GPS receivers featuring the high performance u-blox 6 positioning engine. These flexible and

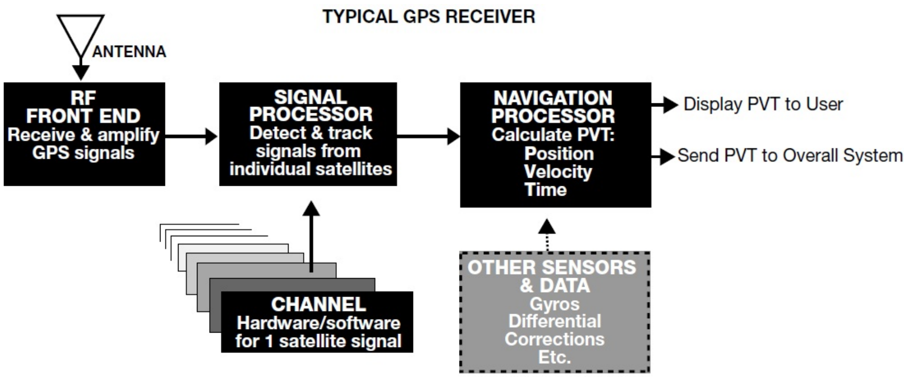

Figure 3.10: GPS Receiver[6]

cost effective receivers offer numerous connectivity options in a miniature $16 \times 12.2 \times 2.4$ mm package[18].
GPS module selection NEO-6M, NEO-6M is a high performance GPS positioning module. The module uses U-BLOX NEO-6M module group, the module comes with high performance active dual antenna system. Module via serial port connected external system, baud rate 9600BPS, compatible 5V/3.3V Arduino uno system [18].

3.5.3.1 Features

1. Standalone GPS receiver.
2. Base on U-BLOX NEO-6M modular, it is compact and excellent performance.
3. Able to set parameters via the serial port and save in EEPROM.
4. It is compatible with 3.3V level, easy to connect to any Micro-controller.
5. Comes with a rechargeable backup battery for storing satellite searching data.
6. The module interface is RS232 (TTL level, 3.3V for 'H', 0V for 'L'), it supports 4800 , 9600 ,19200 , 38400 (default), 57600 , 115200, 230400 baud rates [19].

3.5.3.2 Pins Definition

The table 3.4 discusssed GPS pin definition. PPS pin is connected to a status indicator LED: PPS, this pin is connected to the port UBLOX NEO-6M

TIMEPULSE module, the output characteristics of the port can be set by the program. PPS pin, by default, there are two states:

1. Always on, which means that the module has started to work, but have not yet achieved positioning.

2. Flashing (100ms off, 900ms bright), which means that the module has been successful positioning.

Thus, by PPS indicator, we can easily determine the current state of the module, easy to use.

Table 3.4: Pins Definition [19]

Pin	Pin Name	Description
1	PPS	Time Pulse output
2	RXD	Rx.Connect to Micro-controller's Tx pin.
3	TXD	Tx. Connect to Micro-controller's Rx pin.
4	GND	Connect to ground.
5	VCC	Connect to 3.3V 5V.

3.5.4 Global System for Mobile(GSM) Module

GSM (Global System for Mobile) / GPRS (General Packet Radio Service) TTL -Modules SIM800 Quad-band GSM / GPRS device, works on frequencies 850 MHZ, 900 MHZ, 1800MHZ and 1900 MHZ. It is very compact in size and easy to use as plug in GSM Modem.The Modem is designed with 5V DC TTL interfacing circuitry, which allows User to directly interface with 5v micro-controller (Arduino) [20].

3.5.4.1 GSM Features

A GSM module is a wireless modem that works with a GSM wireless network. It is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator. It is suitable for SMS, as well as DATA transfer application in mobile phone to mobile phone interface. The modem can be interfaced with a Microcontroller using USART (Universal Synchronous Asynchronous Receiver and Transmitter) feature (serial communication) [20].
for more information on specification see table 3.5.

Table 3.5: GSM Module SIM 800L features [20]

Feature	Implemention
Power supply	3.7V 4.2V
Power saving	Typical power consumption in sleep mode is 1.2mA
Ground	Ground Level of power Supply
TXD (transmit)	1. Outputs data bytes at voltage Level same as the V Interface. 2. Pin Usually connected to the Rx pin of the Arduino microcontroller
RXD(Receive)	1. Receives data bytes at voltage Level same as the V Interface Pin. 2. Usually connected to the TX pin of the Arduino microcontroller.

3.5.5 GPS and GSM Modems Flow Chart

When GSM modem receives a message the microcontroller will process the message with the keyword saved in it. Then, it will get the location of the stick from the GPS modem and transmit the location to the GSM modem in order to respond to the sender. In case of an emergency, the user of the stick can press the emergency button the microcontroller access the location from the GPS modem and transmit the location to the GSM modem which will send a SMS messages to the all saved numbers in the microcontroller.The GPS will update the location of the stick and automatically save the location in microcontroller EEPROM memory . Addition to that, if the emergency button is pressed the directly the microcontroller will transmit the last location saved in the EEPROM to the GSM modem to send it to all saved number in the microcontroller. Figure 3.11 briefly explains on the design of the navigation system.

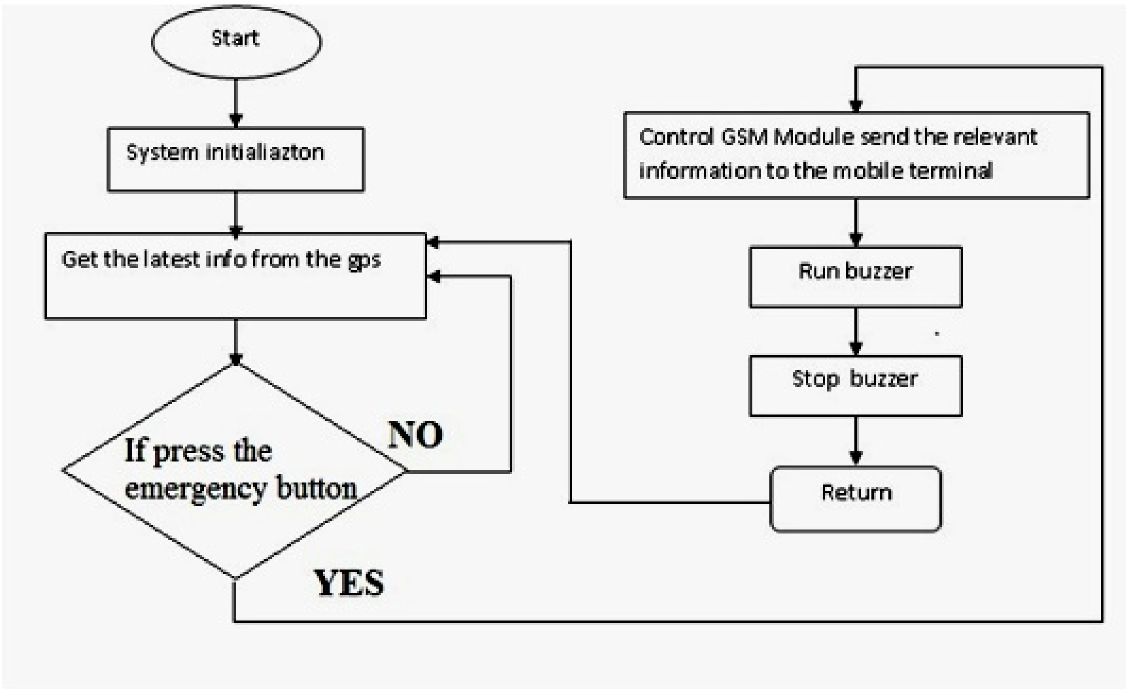

Figure 3.11: GPS and GSM Modems Flow Chart

3.5.6 Power Bank

A typical rechargeable 5V Power Bank was used. With the evolution of technology,electronic devices have different kinds of functions are developed. Those electronic devices may be configured to have their own power supply standards. A power bank is a portable device designed for charging an electronic device . A power bank, comprising: a voltage output port, arranged to provide a first voltage level; and a voltage-controllable and current-bidirectional port, arranged to selectively transit a first communication protocol, wherein when the voltage-controllable and current-bidirectional port is arranged to transit the first communication protocol, the voltage-controllable and current-bidirectional port is arranged to output a second voltage level according to the first communication protocol [21].

3.5.7 Vibration Motor

This is the type of DC vibration motors used in mobile phones. It requires a voltage supply of 3V to 5V with current around 125 mA. This type of motors can be programmed to control its speed by using the PWM (Pulse Width Modulation) method [22].

3.5.8 Buzzers Module

Buzzer is frequently used as alarming device. It consists of two term inals on is VCC and other is GND. Buzzer has an operating voltage of 5v - 12v. Buzzer has simple architecture and it is very easy to handle instead of speaker. Unlike the speaker Buzzer can operate with the DC voltage directly. Buzzer has simple architecture and it is very easy to handle instead of speaker [23].In this project used buzzer to ensure the message have been send from GSM module to mobile phone .figure 3.12 show The Buzzers Module .

Figure 3.12: 5V Buzzers Module

4 Chapter Four: Implementations, Simulations and Results

4.1 Introduction

In this chapter, the results of this project are discussed. The results are tested and verified in order to ensure the function of the project fulfills the objectives.

4.2 Mobility System

HC-SR04 is used to detect the existence of an obstacle. When the ultrasonic sensor detects the existence of an obstacle and then the distance between blind and obstacle less than only one meter , it will send the signal to vibrating motor. The trigger will send the ultrasound at 40 kHz. When the ultrasound detects an obstacle, it will bounce back and generate an echo. The distance between the obstacle and ultrasonic sensor in centimeters can be determined by using the formula distance=time/58.8 see A ppendix B. Figure 4.1 shows the result of obstacle detection by ultrasonic sensor.

Figure 4.1: Distances detected from HC-SR04

Table 4.1 show the differences between ultrasonic sensor measurement and actual measurement between the obstacle and ultrasonic sensor. The error between the result of ultrasonic sensor and measured values is small that is 0.768 cm. Hence, it can show that the result of ultrasonic sensor's detected distance value is reliable.

Table 4.1: Result of sensor detected distance and measure distance

No	Measure Distance (cm)	Sensor Detected Distance (cm)	Error (cm)
1	3	2.93	0.07
2	4	3.37	0.63
3	5	4.27	0.73
4	8	7.1	0.9
6	10	9.37	0.63
7	11	10.48	0.52
8	12	11.48	0.54
9	13	12.43	0.57
10	14	13.28	0.72
11	15	14.23	0.77
12	20	19.2	0.8
13	25	23.55	1.45
14	30	28.4	1.6
Average Error			0.768

figure 4.2 shows the hardware implementation on mobility system. The ultrasonic sensor and vibrating motor is located at the midst and upper part of smart cane prototype respectively.

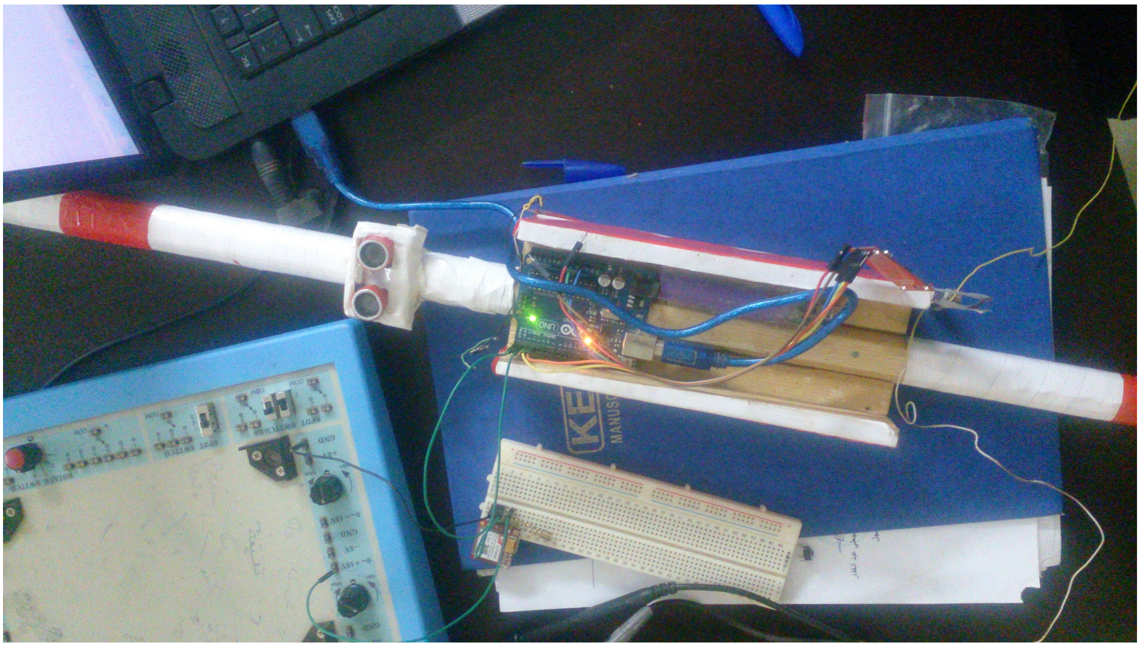

Figure 4.2: Hardware implementation on mobility system

4.3 Testing For navigation system

Thus GSM, GPS and vision based positioning provides an accurate positioning,compatible with blind mobility and guidance.
Figure 4.3 shows the coordinates obtained from the GPS receiver.The result shows the current location of the GPS receiver.

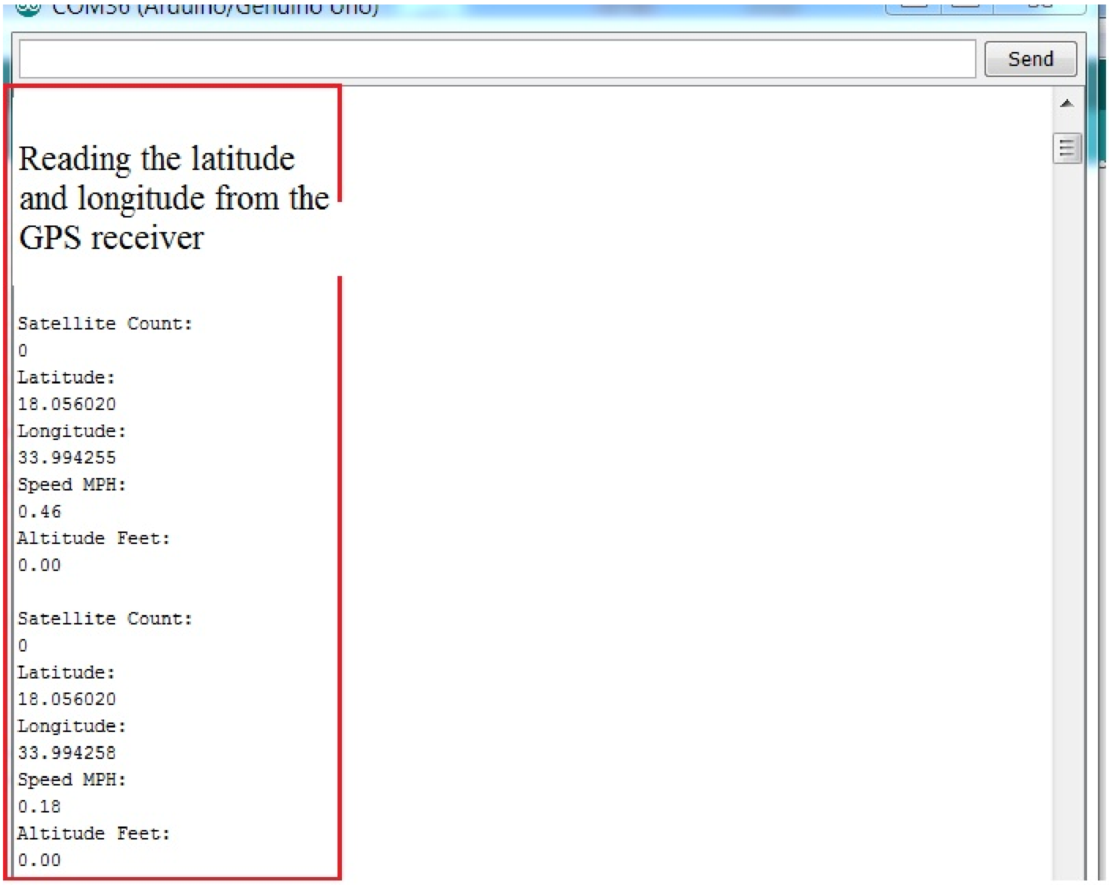

Figure 4.3: coordinates obtained from the GPS receiver

Figure 4.4 and figure 4.5 shows a test for determining the blind location using the GPS/GSM module. By using the geocoding, the latitude and longitude of a location can be obtained blind location. The location of an address will be showed in the map .

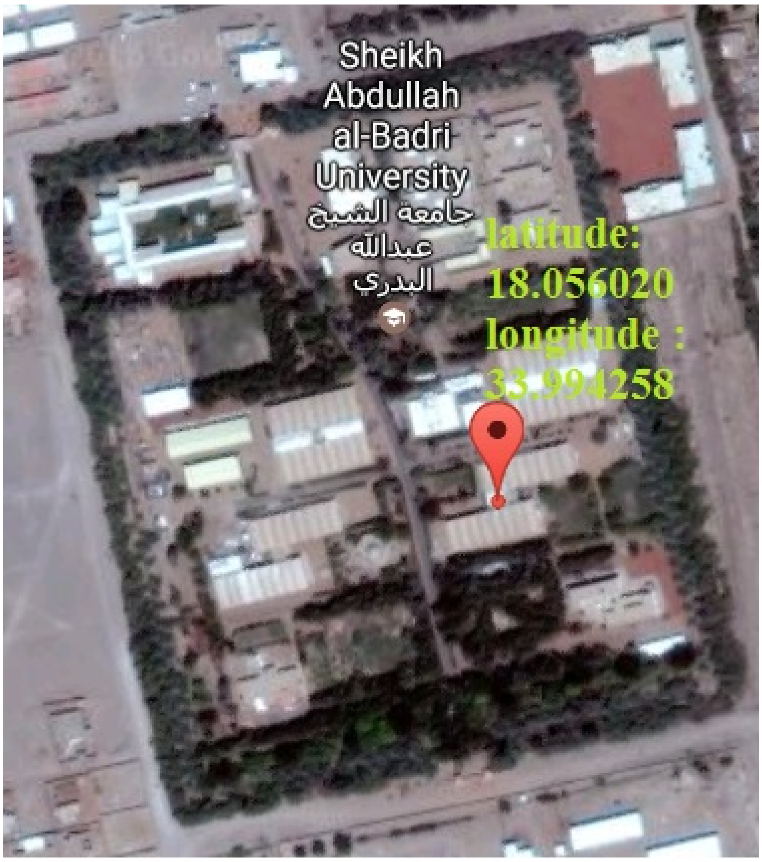

Figure 4.4: The result of using the geocoding

Figure 4.5: The result of using the geocoding

The coordinates of the location will be send to any mobile by GSM module. Once the location information is obtained through the GPS receiver powered by GPS 6M-0-001 message is sent to the microcontroller unit and then using the GSM SIM 800L module placed in the white cane. Figure 4.6 and 4.7 shows the alert message sent By the blind .

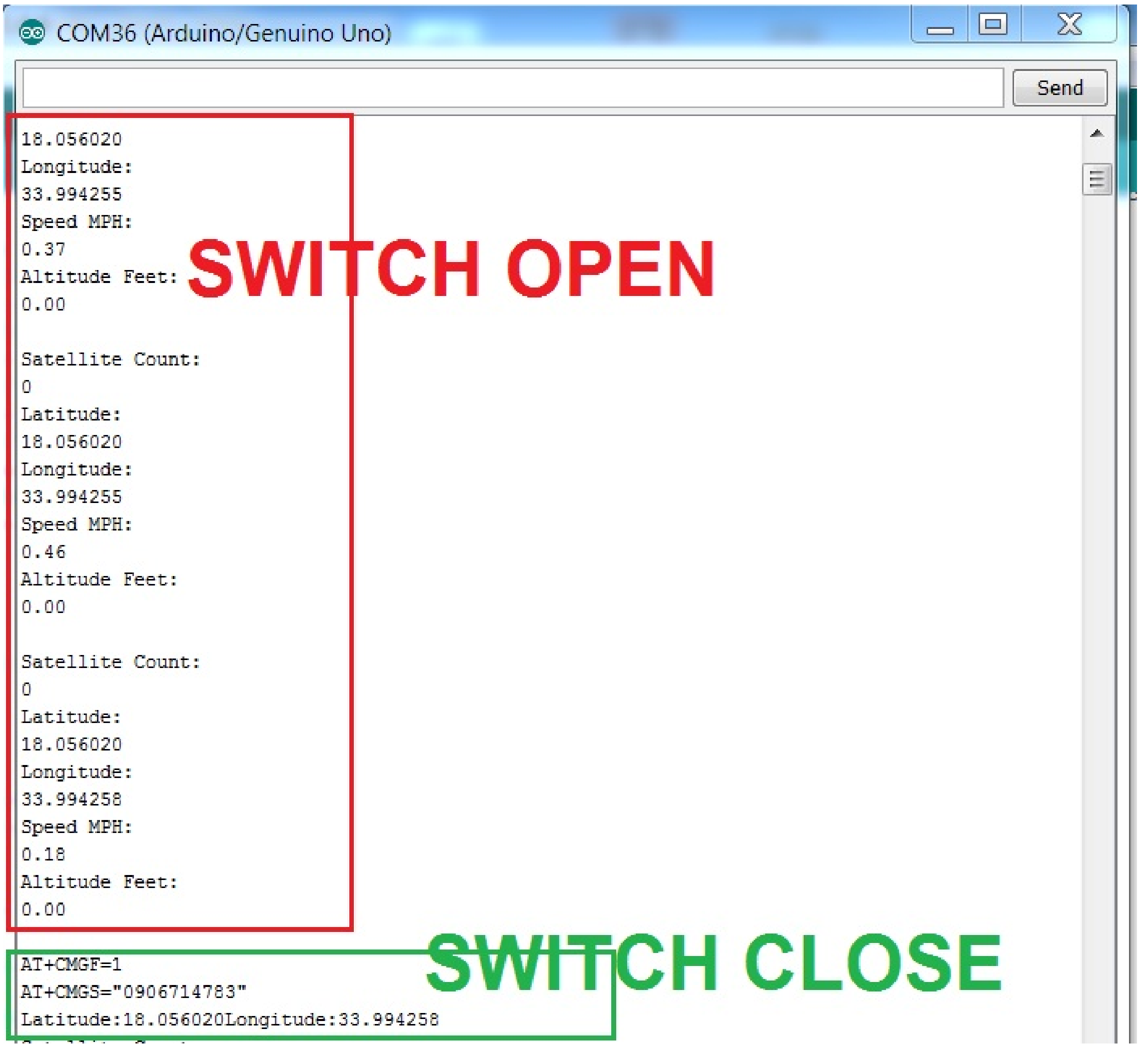

Figure 4.6: Message received in the mobile from gsm Module in simulation.

Figure 4.7: Message received in the mobile from gsm Module

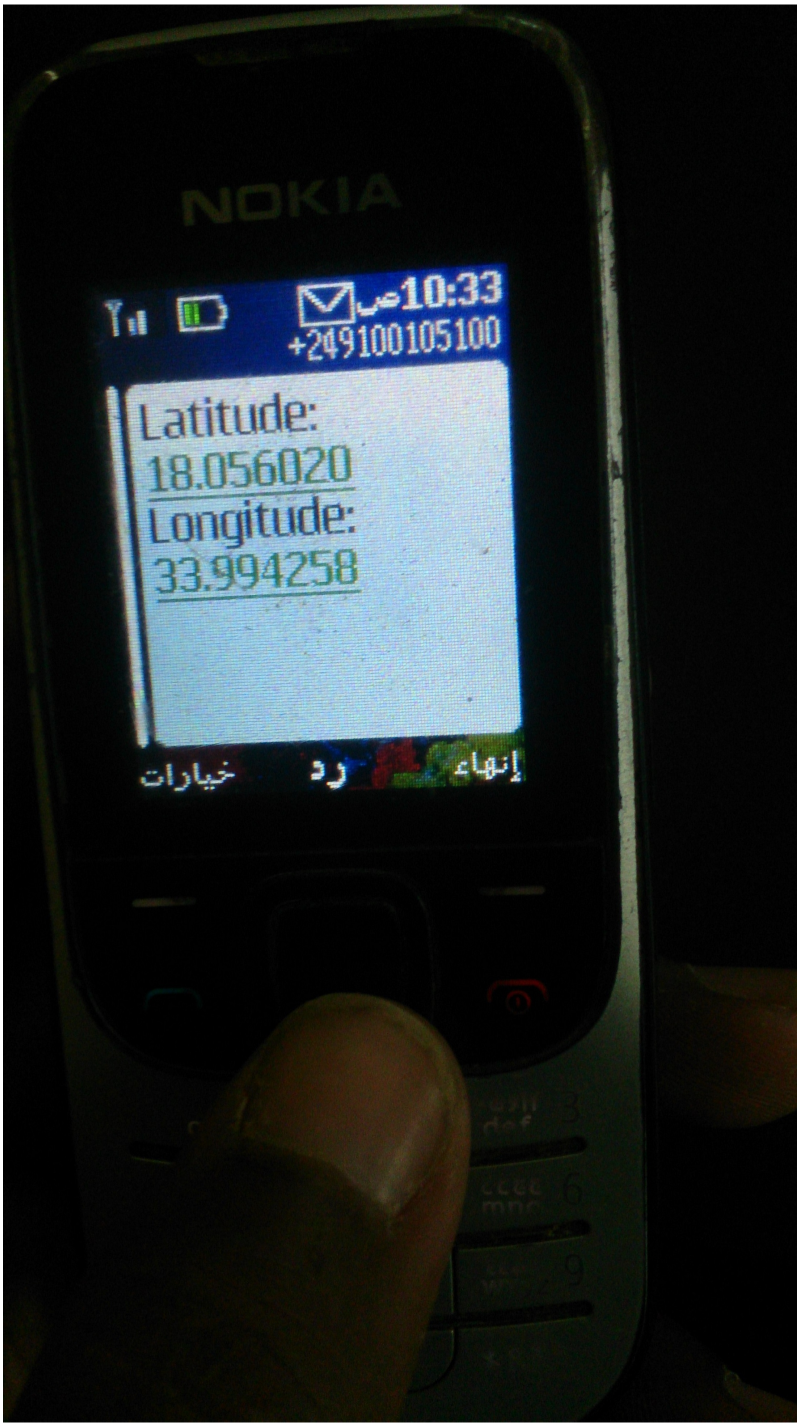

Figure 4.8: Message received in the mobile from gsm Module

4.4 Summary

In this chapter, we showed the full set up of the whole system prototype . The results indicate that the system is efficient in specifying the details of the objects that may encounter the blind and provides GPS and GSM modules to enable the blind to communicate with the home making his/her navigation more safe and secure.

5 Chapter Five: Conclusions and Recommendations

5.1 Conclusions

A prototype of version of An Obstacle-Aware Global Position System /Global System for Mobile Enabled Electronic White Cane has been tested in laboratory conditions and is successful at its major purpose of identifying potential hazards at ranges of 1 to 1.5 meters this distance is suitable with the blind .

As a conclusion, this project includes the combination of ultrasonic sensor, global positioning system, vibrating motor, Arduino UNO and Intel Atom board to build a smart cane for the blind people. The development environments involve Visual Basic, Arduino IDE and Processing. Two main objectives of this project that are to increase the mobility and also to enable navigation system had been successfully implemented. To increase the performance of mobility for the blind people, ultrasonic sensor and vibrating motor are used. Blind people will realize the existence of an obstacle before contact with it. It helps to increase the efficiency for blind people to travel and also increases the safety. Implementation of a global positioning system enables a blind person to move to an unfamiliar place without human guidance. It enables a blind person to live more independently and confidently. The hardware and software of the project had been successfully integrated and worked to meet the requirements. The prototype of a smart cane is built and the function meets the objectives of this project.

5.2 Recommendations

This system is so open to be enhanced to give better execution, and here are a few proposals to be incorporated into any Recommendation:
The precision of the hindrance identification can be expanded. Thusly, the sensitivity of the ultrasonic sensor and vibrating quality of a vibrating engine ought to be progressed. The ultrasonic sensor can be changed in accordance with distinguish quick moving articles.
The navigation system can be improved by using speech recognition to control the function of the smart cane. The system should be able to capture speech more precisely and accurately to decrease the probability of entering the wrong address.
Another point is how to ensure the receipt of the message bearing the site for the blind data. All previous comments can be considered to enhance the project idea.

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Appendix A

1 Program 1

This code is used for ultrasonic sensor.

```
const byte vipration=13;
const byte trigger=2;
const byte echo=4;
byte limitRange=100;
float distanse;
unsigned long period;
void setup()
{
  Serial.begin(9600);
  pinMode(vipration,OUTPUT);
  pinMode(echo,INPUT);
  pinMode(trigger,OUTPUT);
}

void loop() {
 digitalWrite(trigger,LOW);
 delayMicroseconds(3);
 digitalWrite(trigger,HIGH);
 delayMicroseconds(10);
 digitalWrite(trigger,LOW);
 period=pulseIn(echo,HIGH);
 distanse=float(period)/58.8;
  Serial.println(distanse);
 if(distanse≤limitRange)
 {
  digitalWrite(vipration,HIGH);
 }
 else
 {
```

```
   digitalWrite(vipration,LOW);
  }
   delay(60);
}
```

2 Program 2

This code is used for GPS and GSM module.

```
#include "TinyGPS++.h"
#include "SoftwareSerial.h"
char phone_no[]="0906714783";
SoftwareSerial serial_connection(2, 3); //RX=pin3, TX=pin2
TinyGPSPlus gps;//This is the GPS object that will pretty ...
    much do all the grunt work with the NMEA data
const int sw=7;
const int bu=8;
int val;
void setup()
{

   pinMode(bu,OUTPUT);
  pinMode(7,INPUT);
  Serial.begin(9600);//This opens up communications to the ...
      Serial monitor in the Arduino IDE
  serial_connection.begin(9600);//This opens up ...
      communications to the GPS
  Serial.println("GPS Start");//Just show to the monitor ...
      that the sketch has started
}

void loop()
{
  while(serial_connection.available())//While there are ...
      characters to come from the GPS
  {
    gps.encode(serial_connection.read());//This feeds the ...
        serial NMEA data into the library one char at a time
  }
  if(gps.location.isUpdated())//This will pretty much be ...
      fired all the time anyway but will at least reduce it ...
```

```
       to only after a package of NMEA data comes in
    {
      //Get the latest info from the gps object which it ...
         derived from the data sent by the GPS unit
      Serial.println("Satellite Count:");
      Serial.println(gps.satellites.value());
      Serial.println("Latitude:");
      Serial.println(gps.location.lat(), 6);
      Serial.println("Longitude:");
      Serial.println(gps.location.lng(), 6);
      Serial.println("Speed MPH:");
      Serial.println(gps.speed.mph());
      Serial.println("Altitude Feet:");
      Serial.println(gps.altitude.feet());
      Serial.println("");
       delay(300);
       val = digitalRead(sw);
       if(val==HIGH)
   { Serial.println("AT+CMGF=1");
    delay(2000);
    Serial.print("AT+CMGS=\"");
    Serial.print(phone_no);
    Serial.write(0x22);
    Serial.write(0x0D);  // hex equivalent of Carraige return
    Serial.write(0x0A);  // hex equivalent of newline
    delay(2000);
     Serial.print("Latitude:");
    Serial.print(gps.location.lat(), 6);
    Serial.print("Longitude:");
    Serial.print(gps.location.lng(), 6);
    delay(500);
    Serial.println (char(26));//the ASCII code of the ctrl+z ...
       is 26
    digitalWrite(bu,HIGH);
    delay(1000);
    digitalWrite(bu,LOW) ;
   }
    }
  }
```

Appendix B

1 Ultrasonic Ranging Module HC-SR04

Ultrasonic Ranging Module HC - SR04

Product features:

Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules includes ultrasonic transmitters, receiver and control circuit. The basic principle of work:

(1) Using IO trigger for at least 10us high level signal,

(2) The Module automatically sends eight 40 kHz and detect whether there is a pulse signal back.

(3) IF the signal back, through high level , time of high output IO duration is the time from sending ultrasonic to returning.

Test distance = (high level time×velocity of sound (340M/S) / 2,

Wire connecting direct as following:

- 5V Supply
- Trigger Pulse Input
- Echo Pulse Output
- 0V Ground

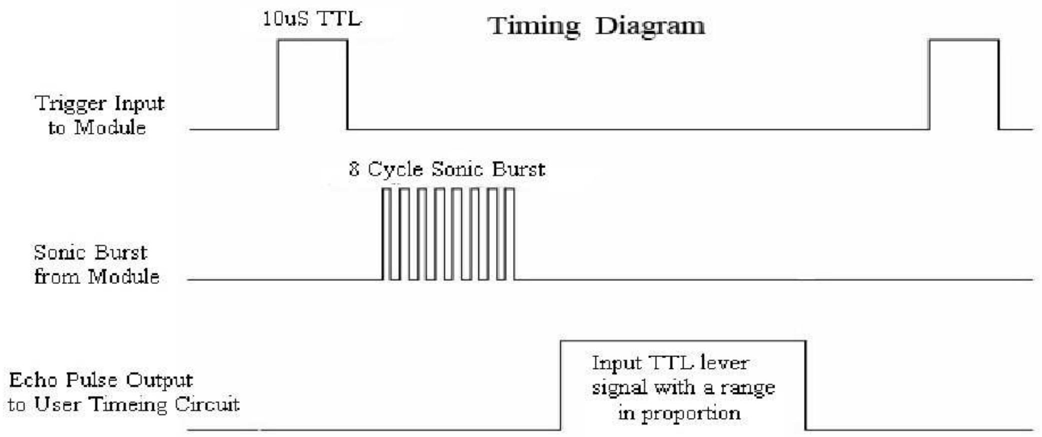
Electric Parameter

Working Voltage	**DC 5 V**
Working Current	**15mA**
Working Frequency	**40Hz**
Max Range	**4m**
Min Range	**2cm**
MeasuringAngle	**15 degree**
Trigger Input Signal	**10uS TTL pulse**
Echo Output Signal	**Input TTL lever signal and the range in proportion**
Dimension	**45*20*15mm**

Vcc Trig Echo GND

Timing diagram

The Timing diagram is shown below. You only need to supply a short 10uS pulse to the trigger input to start the ranging, and then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raise its echo. The Echo is a distance object that is pulse width and the range in proportion .You can calculate the range through the time interval between sending trigger signal and receiving echo signal. Formula: uS / 58 = centimeters or uS / 148 =inch; or: the range = high level time * velocity (340M/S) / 2; we suggest to use over 60ms measurement cycle, in order to prevent trigger signal to the echo signal.



Attention:

- The module is not suggested to connect directly to electric, if connected electric, the GND terminal should be connected the module first, otherwise, it will affect the normal work of the module.
- When tested objects, the range of area is not less than 0.5 square meters and the plane requests as smooth as possible, otherwise ,it will affect the results of measuring.

2 GPS Pin Assignment and Desription

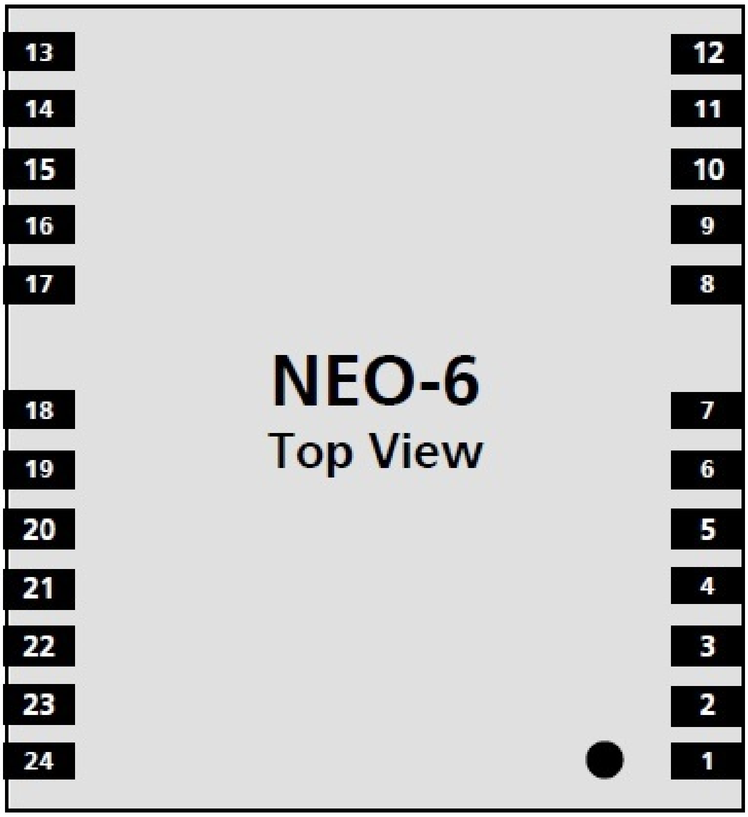


Figure 1: Pin Assignment

No	Module	Name	I/O	Description
1	All	Reserved	I	Reserved
2	All	SS_N	I	SPI Slave Select
3	All	TIMEPULSE	O	Timepulse (1PPS)
4	All	EXTINT0	I	External Interrupt Pin
5	All	USB_DM	I/O	USB Data
6	All	USB_DP	I/O	USB Data
7	All	VDDUSB	I	USB Supply
8	All	Reserved		See Hardware Integration Manual Pin 8 and 9 must be connected together.
9	All	VCC_RF	O	Output Voltage RF section Pin 8 and 9 must be connected together.
10	All	GND	I	Ground
11	All	RF_IN	I	GPS signal input
12	All	GND	I	Ground
13	All	GND	I	Ground
14	All	MOSI/CFG_COM0	O/I	SPI MOSI / Configuration Pin. Leave open if not used.
15	All	MISO/CFG_COM1	I	SPI MISO / Configuration Pin. Leave open if not used.
16	All	CFG_GPS0/SCK	I	Power Mode Configuration Pin / SPI Clock. Leave open if not used.
17	All	Reserved	I	Reserved
18	All	SDA2	I/O	DDC Data
19	All	SCL2	I/O	DDC Clock
20	All	TxD1	O	Serial Port 1
21	All	RxD1	I	Serial Port 1

Figure 2: Pin Description

No	Module	Name	I/O	Description
22	All	V_BCKP	I	Backup voltage supply
23	All	VCC	I	Supply voltage
24	All	GND	I	Ground

Figure 3: Pin Description