A Smart Walking Stick for Visually Impaired and Deaf People

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Certificate of Approval

We accept the work contained in this report titled, “A Smart Walking Stick for Visually Impaired and Deaf People” as a confirmation to the required standard for the partial fulfillment of the degree of Bachelor of Science in Software Engineering.

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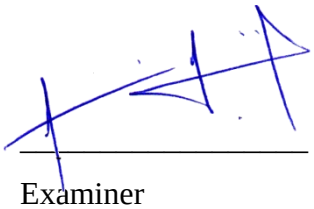

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Declaration of Authorship

I declare that this thesis titled, “A Smart Walking Stick for Visually Impaired and Deaf People” and the work presented in it are our own. I confirm that:

- This work was done wholly or mainly while in candidature for Bachelor of Science in Software Engineering degree at this University.
- Where any part of this thesis has previously been submitted for a degree or any other qualification at this University or any other institution, this has been clearly stated.
- Where I have consulted the published work of others, this is always clearly attributed.
- Where I have quoted from the work of others, the source is always given.
- With the exception of such quotations, this thesis is entirely my own work.
- I have acknowledged all main sources of help.

Ashiq Ullah

Acknowledgment

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Dedication

It is my genuine gratefulness and warmest regard that we dedicate this work to the faculty staff, classmates, roommates, and our parents who gave their knowledge, experience and skills as a material to completing my work on time. Special thanks to my teachers and friends for their assistance in planning, designing, coding, consulting and for making this work a reality.

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Abstract

It is globally estimated that there are approximately 1.3 billion people living with some sort of visually impairments. According to global trends (2015), there are 36 million blind people all around the world and there are at least 216 million people with moderate and sever vision-impairments. All of these visually impaired people with different type of impairments facing different problems in their daily lives. According to the World Access for the Blind, the biggest challenge or problem for a visually impaired person is movement or independent mobility, especially in a place which is not designed and constructed for blind people. Keeping in mind all the mobility issues faced by a visually impaired person, this paper presents a smart walking stick based on microcontroller, Android mobile application and other modules i.e. ultrasonic sensors for visually impaired and deaf people. This stick helps visually impaired people by detecting the obstacles using ultrasonic sensors being used. Three ultrasonic sensors are integrated in the stick and these ultrasonic sensors generate three different types of beeps and vibrations to inform the visually impaired person and deaf person with visually impairments respectively. The stick is able to detect obstacles in 50cm accurately. An integrated camera used in this stick helps visually impaired person in sending real-time images to the server from where these images can be retrieved by an Android application installed in one of the family member's mobile phones. Tracking a visually impaired person is also a big issue. To overcome this issue, this stick sends real-time GPS data to the server and using the mobile application, the person can be located easily. The microcontroller used in this system (Stick) is a type of Arduino which is programmed in C language and the mobile application is developed in Android Studio IDE using Java as a programming language. The stick is being tested and works as it was supposed to do.

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List of Acronyms

3G: ---------- 3rd Generation
AC: ---------- Alternative Current
AVR: ---------- Automatic Voltage Regulator
DCA: ---------- Direct Current Amperag
GPIO: ---------- General Purpose Input/Output
GPRS: ---------- General Packet Radio Services
GPS: ---------- Positioning System
GSM: ---------- Global System for Mobile
IDE: ---------- Integrated Development Environment
IoT: ----------Internet of Things
IP: ---------- Internet Protocol
IR: ---------- Infrared Radiation
LDR: ----------Light Dependent Resistor
mA: ---------- MilliAmps
mAh: ----------Milliampere Hour
PC: ---------- Personal Computer
PHP: ---------- Personal Home Page
PPS: ---------- Pulse Per Second
RxD: ---------- Receiver Data
SOC: ---------- System on Chip
TCP: ---------- Transmission Control Protocol
TxD: ---------- Transmit Data

Chapter 1
Introduction

1.1 Introduction:

It is very obvious that we use two gifts (eyes) given by our creator almost in every activity we perform daily. The activities can be reading, writing, coding, walking, eating, driving and running. Almost all of us agree that sight is the most valuable gift given yet. None of us would like to consider or suppose him/her without having this amazing sense. No one wants to have a visual problem, but there are many people around the world having some type of visual problem. Some of them can't see things clearly if these things aren't close to them and some of them can't see things closer to them - called short-sighted and long-sighted respectively. Some even can't read something written on a board and some of them can't read text printed on a book page in small font sizes.

The types of visual impairments, I mentioned above can be treated easily at some point, but sometimes a complete loss of vision occurs due to some disease and the person becomes totally blind which is irreversible in many cases. It is globally estimated that there are approximately 1.3 billion people live with some form of vision impairments [1]. According to Global Trends (2015), there are 36 million blind people all around the world and there are at least 216 million people with moderate and severe vision impairments [2]. There are many levels or types of visual impairments but here we are trying to focus on the problems visually impaired people face in their daily life rather than discussing blindness causes etc., and we have tried to minimize their problems as other people tried in in significant ways. We have also tried our best to solve or minimize problems or challenges the blind or visually impaired people face today by working on in this project. Here we introduced a new and a little different way (A Smart Walking Stick for Visually Impaired and Deaf People) to minimize their problems by doing this project and by adding new features.

1.2 Problem Background

Every one of us wants to be independent and we do not want to be a burden on someone else. In this case, we all work hard to be independent but what about blind people? They have more challenges as compare to normal people. But they take them and face them as we normal people accept many responsibilities. Still they have face challenges and problem from understanding the note of a currency to understanding or figuring out whether they are at the right place. A Visually impaired person finds himself/herself challenging to go out

independently. According to the **World Access for the Blind**, the biggest challenge for visually impaired or a blind person is physical movement or independent mobility [3]. It is very challenging for a blind person to move freely, usually there where he or she haven't been before in the place which isn't designed and constructed for blind people's condition. The blind person always tries to remember places and obstacles coming in his/her way. As compared to normal people they have strong sense of direction and they memorize things quickly. Hence their navigation is based on their mental mapping as well [4]. No one should move things around in house without asking or informing the blind person [5]. They can't go or walk somewhere without assisting them by the second person, usually by their friends or family members. They know how to go to familiar places. For example inside home, they can go to bathroom, dining room or bedrooms, etc. and outside they can go to shops near his/her house, but they can't go to the unfamiliar places alone. It is also a challenge for a blind person to move around in a crowded area. Saving from pits or water pits is also a big challenge for a blind person.

As you know that everything surrounding us for example chairs, desks, walls, doors, etc. are obstacles for blind people. They can hit them anytime. The blind person checks first using his/her hands, feet or a simple stick and then walks. Here checking means touching the things around him/her. After touching these obstacles, they either change their direction of walking or they stop there asking for help. While touching things they sometimes drop or break things as well and sometimes they hurt themselves. While walking outside, they usually touch other people using a simple stick in their hands, because the non-blind people are mostly unaware of their presence. After touching these people, they feel sorry, and usually, they end the conversation by saying "sorry, I can't see". A blind person has problems in using public transport. First of all, they can't reach at bus stop easily, however if they locate it or they have learned how to reach a bus stop after being suffered for many times, they can't find out easily the right bus or other transport for themselves. They don't know by which bus or car they should drive, and they don't know where they are going and where are they without asking the driver. Besides navigation, they have other challenges as well. For example, reading a book or newspaper, etc., but we didn't take some of these challenges in the account of this project.

This is also a challenge for a blind person to learn writing, reading, etc. We teach our children how to read and write if they are normal but what about a blind child? How to teach them? Of course, it is very difficult to teach them how to read and write. Usually, braille printing

services are used for reading. Besides reading they have challenges related to identification too. A blind person hardly recognizes things. They hardly recognize or identify things using their mental mapping with the help of touching. If they want to learn identification of something, they use to touch each item again and again. Once they learn. Then they can tell you what this is if you ask them about.

Accidents happen with even normal people but probably blind people can fall while going from one place to another. Then if there is someone nearby, they may help him/her but if there is no one then this may lead to a serious injury or even death sometimes.

Taking advantages from the current modern technologies, blind people are limited to its usage. They can't use everything developed yet. For example, the computer has brought a lot of changes in human life. It has made everything at least very faster and easier. Normal or sighted people are using them in daily life to solve problems. We think that these things or technological devices should be developed by keeping blind or visually impaired people in mind too. They should be able to use computer systems, mobile phones, etc. Here are some well-known issues each visually impaired person faces.

i. Real-time and useful navigation both indoor and outdoor
ii. Detecting the position of a blind person
iii. Detecting obstacles in his/her way, they can be fire, water or water pits.
iv. Reading and Writing
v. Identification of faces and things
vi. Using modern technological devices

1.3 Problem Statement

All the proposed systems have their own advantages as no one can be perfect. Systems proposed by different people are noteworthy. We appreciate their work, but here we are going to propose some new features which are pointing to different problems. Many researchers haven't introduced a vibrating system that will match user requirement. For example if the user or the blind person is having problem of auditory acuity as well. In this case simple audio system or irrelevant vibrating system won't help them. The vibrator needs to be vibrated accordingly. In case of emergency or unwanted situations the blind person might want to record the situation using camera. Sometimes the person might want to take picture of something and send it to the related people for which the current systems are unable to do this for them. The current systems haven't introduced a real time tracking system using mobile application which will tell the relative of the visually impaired person the current

location or last known location. In case of an aged person or in case of accident the blind person may fallen down and become unconscious where he/she won't be able to get up. In this case, the family is needed to be notified with a message that the person is laying down. The current systems might not able to detect the obstacles coming in higher level.

1.4 Main Objectives

- Designing a stick that will make a path or environment free of obstacles, so they can detect objects without physical contact
- To design such a stick that will help blind person to capture picture
- To design such a stick that will help blind person to record video or audio in unwanted situations
- To design a stick through which blind person will post pictures to online server both automatically and manually
- To design a stick which will post longitude and latitude's data both manually and automatically
- To design a stick that will notify family members in case of irregular orientations

1.5 The Proposed Methodology

Keeping in mind all the advantages and disadvantages of the existing systems developed (Especially The smart stick for blind) and our problem statement, we are proposing new features in the existing system. Apart from the obstacles detecting, sensing fire, sound system etc. we have added other features. We hope that these features will not just improve the existing system (Stick) but will also improve the usability and effectiveness of the system. So our contribution in the existing system is to add more features in the existing system. Here in this section we will mention these features briefly and will explain each feature diagrammatically in further chapters if possible.

i. *Vibrator:*

In case of a both deaf and visually impaired person, a vibrator will be used in the proposed system to vibrate according to the situation.

ii. *Video Recording:*

This feature will enable blind person to record a video. He/she may use it for legal or other purposes.

iii. *Image Capturing and Sending it to the System:*

Blind person might want to take picture of something, so that he/she sends it to the server from where other people like parents or family members can retrieve them using their mobile application.

iv. *Real Time Tracking Using Mobile Application:*

Family members or other concerned people will be able to track the blind person by using a mobile application.

v. *Falling Down Traking:*

In case of falling down, the system will inform blind person's relative etc. This can be done by using accelerometers and gyro sensors. These sensors will help in orientation problems.

Block Diagram

The below block diagram shows the abstract and complete block diagram of the proposed methodology. The stick will have **on/off** and other buttons related to camera and other functionalities. Each button will have its own functionality, For example **taking a picture** and so on. Camera will be used for taking pictures. The picture and video will be saved in the **SD card**. The picture can be automatically or manually uploaded to the server using **3G GPRS/ESP32 Module** which can be retrieved using mobile application. **Buzzer**, **vibrators** and **loudspeaker** will inform the user by making noise, vibrations and sound respectively. By the help of **gyro sensors** attached to the person's unbinding clothes part, In case of falling down, the signal will pass to the controller which will send a notification to the person's relative or parents. The flame or temperature sensors will sense the heat or flam nearby and will send the signals to the controller, which will make noise, audio or vibrations. The **ultrasonic** and **IR** sensor will be used to detect objects by calculating the distance between the object/obstacle and the stick. These sensors will also find the depth or pits on the way. The user will be notified by vibrations or sound accordingly. The **GPS** will detect the current location (Longitude and Latitude) and the data will be sent to the server using **3G/GPRS/ESP8266 Module**. The water pit will sense the water and will pass the signals to the controller. The given block diagram might change with time, but the requirements and features will be as we described. It means the structure or the flow of data might change in future. Choosing the quality and type of all these components like ultrasonic sensors, IR sensors and other module like GPS will depend on our requirements and budget etc. as we know that all these components has limitations. We will keep everything in mind before

selecting types and quality of a component or module. Selecting a right microcontroller also depends on the connectivity, size, space and working capabilities.

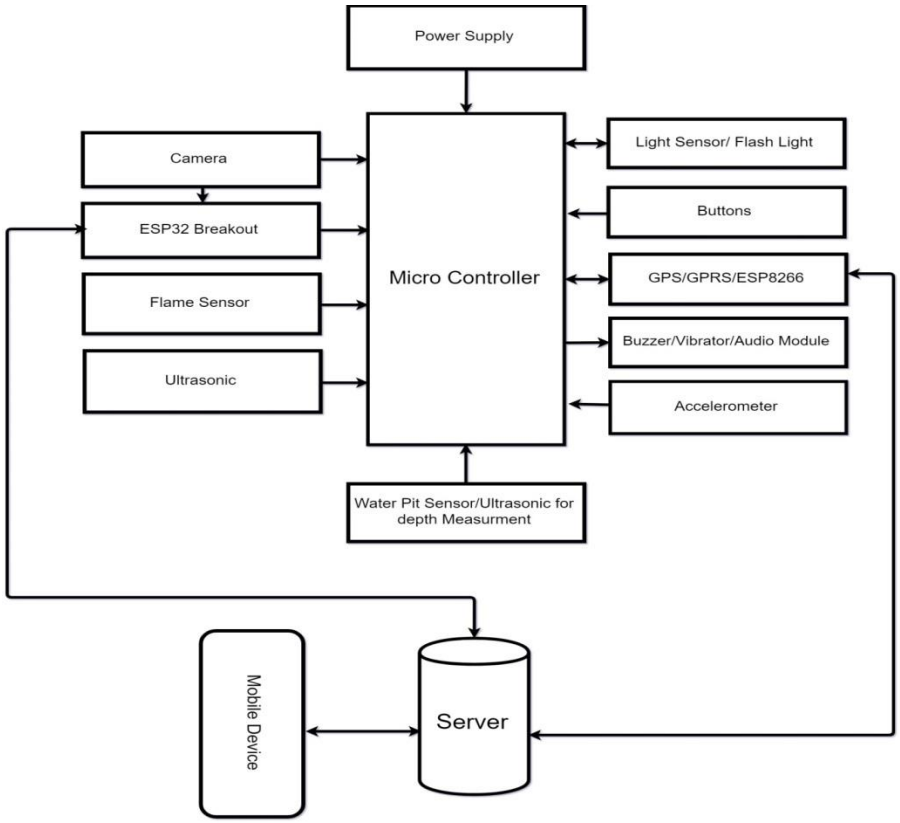

Figure 1.5-1 Block Diagram

1.6 Summary

There are approximately 1.3 billion people having some type of vision impairments and there are 36 million blind people according to the Global Trends 2015. All these people with some sort of visual impairments, faces so many problems or challenges in their lives. A visually impaired person finds himself/herself challenging to go out independently. The biggest challenge for visually impaired or blind person is physical movement or independent mobility according to the World Access for the Blind. As compared to normal people, they have strong sense of direction and they memorize things and places quickly, but they always try to remember places and things both outdoor and indoor for better movement.

To overcome or at least to minimize their problems or challenges, many people have worked on making devices and smart sticks based on technology. They have introduced systems with microcontrollers integrated with sensors like ultrasonic sensors to avoid obstacles. We appreciate their work. Similarly we also introduced almost same type of smart stick, but with little different features. We have furthered some of the features already introduced. We on the

other hand added new features. The features we introduced or improved are to implement a vibrator in case a person is deaf as well. In this case the vibrator will have some basic tones showing feedback from different sensors. The vibrator works as a haptic message, which is triggered for each sensors input in different tones. The second feature is to take and send picture through a camera installed in smart stick. A real time tracking using android mobile application is introduced in here and falling down tracking system to know if the person is walking or sit which will show if the person is dead or lying. We have introduced three ultrasonic sensors and buzzer as well, and the buzzer will sound.

Chapter 2

Literature Review

2.1 Introduction

In this chapter, we will cover everything that has and hasn't investigated in in the previous or related work. We will study different papers published where researchers have worked on the same issue we are working now. Literature review will helps us to avoid reinvention of ideas or something that is already done in past. We will identify the people and their works in the same field, we are working in now. By studying all these papers come under this title will demonstrate the depth of our knowledge about this research area. At the same time, we will try to identify ideas presented by other researchers that may help us in achieving our goals. Once we study related work done by other people and once we compare them with each other, then we will be able to identify all the techniques and methods that maybe significant to our project.

2.2 Related Work

Human has brain as well as thinking capabilities which lead them inventing new ways to solve problems in a better way as compare to other creature. They develop with the time and are flexible. If they face a problem they try to find solution for it. Blindness is also a problem and there are hundreds of methods, devices and things that have been developed to solve problems related to blindness. Many methods from assisting blind by another person to mobile applications and smart sticks are helping them in walking, identifying and navigating. **Guide dogs** are being used to guide blind people around obstacles and to guide them throw crowded areas, stop and stairs. They can even help you in finding things if you ask them about chair, bed etc. [6]. A **white cane** called "a symbol of independence, freedom, confidence and symbol of blindness" which enables the blind person to move freely in his/her environment [7]. In regards to detect obstacles, many proposals have tried to address this challenge and they have been nearly succeeded in this. So many hand-held and wearing devices have been introduced which detects obstacles nearby and warning the user or blind person to change the direction of moving. IR and ultrasonic sensors have been used in the devices to measure the distance between the user or blind person and the object. **Smart blind sticks** are recently introduced which has capabilities to detect obstacles with in a range (2-3 meters), sensing water or humidity, detecting fire etc. [9]. This smart blind stick is our main topic and we will focus on its functionalities and working etc. in later sections.

In case of locating the person or guiding the person, a wide range of mobile applications have been introduced or developed using the modern technology including **GPS** and **Google maps**. Most of them tell you your current location; inform you about the nearby places. For reading, a braille printing services has been used for many years and it is a system of raised dots that can be read with the fingers by people who are blind or who have low vision [8]. After that scanner has been introduce to convert the text document into digital form. This facility is also available in today's smart phones.

Mobile companies, computer manufacturers and operating systems' developers have worked very magnificently to make their mobiles, computer and operating system available for blind or visually impaired people too. Many features like **narrator**, **magnifiers** etc. are introduced by Windows Operating System. Apple Company has introduced "Siri" which guide everyone with visual problems. **Google Assistant** is recently introduced in android and in mobile application which takes verbally commands and does what you tell it. Similarly in windows 10, **Cortana** is added which assists every user and works at least similar to Google Assistant. Bellow we will focus on few related work yet done in the area of sensing obstacles etc.

As we said that many magnificent proposals have been done in the area of location and mobility assistance for blind or visually impaired people. For many years, guide dogs and white canes are being used for navigation purposes. Then different electronic devices or mobility aids have been introduced due to the advancements of modern technologies. These mobility aids sticks or hand-held and wearing devices are generally known as "Electronic Travel Aids" [10]. Most of these devices or sticks have used almost ultrasonic and IR sensors to detect obstacles in the way or path. For water detecting, wet sensor or humidity sensors have been used [11]. All of these devices or systems are suitable for both indoor and outdoor navigation. Some of the previously used mobility aid devices are Sonic Pathfinder, Mowat Sensor.

- Sonic Pathfinder:

  It is an early mobility aid device used by people with vision impairment. Sonic Pathfinder is produced as a result of "Blind Mobility Research Unit at Nottingham University, England" [12]. Sonic Path-finder is a head-mounted device showing in figure 1 that transmits ultrasonic waves at high frequency. There are sending and receiving transducers. Some transmit ultrasonic waves and the other receives the echo came back after hitting object in a range. As a result the microcontroller or microcomputer measure the distance between the object and the user's head. If it is near, then the user is informed

by producing audible messages. In this way the person changes direction or will move forward carefully to touch the thing. Sonic Pathfinder also gives suggestions etc. by using Artificial Intelligence [12].

Figure 2.2-1 Sonic Pathfinder

- Mowat sensor:

  It is another hand held device for blind person which uses high frequency sound to detect object with in a range. When it detects an object, it vibrates in different ways. It also measures the distance and it also tells the person how close the object is [14].

Figure 2.2-2 Mowat Sensor

- Smart Stick of Low Cost for Blind and Partially Sighted People [9] :

  In this area of research Mithiles Kumar, Faysal Kabir and Sahadev Roy have done a very noteworthy work where they proposed a stick similar to the stick we are proposing here. They named it “Low Cost Smart Stick for Blind and Partially Sighted People” showing below in figure 3. In the proposed system, they introduced water sensor for sensing water, IR sensor to detect the closest items. Ultrasonic sensors are to detect items or

objects in a range between 1- 3 meters, and to measure the distance between the stick and the objects. Buzzer and vibrator have also introduced. Flame sensors are to detect a flame of fire. LDR is to detect the light and condition. Flash light was also introduced in the current system. The flash light will be on when the person is in dark, telling other people that there is someone moving/coming [9].

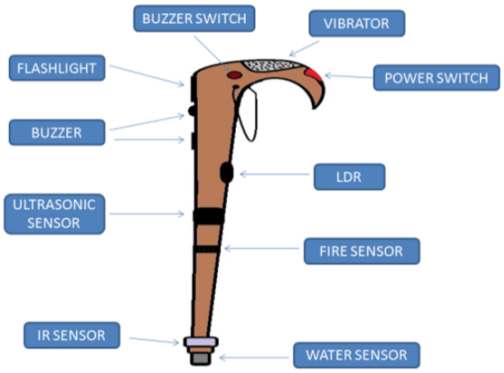

Figure 2.2-3 Low Cost Smart Stick

- Discrete Distance and Water Pit Indicator using AVR ATmega8 in Electronic Travel Aid for Blind [10] is another notable work for indicating water pit and discrete distance has done by Manoj Badoni and Sunil Semwal, where they suggested using wire probes to detect the water pits.

Figure 2.2-4 Wire Probe

- Face recognition system is also introduced by many researchers including M.Rajeshwari, G Sharmila – Assistant professor and students of "Department of Information technology, Panimalar Institute of Technology, Chennai, India" where they used **Haar** algorithm for detection and **LBP (***Local Binary Pattern***)** algorithm for face identification. It compares the image detected with the images already stored in the system [15].

- Voice Enabled Smart Walking Stick For Visually Impaired is also introduced by Akhila Jose, Greeshma George etc. Students of "Dept. of EEE, Mar Baselios Institute of Technology and Science, Nellimattom, Kerala, India" [11].

- Gentlemen like G. Prasanthi and P. Tejaswitha also proposed a sensor assisted stick for visually impaired people. The objective of their stick was to develop a stick for blind people to detect obstacles, manholes and pits on the ground in order to make the blind person free to walk. They proposed sensors to detect the obstacle for collision avoidance, and even to avoid obstacles in all other direction as well. They also introduced voice record as well [16].
- In [17], they designed a microcontroller based mobility aid for blind people. The stick they proposed is consisting of sensors with AT89C52 which is a microcontroller. They used it for to process, receive and send signals to the alarm system. They designed this system and implement this system in assembly language. They also checked it through blind people. They used hardware like the microcontroller we mentioned above, ultrasonic sensor, pit sensor, and alarm system, etc. The designed system is affordable, usable and reliable. They also used different sound patterns in their alarm system to differentiate the warning of different sensors.
- Smart White Cane [18]:

  A Smart White Cane is a proposed walking aid by R. Sheth, S. Rajandekar, S. Laddha and R. Chaudhari. They designed it to detect obstacles by a visually impaired person. They used ATMega328PU which is a microcontroller, ultrasonic sensor which are also used by us in our probject, vibrator, and headphones for audio feedback from the system. They tried to inform the user using the pre-recorded messages and through haptic in case of deaf person. The stick can detect many things like obstacles, depth, up and own, etc.
- G.Gayathri, M.Vishnupriya, R.Nandhini, and Ms.M.Banupriya[19], proposed a study to in order to introduce walking stick which will alerts blind people over obstacles, water pit, etc. Their stick will be tool, in fact a navigation tool for the intended users. Their stick consists of sensors for giving information about the surrounding. GPS technology is used to determine the optimal path using pre-defined locations stored in the system.
- In reference [20], these three people introduced a voice based ultrasonic smart walking stick for blind people. They used ultrasonic sensors to monitor and get data from the surrounding and to achieve information from the collected data. The information then converted into audio messages for sake of the blind person to be guided accurately. They also introduced a remote and GPS system in the stick to find the stick by the user and to track the person respectively.

- In [21], they used five ultrasonic sensors in five different location or sides in order to cover maximum area. In order to detect obstacles ahead and to detect indoor objects, they used camera. They used Raspberry pi which keeps the image dataset. The dataset consists of different collected samples of the different obstacles. The images then are compared with the already stored sample using an algorithm called Haar Classifier.
- K.S.Manikanta, T. S. S. Phani and A .Pravin in [22], proposed the designing and implementation of smart walking stick for obstacles detecting using ultrasonic sensors and navigation system using GPS and SIM800L Modules. The stick has a button to send emergency messages to the dedicated users. A wireless based IR sensor to locate the stick by the visually impaired person. Both buzzer and vibrator are used to inform the user.

2.3 Discussion

As we told before that many people and researchers in the field of technology have worked in different ways to eliminate most of the challenges faced by a visually impaired person. They almost worked on the issue related to mobility of the visually impaired person. For obstacle detection, most of the researchers have been used ultrasonic or sonar sensors and IR sensors to detect the objects coming in the way of a visually impaired person. For example in sonic path finder – a hand-held device, they have used ultrasonic sensor's wave's transition to detect things. The mowat sensor; on head wearable device also used the same technique. In the noteworthy research done by Mithiles Kumar and Faisal Kabir, they have introduced water sensors for sensing water presence, and IR sensors for detecting closest item. As you can see they also introduce light and flame sensors to detect the flame of fire and light intensity. Manoj Badoni and Sunil Semwal introduced water probe to detect water presence. M Rajeshware and his friends introduced face recognition system for visually impaired people, where they used algorithms like Haar for detection and Local Binary Pattern for face identification. Other gentlemen proposed a sensors assisted stick for obstacles detecting, manholes etc. in order to make the visually impaired person's free to walk. They used sensors in almost every direction. The study in [17], proposed a microcontroller based stick having an alarm of different tones showing feedback from different sensors. In smart white cane, they introduced both vibrator and pre-recorded audible messages. G. Gayathri and his/her friends used GPS technology to determine the optimal path using pre-defined locations stored in the system. Some introduced a remote to find the stick by a visually impaired person. In [17], they proposed a camera for indoor object detection. In [22], they

introduce SIM800L module and GPS system. I have compared some of these and from other research papers in the table given below.

Table 2.3-1 Papers Comparison Based On Features

Paper	Feature 1	Feature 2	Feature 3	Limitations
Mowat Sensor & The Nottingham Obstacle Detector (NOD)	Obstacles localization	Smaller in Size	Handheld	Limited to obstacles localization only
White Cane [27]	Obstacles Detection by touching them	Symbol of blindness	Round head/bottom and long	Limited to detecting obstacles only
Use of Sonic Pathfinder for Mobility	Obstacles Detection using sensors	Avoiding Contacting Objects	Suggests Changes in Direction	Limited to detecting obstacles only
Smart Cane for Visually Impaired [28]	Obstacles detection using sensor	Avoid contacting	Emergency Calling using GPS-GSM	Sends sms to predefined number
Smart Cane Indicating a Safe free Path [29]	Obstacles Detecting Three Directions using three distance sensors	Vibrate according to situation	Affordable	No sound system and limited to vibrations only, no GPS system
Low Cost Smart Stick for Blind and Partially Sighted People [8]	Both large and small Obstacles, water, flame and light detecting sensors	Buzzer/Vibrator	Flash Light	No GPS Based Navigations
Voice Enabled Smart Walking Stick	Obstacles localization and sound synthesizer	Predefined locations using SD card	GPS System to locate the current location	Person's orientations aren't handled

Chapter 3
Existing Technology

3.1 Introduction to Arduino

Arduino is an open-source electronics platform which is used for building electronics projects [23]. This open-source platform is based on easy-to-use hardware and software components. Arduino has both physical programmable circuits and software Development Environment. You can use this IDE to upload the code or a piece of instruction to the Arduino circuits. Arduino board can read input from different sensors like flame sensor, ultrasonic sensors etc. They can also trigger motor, LED. The Arduino platform is very popular for the people who just started to learn things related to electronics and related to software and hardware integration. The Arduino platform uses simplified version of C++. As a result it is making it easier to learn programming in Arduino. You can easily connect other hardware components like Wi-Fi modules, GSM modules to Arduino as well to provide internet to the board for online communication with online server and other boards and components, etc.

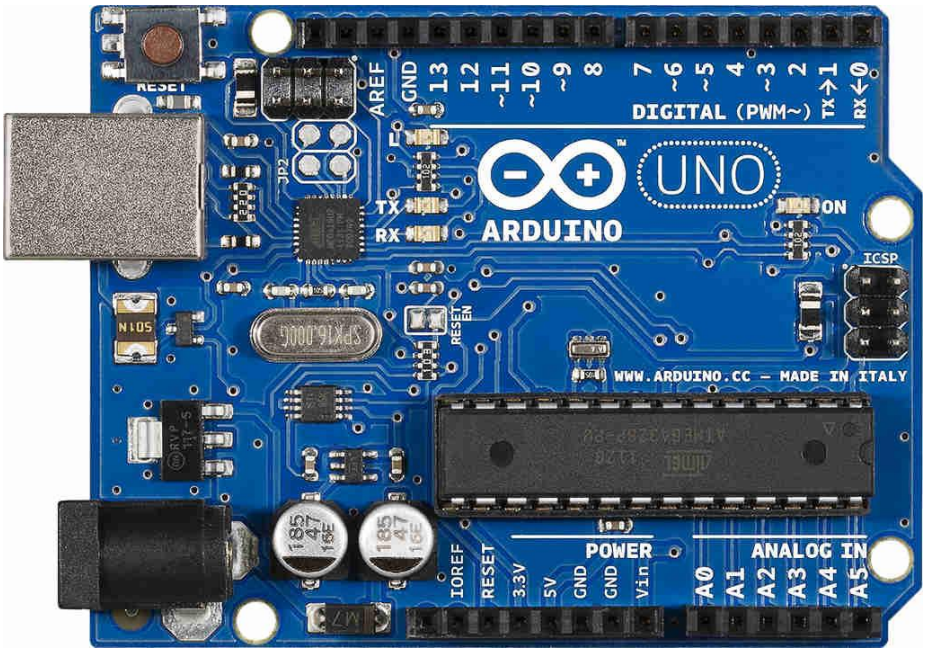

Figure 3.1-1 Arduino UNO Board

3.1.1 Types of Arduino Boards

Board of Arduino is an open-source hardware which helps us in making electronics projects. To upload code to these boards, you will need to install an IDE provided by this platform. Arduino has different types of boards depending on pin, storage capacity, etc. They are used for making different engineering and electronics projects and for making applications IoT

applications. There are other microcontroller platforms and similar to Arduino like Raspberry pi, etc. [14].

The list of Arduino boards is given below:

- Arduino Uno (R3)
- Lily Pad Arduino
- Red Board
- Arduino Mega (R3)
- Arduino Leonardo

3.1.1.1 Arduino Uno (R3)

If you are a beginner to Arduino, then UNO is the best option for you to play with. This Arduino board is consisting of 14 pins assigned for digital input/output. Six of these pins can be used for pulse width modulation (PWM). Six pins from A0 to A5 are analog inputs. There is a reset button also. In this board you have a USB Connection and a charging plug. For programming it, simply connect this board using a USB cable to a PC where we have installed Arduino IDE. The computer will supply 5v AC current if you don't want to supply current from another source.

Figure 3.1-2 Arduino UNO Board

3.1.1.2 Lily Pad

This board is designed by Leah and SparkFun and this board is wearable and e-textile board which can be easily implemented in things like clothes etc. This board can easily sew into clothing by using conductive thread. Lily Pad boards are even washable. They can be powered via the USB cable or you can provide external power supply.

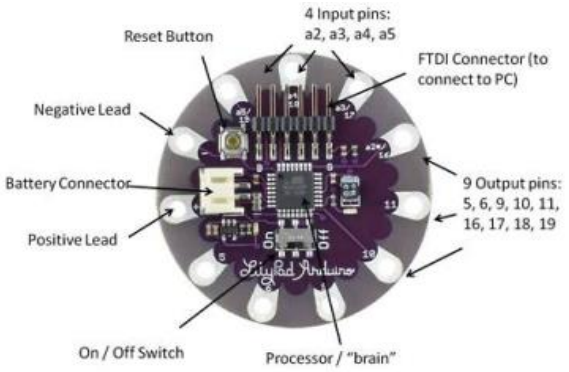

Figure 3.1-3 Lilypad Arduino Board

3.1.1.3 RedBoard Arduino Board

This RedBoard looks just like and acts like an Arduino Uno, but is little different and is modified to make the more suited to our projects. Redboard uses mini-B connection while Arduino Uno uses a B type USB connector. There are no sharp edges on the back of the board. Color is also a distinct thing, we may not consider it.

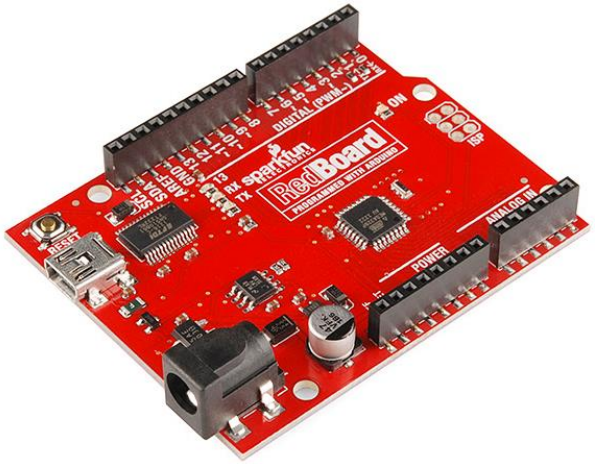

Figure 3.1-4 Redboard Arduino Board

3.1.1.4 Arduino Mega

This board is similar to the UNO we talked about, but you can call it a big brother of Arduino UNO, because it has a lots of pins assigned for digital input/out. Fourteen pins are PWM, six are analog inputs pins, a reset button to reset the board. It also provides a power jack. You can upload code to this board through USB cable plugged into USB hub. It has more storage capacity than Arduino.

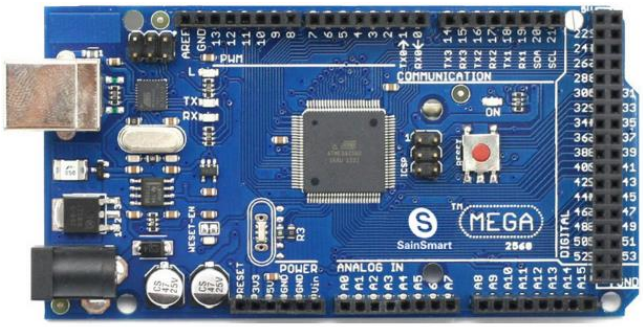

Figure 3.1-5 Arduino Mega Board

3.1.1.5 Leonardo Arduino Board

Arduino developed this board for the first time. This board has a microcontroller and a USB. This is very simple and cheap board. This board is consisting of 20 pins assigned for digital i/o. seven of them are PWM outputs. Twelve are analog input. This board is different from other boards just in ATmega32u4 and in built-in USB communication

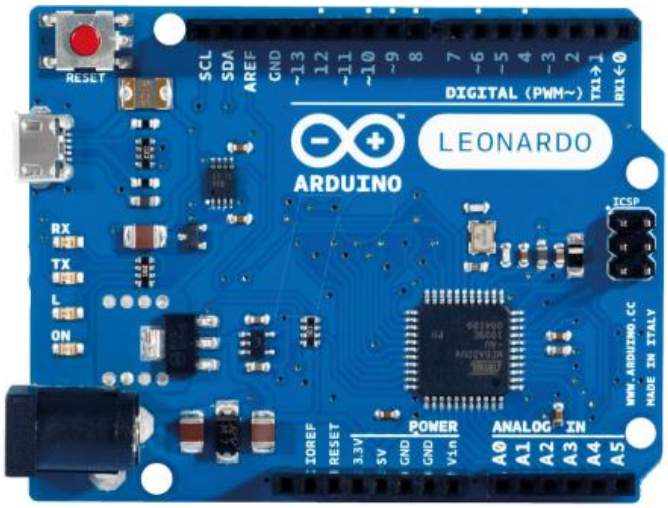

Figure 3.1-6 Leonardo Arduino UNO

3.2 Ultrasonic Sensors

To generate, detect and to process ultrasonic signals ultrasonic is the transmission of ultrasonic waves of frequency more than heard by human ear. This can be used for different applications e.g. ranges calculation. We have used Ultrasonic Ranging Module HC - SR04 in our project. You can see in the below. This ultrasonic sensor has 4 pins. The pins are VCC for 5v voltage, Trigger, Echo and GND respectively. We used this module to measure the distance between the stick and the obstacles coming in the ways of a visually impaired person. The module has transmitter T and Receiver R the T transmits the waves and the R receives the echo sound. As a result you can calculate the distance traveled by sound simple formula given here [25].

Distance = Speed × Time

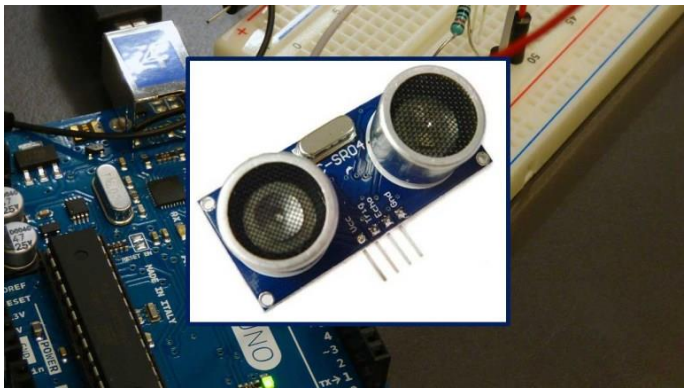

Figure 3.2-1 HC-SR04 Ultrasonic Sensor Module

3.3 Coin Flat Vibrating Vibration Motor

This Coin is vibration Motor which is also called flat vibration motor or pancake vibration motor. This is a type of ERM Motors. It looks like a coin because of its thickness. This vibrator is located in shell, which helps in reducing the thickness. The shell also provides strong closure. This type of vibrator motor can be used to provide user with alerts and haptic feedback.

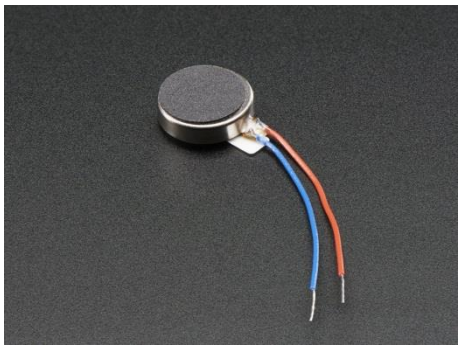

Figure 3.3-1 Coin Flat Vibrating Vibration Motor

3.4 KY-006 Small Passive Buzzer

This is a buzzer module is a structure of integrated electronic traducer. This needs only DC power supply and is widely used in computers, printers, alarms and toys etc. There are three pins of which S can be connected to output digital pin and – pin of the module to the GND of the Arduino.

Figure 3.4-1 KY-006 Small Passive Buzzer

3.5 ESP8266 (ESP-01)

The ESP8266 module which is also called ESP-01 is a self-contained SOC with integrated TCP/IP protocol stack that can give any microcontroller like Arduino access to your W-iFi network. This module can be implementing in many home assistant applications. You can program this module to connect to internet and to monitor devices anywhere through internet via computer, mobile applications. This module can work stand alone as well. It means that you won't need to connect to any microcontroller in some applications. I personally used it in this project and in another application where I controlled a relay through this module via an android application created by me for this purpose. This module both support SoftwareSerial library and ESP8266 http and httpClient libraries to communicate with internet. The module itself provides an ip which can be visited in mobile or computer's browser. This module runs on AT commands and has 8 pins. You can see them in below figure. The most difficult thing in this module is to program it for the first time. You can use many methods, but the best method is to use a programmer to upload code into it.

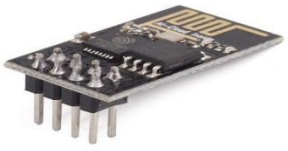

Figure 3.5-1 ESP8266 ESP-01

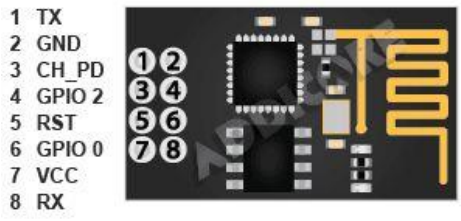

Figure 3.5-2 ESP8266 ESP-01 PINSOUT

3.6 ESP32 CAM

The ESP32-CAM is a camera module based on ESP32-S chip. This module is small in size which cost approximately $15. This camera is integrated with OV2640 camera and it has several GPIOs to connect to different peripherals. Besides that it also proved a feature of micro SD card slow. This micro SD card slot can be useful to store images taken through this camera. This slot can also be used for storing file to serve the client.

Figure 3.6-1 ESP32-S CAM

This camera can be used for many applications like face recognition, time-lapse image capturing, remote image capturing, in video surveillance. This module also provide video streaming server. You can also send picture through this module and we in fact use this camera for this purpose. There are 3 GND pins and two power pins. One power pin is 3.3v and the second one is 5v. The serial pins are GPIO 1 and GPIO 3. To upload code into the module, you will need these two pins. To make the module in flashing mode, you have to connect GPIO 0 to GND. After flashing, just disconnect GPIO 0 from GND. GPIO 2, 4, 12, 13, 14 and 15 are used by the module itself to access micro SD. You can see all the pins given in the figure below.

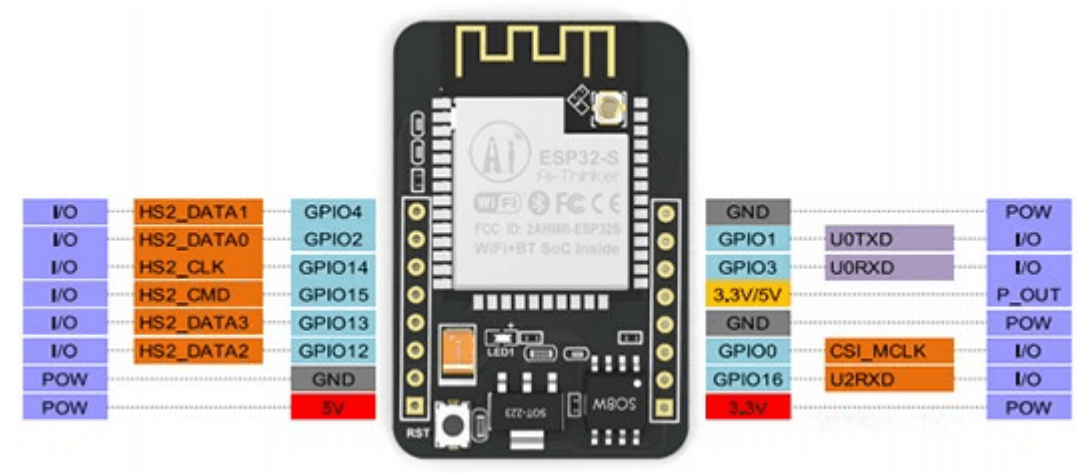

Figure 3.6-2 ESP32 Cam Pin out – From SeeedStudio

3.7 GPS Module (NEO-6M-0-001)

A GPS system is a Global Positioning system based on satellite navigation. This GPS module is a powerful GPS module used with multiple microcontroller i.e. Arduino to track the targeted things in which you will implement this module. In our project we used this module to track visually impaired person using mobile application. It provides a price location and works for many satellites placed in orbit. This module has five pins. They are PPS, RxD, TxD, GND and VCC.

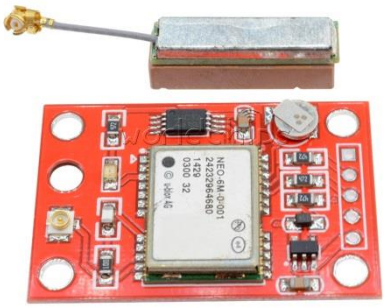

Figure 3.7-1 GPS Module

This module runs on power from 3.3v to 5v. You can power it using Arduino pin 3.3v or 5v. The RxD and TxD pin will be connected to the Arduino serial. You can use Software Serial to get the raw data from the module. For getting what you want, you need to use libraries like TinyGPSPlus and more.

NEO-6M GPS Module	Wiring to Arduino UNO
VCC	5V
RX	TX pin defined in the software serial
TX	RX pin defined in the software serial
GND	GND

Figure 3.7-2 GPS Module Pin Wiring With Arduino

3.8 Summary

We studied different devices and modules we have used in our project from existing technology. We have talked about Arduino, which is an open source electronics platform for building electronics and embedded system projects. We have used Arduino as a micro controller in our project and we used its Ide. Arduino IDE used to edit, debug, compile and upload Arduino coding or sketch into different Arduino boards or modules. The Arduino platform uses C and C++ language as official language. Arduino make it easier for you to learn programming in Arduino. Then we discussed few types of Arduino boards available in the market. Some of them Arduino UNO, Lily Pad and Arduino Mega, etc... They are almost different in few things like structure, power supply methodologies, number of pins and storage capacity. Then we discussed ultrasonic sensors. The one we used in our project is the HC-SR04. The ultrasonic sensors use ultrasonic waves to measure the distance between two objects. There are two eyes of this ultrasonic sensor. One eye transmits waves and the second one receives the reflected waves once the waves hit an object. As a result the time taken by the waves from both sides is used to calculate the distance between two items. Then we discussed a type of vibrator called coin flat vibrating motor. We used this vibrator for haptic feedback given by the system. This type of vibrators is very small and thin in structure and is suitable to be used in small devices like mobile phones. For audible feedback we choose to use small passive buzzer. There are three pins in this type of buzzer. We used the pin “s” and the pin “-“, and connect them to the digital pin of the Arduino and to the GND pin of the Arduino respectively. Then we have a Wi-Fi module esp8266 esp-01 which is very cheap in cost and small in size. This module helps you access to your Wi-Fi network easily. The module itself runs on AT commands, but you can use esp8226 libraries to get access to different TCP/IP protocols and http requests etc. For taking and sending picture, we have chosen ESP32-S Cam which is a type of camera based on ESP32 chip integrated with OV2640 camera and micro SD card slot. Besides all these, for tracking system, we have

chosen a GPS module called NEO-6M 0.001; a powerful GPS module which can be used with microcontroller like Arduino.

Chapter 4
Software Components and Requirements

4.1 Introduction

To gather all the software requirements, we will need to use different software engineering approaches. As a result we will achieve the objectives we have mentioned in chapter 1. In our project we have two users, one stick and one Android application. The user1 is referred to the visually impaired person. The user2 is one who is using Android application. The user1 will use the stick. The stick will have a serial number needed for the registration in the Android application. First of all we will gather and specify the requirements related to user1 through different software engineering requirement specification. After that we will dig into the Android application side.

4.2 User1 Requirements Specification

To specify the requirements related to user1, we will need to understand his/her interaction with the stick itself. There are some use cases for the user1 which shows how he/she interacts with the system (stick). These use cases are given below.

- **Power On The Stick**:

  The user1 will simply presses the power on button given on the top of the stick. When he presses the button, the stick boots up and initializes to be used now.
- **Follows The Haptic and Audible Feedback**:

  The user1 follows the haptic feedback in case he/she is deaf as well. Otherwise, he/she follows the audible feedbacks which are in this case beeps with particular patterns.
- **Using GPS Location**:

  The user1 on the GPS system in case, he/she wants to go out, and wants to be located using the Android application.
- **Take and Send Photo**:

  To take and send pictures to the online server, the user1 will press and hold the button assigned for camera until a beep is generated.

4.2.1 User1 Use Case Diagram

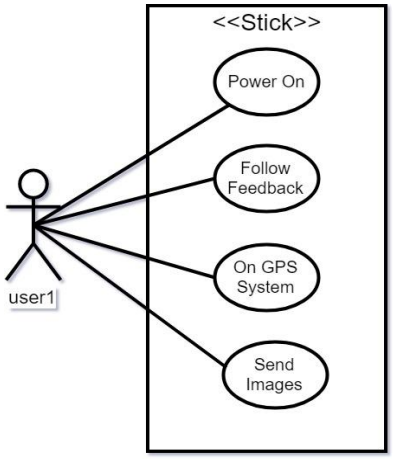

Figure 4.2-1 User1 Use Case Diagram

4.3 Ultrasonic Sensors, Vibrator, Buzzer Block Diagram

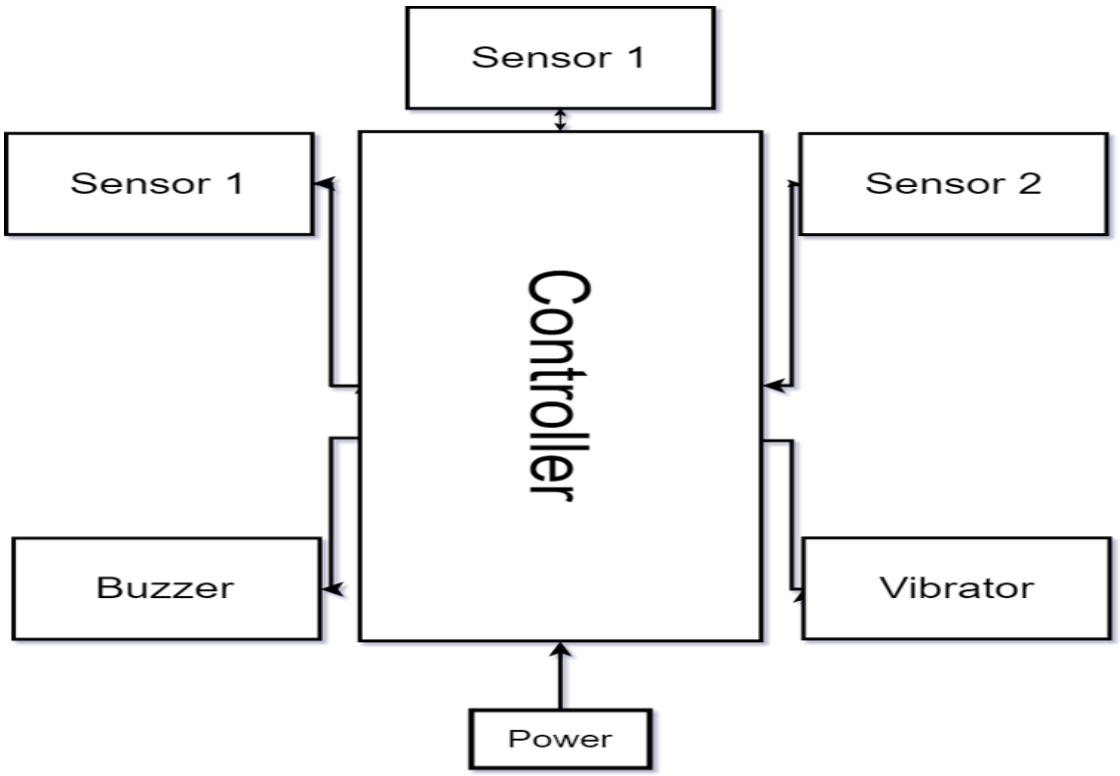

Figure 4.3-1 Ultrasonic, Vibrator, Buzzer Block Diagram

4.4 Three Ultrasonic Sensor Programming Flow/Reasoning Chart

Three ultrasonic sensors, a vibrator and a buzzer is will be implemented according to the below flow chart. The values can be changed later.

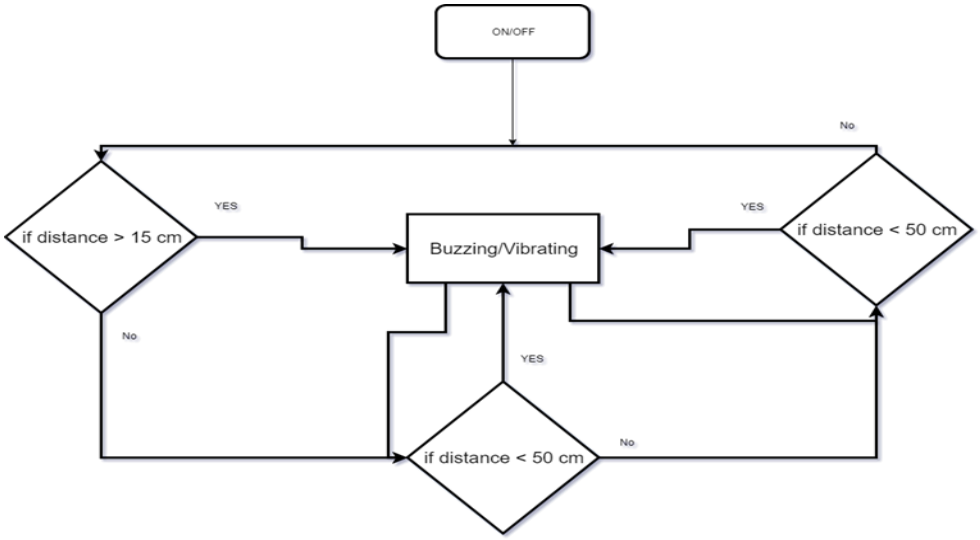

Figure 4.4-1 Ultrasonic Distance Reasoning

4.5 Block Diagram of Data from GPS Module to Server

The GPS module sends raw data to the Arduino. The Arduino gets latitude and longitude values and concatenates it to a single string which is sent to the esp8266 module. The esp8266 module waits for the coming serial data and gain that once the Arduino sends that string consist of latitude and longitude. The esp8266 then send this string as http GET to the server where a script of PHP waiting to get this piece of string as a value to the GET. The PHP code then split the latitude from longitude value and save them in a database with timestamp.

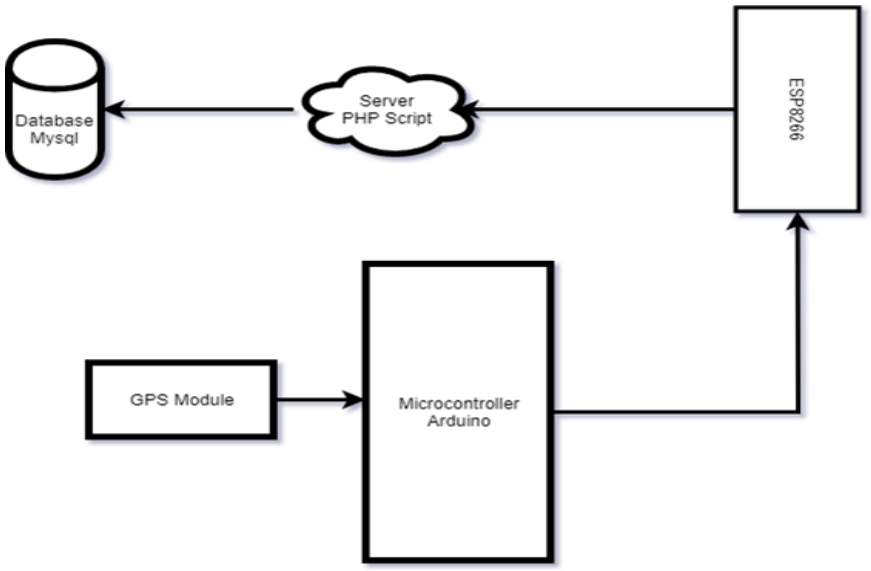

Figure 4.5-1 from GPS to Server

4.6 ESP32 Cam Block Diagram Explanation

By powering the camera on, the module tries to connect to the internets. After connecting to the internet, it takes a picture after a time-lapse and sends it to the online server, where a PHP server waits to get the content of the image and to store the image in a user's folder. The script also stores the path to that image in MySQL database in against the user's serial number.

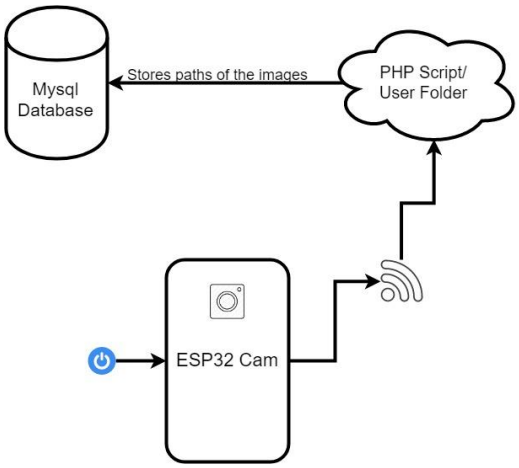

Figure 4.6-1 ESP32 Cam Block Diagram

4.7 User2 Requirements Specification

To specify the requirements concerned with user2, we will need to analyze all the interactions he/she does with the system (Stick) and with the Android application he will used to locate the user1 which is a visually impaired person. There are some use cases where he/she shows while interacting with the system and application. These use cases are given below.

- **Charge the Stick's Battery:**
  The user2 plugs the charger to the stick in order to charge the battery of the stick.
- **Downloads and Installs Application:**
  The user2 downloads the application into his/her mobile from online app market or from the link given, in order to track the user1 (visually impaired person).
- **Sign Up / Registration:**
  User2 opens the application. A pop up appear to select the desired language. Then the user2 taps on Registration Button. The user2 enters his/her info (name, username, email, password and a serial number given with the stick) and click Sing Up. The info given is validated and user is registered and is logged in to the account.
- **Login to the Application:**

User2 opens the application and enters his/her info (username and password). After giving info the user2 tap on Login Button and the application verifies his/her username and password through database. After verification, the user2 is logged in.

- **View Photos:**

  A logged in user2 taps on a tab “Photos” given in the bottom menu of the application. A window appears with three buttons, “Fetch Images”, “Next” and “Previous” for fetching the images, seeing old images and new images respectively. Then the user2 tap on “Fetch Images” to fetch all the images in user’s folder. Tap on Previous and Next to watch the new and old images uploaded.

- **Change Language Preference:**

  A user2 taps on the iconic menu given at the right or left top action bar and selects either URDU or English as a interface language.

- **Logout from the Application**:

  A logged in user2 taps on the iconic menu given at the right or left top action bar and clicks on Logout Menu and app redirects the user to authentication activity.

- **Recover Password**:

  The user2 forgets his/her login password and he want to recover the password. To recover the password user2 taps on “Forgot Password” button. The button leads the user2 to enter his/her email. The user2 enters his/her email and tap on submit button. The system sends a six digit code to verify the user2 and leads the user2 to enter the verification code. The user2 opens his/her email and copies the code. He then enters this code in the application. The system verifies the code and after verification, the user2 is allowed to enter new password. The user2 enter correct new password and taps on change password. The app redirects him to the previous activity. Now, the user2 logins using the updated password.

4.7.1 User2 Use Case Diagram

The following use case diagram shows the interactions of the user2 with the mobile application, before and after registration to the application.

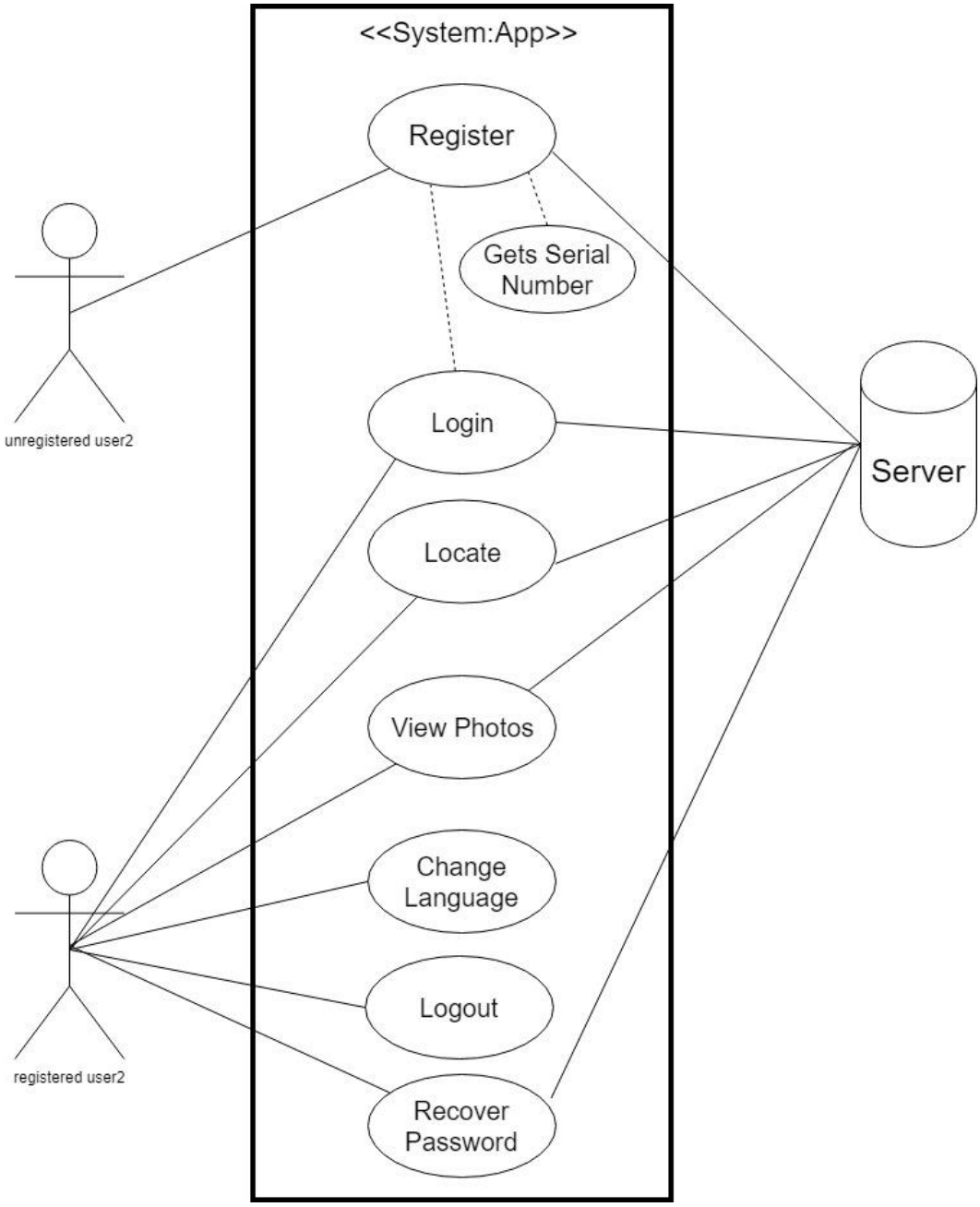

Figure 4.7-1 User2 Use Case Diagram

4.8 Database and Tables Structure

Four different tables are needed to be created under a database in phpmyadmin. These four tables are users, serial, GPS, and esp32pic. The user table will have user's authentication's information. Serial table will have a list of active and inactive serial numbers. GPS will have the latitude and longitude data and esp32pic table will stores paths for the stored pictures.

4.8.1 Users Table

This table is a database table used for storing mobile application users' data. Where "id" represents each user's unique identity number of type INTEGER, name, email, username,

password, serial, token stores name, email, username, password, serial, token of type VARCHAR. The date field stores user2's registration date and time.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id	int(11)			No	*None*		AUTO_INCREMENT
2	name	varchar(30)	latin1_swedish_ci		No	*None*		
3	email	varchar(100)	latin1_swedish_ci		No	*None*		
4	username	varchar(30)	latin1_swedish_ci		No	*None*		
5	password	varchar(255)	latin1_swedish_ci		No	*None*		
6	serial	varchar(30)	latin1_swedish_ci		No	*None*		
7	token	varchar(255)	latin1_swedish_ci		No	*None*		
8	date	timestamp			No	CURRENT_TIMESTAMP		

Figure 4.8-1 User Table

4.8.2 Serial Table

The serial table on the other hand has some serial numbers generated by the administrator. These serial numbers are given with each stick. The serial number is required while registering to the application. The field "id" represents unique id of the serial number, serial field stores serial and the status stores 1 or 0 showing an active or in active serial number.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id	int(11)			No	*None*		AUTO_INCREMENT
2	serial	varchar(30)	latin1_swedish_ci		No	*None*		
3	username	varchar(30)	latin1_swedish_ci		No	*None*		
4	status	int(1)			No	0		

Figure 4.8-2 Serial Table

4.8.3 GPS Table

The GPS table stores the latitude and longitude data uploaded from the stick against a username. This data then retrieved by the user2 through android mobile application. The field time stores the data updated time.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id	int(11)			No	*None*		AUTO_INCREMENT
2	username	varchar(30)	latin1_swedish_ci		No	*None*		
3	time	timestamp			No	CURRENT_TIMESTAMP		
4	lat	varchar(12)	latin1_swedish_ci		No	*None*		
5	lang	varchar(12)	latin1_swedish_ci		No	*None*		

Figure 4.8-3 GPS Table

4.8.4 ESP32PIC Table

Once the camera module uploaded the pictures to the server, the responsible PHP script also stores the path of the pictures in the database. This table in fact stores those paths to the

pictures. The field picPath is the path of a picture, uploadDate stores uploaded date and time and the username stores username of the stick.

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
1	id	int(11)			No	*None*		AUTO_INCREMENT
2	picPath	varchar(200)	latin1_swedish_ci		No	*None*		
3	uploadDate	timestamp			No	CURRENT_TIMESTAMP		
4	username	varchar(50)	latin1_swedish_ci		No	*None*		

Figure 4.8-4 ESP32PIC Table

4.9 Arduino IDE

Arduino as we told that it is software to upload code into different Arduino boards. This is an open source integrated development environment to compile and write code into different Arduino and non-Arduino modules. This IDE is the official software provided by the Arduino platform for free. This software is easily available for multiple OS like Windows, Linux and Mac and it runs on Java platform. The IDE has built-in debugging, editing and compiling tools. The code written to the Arduino modules is called sketch. The IDE compiles and generate Hex Files which are then uploaded in the controller of the Arduino modules. The Arduino IDE supports both C and C++ languages. The IDE has usually two things; the compiler and editor. You need to write the code in its editor and then plug your module through USB connection to the Computer. Compile the code and then upload it to the modules controller.

Figure 4.9-1 Arduino IDE Editor Blink Example

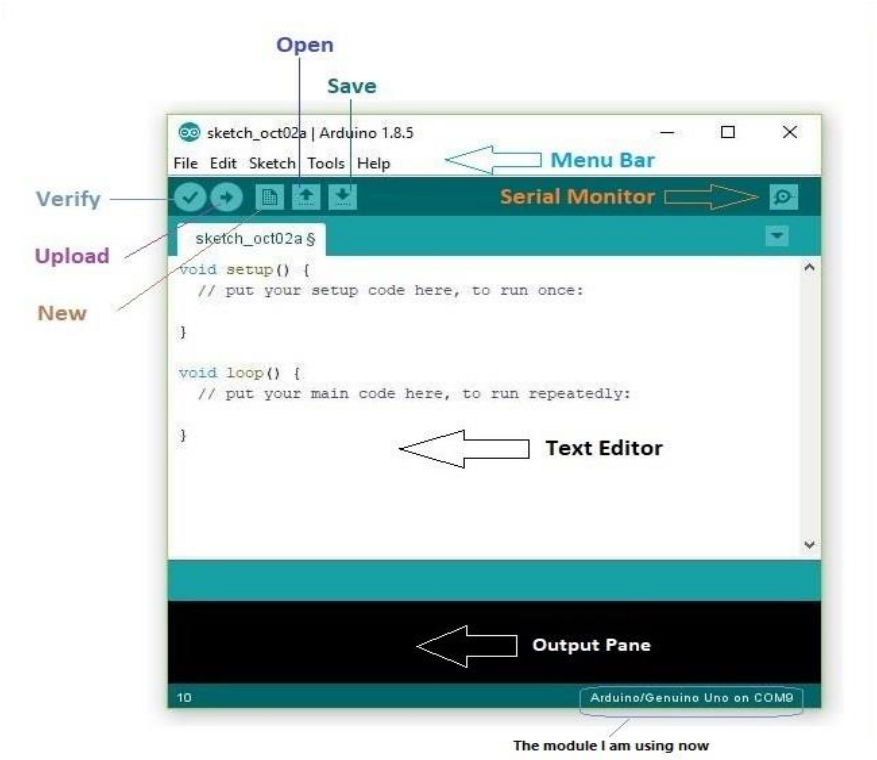

Figure 4.9-2 IDE Buttons' Details

4.10 Android Studio

Android studio is official software used for the android application development. It is the official IDE from Android platform which is based on the IntelliJ IDEA [26]. The IntelliJ IDEA is a java IDE for software development and also provides variety of tools for editing and developing. The Android studio uses Gradle build system, code templates, different emulators and Github integration in order to run the application within an Android operating system. Android Studio provides awesome editors to assist the developing by offering refraction, code completion, and debugger. Using Android Studio you can easily generate APK files which can be uploaded to Google Playstore. In 2013, the Google announced this software. The stabled version released in 2014. The Android Studio is available for many OS like Windows, Mac and Linux desktop version.

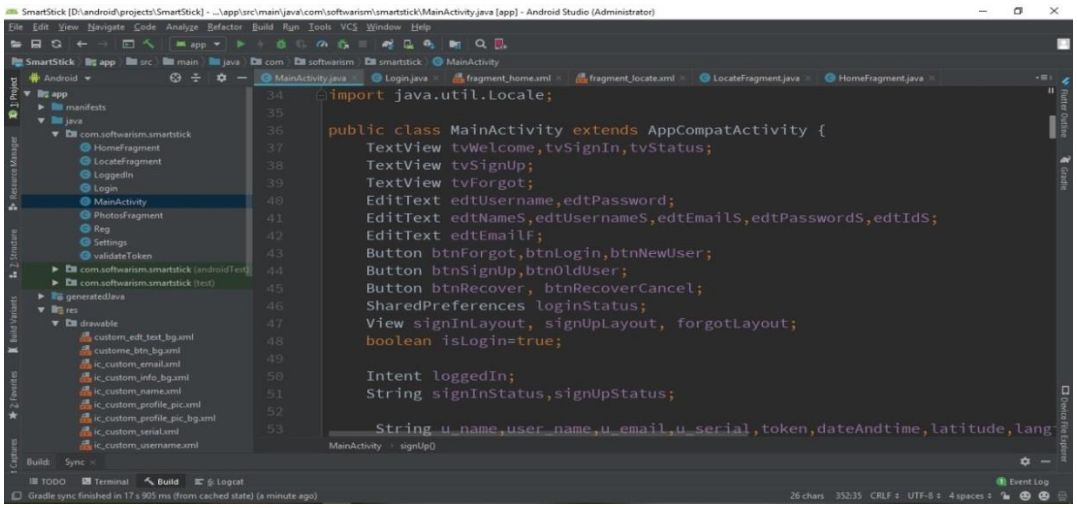

Figure 4.10-1 Android Studio User Interface & Editor

4.11 Summary

In chapter 4, we used different software engineering techniques and software UML diagrams to collect and specify the users' requirements. We recognized two types of users. One the visually impaired person itself and the second one is the one who will use mobile application to track the visually impaired person and will view the photos uploaded by the visually impaired person. We named them as user1 and user2. We have discussed the user1 requirements using a use case diagram. After that we presented a block diagram of ultrasonic sensors and vibrator, etc. and we showed that how will we control by using a reasoning flow chart. How will we send the location's data from the stick, and for that we presented a block diagram showing a GPS module integrated with Arduino and ESP8266 module to send the raw data from the GPS module to the server. Then we found and analyze the requirements of taking picture by showing a module called ESP32 cam and its functionality to send picture to the server, by using a block diagram. After that we specified the requirements of the user2 by both small use cases and by presenting a mobile application's use case diagram. We found almost eight interactions of the user2 with the mobile application. To store the data from mobile application and from the stick we needed a database of different 4 tables. The data for authentication to the mobile application will be stored in the users table, the serial table will stores all the generated serial number by the stick provider, the GPS data from the stick will be stored in GPS table and the ESP32PIC table stores the uploaded pictures' paths in database. Then we discussed two IDEs used for Arduino programming and for Android mobile applications development. We will use Arduino IDE to edit, debug, compile and upload coding to the micro controller, and we will use Android Studio which is from Google based on Intellij IDE for Mobile application's development.

Chapter 5
Smart Stick Guider for Visually Impaired and Deaf Person

5.1 Introduction

Here in this chapter, we will discuss the design and implementation of our project. We will talk about how we have integrated the overall system. We will cover both hardware and software configuration here in this chapter. Our goal is to demonstrate that how did we achieve our objectives. How we have wired different modules with micro controller. We will show schematic diagrams of each component and we may also provide source code in here if possible or at least we will try to explain few basic things related to communication between different modules. We have to explain how we prepared algorithm to control every device or module, so that it can work accurately. We will focus on the online tracking feature, picture capturing and then sending it to the server, we have to illustrate that the module or method we have used to share the current location with the intended user using mobile application. How to take picture and which mechanism should be used to send the image to an online server. We will discuss the Android mobile application we have developed for viewing the uploaded picture and for tracking the visually impaired last known position. What are the requirements to login and sign up to the application? Who is allowed to register for the application? We will cover all these questions in details further. Now let's start our project from the obstacle detecting.

5.2 Obstacles Detecting and Feedback Schematic Diagram

The following schematic diagram shows the offline obstacles avoidance system of our projects. In this diagram as you can see we have used three ultrasonic sensors integrated with Arduino UNO. The leftmost one is the one we deployed in the bottom of stick to measure the depth. The middle one is deployed in the middle of the stick to detect things coming in the front of the stick at a little height. The rightmost one is deployed in the top of the stick to avoid things coming in the front of the stick on higher position. You can see their deployment in figure 5.2-2. There is a buzzer which beeps accordingly. There is also a coin vibrator which provides haptic feedbacks.

5.2.1 Ultrasonic Pin Wiring

In ultrasonic sensors we have four pins, VCC, Trig, Echo and GND from left to right. Here the VCC is connected to Arduino 5v, Trig and Echo to the Arduino digital i/o pins and GND to the GND of Arduino.

5.2.2 Buzzer and Vibrator Pin Wiring

The buzzer's "S" pin is wired to the Arduino digital pin and the "-"pin is wired to the GND of the Arduino. Similarly the red wire of the vibrator is wired to the Arduino digital pin and the brown one is to the Arduino GND pin.

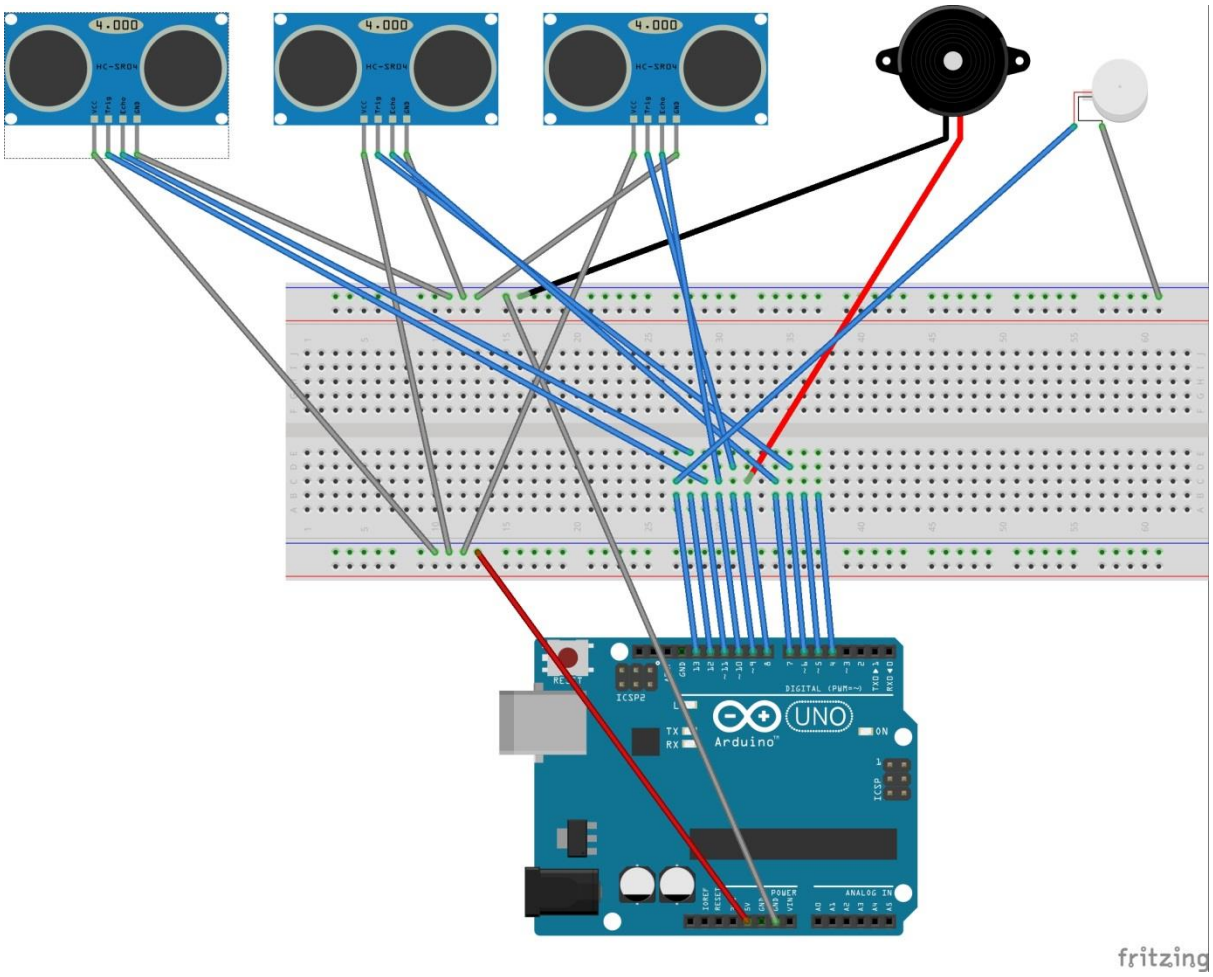

Figure 5.2-1 Schematic Diagram for Obstacles Avoidance

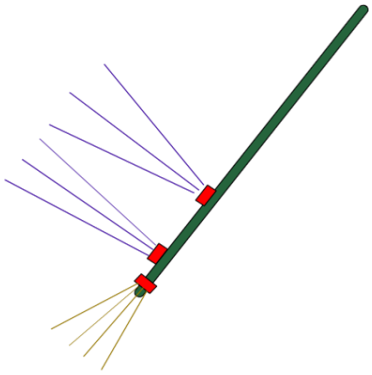

Figure 5.2-2 Ultrasonic Sensor Deployment

5.3 Obstacles Detecting and Feedback Arduino Sketch

In consideration to the above schematic diagram here is the coding or sketch of Arduino which should be uploaded to the Arduino through Arduino IDE.

```
int triggerl=11;
int echol=12;
int triggerm=6;
int echom=7;
int triggert=9;
int echot=10;
int buzzer = 8;
int vib = 13;
float time=0, distance=0, distancel=0,distancem=0,distancet=0;

void setup() {
  pinMode(triggerl,OUTPUT);
  pinMode(echol,INPUT);
  pinMode(triggerm,OUTPUT);
  pinMode(echom,INPUT);
  pinMode(triggert,OUTPUT);
  pinMode(echot,INPUT);
  pinMode(vib,OUTPUT);
  Serial.begin(9600);
}
void loop() {
  //=====for lowest
    distancel=findDistance(triggerl,echol);
  //Serial.print(distancel);
  //Serial.print("cm \n");
  if(distancel>20 && distancel<400){
    tone(buzzer,1500);
    digitalWrite(vib,HIGH);
    delay(350);
    noTone(buzzer);
    digitalWrite(vib,LOW);
    delay(350);
    //Serial.print(distancel);
    //Serial.print("cm \n");
    }
   delayMicroseconds(2);
```

```
   //=====for middle
   distancem=findDistance(triggerm,echom);
// Serial.print(distancem);
 // Serial.print("cm \n");
  if(distancem<50){
    tone(buzzer,1100);
    digitalWrite(vib,HIGH);
    delay(200);
    noTone(buzzer);
    digitalWrite(vib,LOW);
    delay(200);
    Serial.print(distancem);
    Serial.print("cm \n");
    }
   delayMicroseconds(2);

    //=====for top
  distancet=findDistance(triggert,echot);
  // Serial.print(distancet);
  // Serial.print("cm \n");
   if(distancet<50){
     tone(buzzer,1100);
     digitalWrite(vib,HIGH);
     delay(100);
     noTone(buzzer);
     digitalWrite(vib,LOW);
     delay(100);
     //Serial.print(distancet);
     //Serial.print("cm \n");
     }
  delayMicroseconds(2);

}
int findDistance(int trig,int echo){

  digitalWrite(trig,LOW);
  delayMicroseconds(2);
  digitalWrite(trig,HIGH);
  delayMicroseconds(10);
  digitalWrite(trig,LOW);
  delayMicroseconds(2);
  time=pulseIn(echo,HIGH);
  distance=time*340/20000;
  return distance;
  }
```

5.4 Schematic Diagram for GPS Data Sending

The figure 31 shows the schematic diagram of GPS module and ESP8266-01 module. The GPS module sends raw data to the Arduino using its TX and RX pins and the Arduino sends a string of latitude and longitude string to the ESP8266-01 module through serial. The ESP8266-01 then sends the string to the online server which in is our website link. We have kept a PHP Scrip for it in the GET link visited by the ESP8266-01. The Arduino simple uses

TinyGPSPlus library to get the values we are interested in it. These values are just the latitude and latitude if the GPS is available. For this we used Arduino Mega 2560 and the GPS module NEO-6M 0.001 is using HardwareSerial Serial1 for sending data to the Arduino. In Arduino Mega 2560, the Serial1 refers to pin 18 and 19.

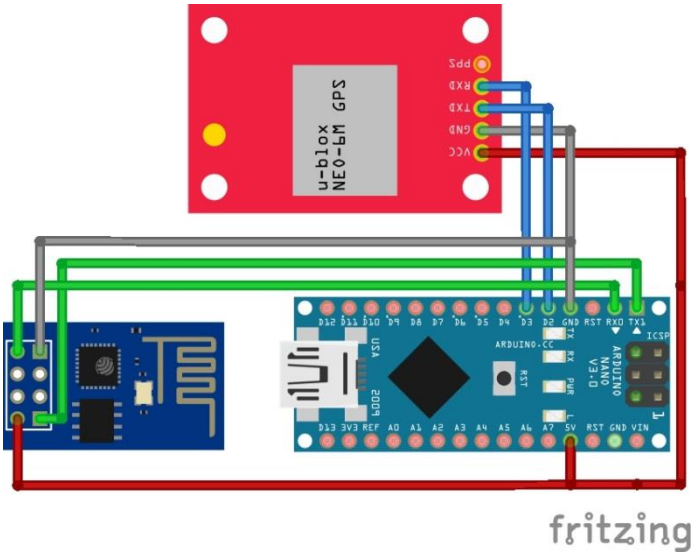

Figure 5.4-1 Schematic Diagram for GPS Module and ESP8266

5.4.1 ESP8266-01 http Get Request Sketch

Using ESP8266Wifi library and ESP8266HTTPClient library, ESP8266 module connects to the predefined Wi-Fi network and sends data to a GET URL in our website. The PHP code in figure 33, which splits the string and stores in the database tables which are shown in the previous chapter. To code the esp8266, we used a programmer and Arduino IDE. Before we upload the code to the esp8266, we install esp8266 library from the Arduino board manager. You can easily understand how to download this library by searching it on Google.

```
HTTPClient http;    //Declare object of class HTTPClient
Serial.println("http://app.softwarism.com/[redacted].php?oranges=" + txtMsg );
http.begin("http://app.softwarism.com/gettwo.php?oranges=" + txtMsg );
//Specify request destination
http.addHeader("Content-Type", "text/plain");  //Specify content-type header
httpCode = http.POST("Message from ESP8266");   //Send the request
payload = http.getString();                    //Get the response payload
```

Figure 5.4-2 ESP8266 GET REQUEST

```php
$var1 = $_GET['oranges'];
$link=Connection();

$latLang = explode(',', $var1);
$lat=$latLang[0];
$lang=$latLang[1];

echo $lat;
echo "<br>".$lang;

$query="INSERT INTO [redacted] (`lat`, `lang`) VALUES('$lat', '$lang')";

mysql_query($query,$link);
    mysql_close($link);
```

Figure 5.4-3 PHP Script to GET String and Stores Lat and Long in Mysqli

5.5 Programming ESP32 CAMERA for Taking and Sending Images

Similar to esp8266 module, to program the ESP32 Camera, we also used a USB Receipt or programmer. The figure below shows the flashing mode of the camera. The GPIO 0 and GND are connected to each other in order to make the module in flash mode. After flashing the module, you will need to disconnect the GPIO 0 and GND from each other.

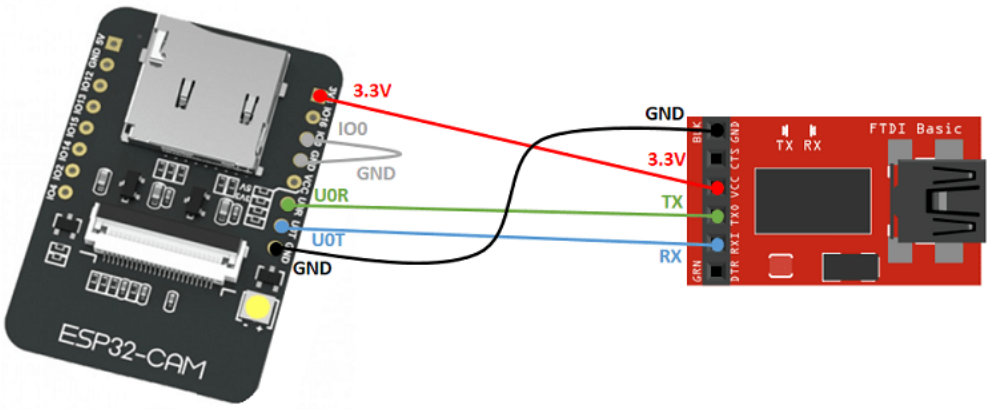

Figure 5.5-1 ESP32 Cam in Flashing Mode - From RandomTutorial

Camera we have used is from DYMore and we used AI Thinker pin configurations for it. Here you can see in the figure below. The overall source code of our project will be soon available at http://app.softwarism.com/source_smart_stick sooner.

```
// CAMERA_MODEL_AI_THINKER
#define PWDN_GPIO_NUM     32
#define RESET_GPIO_NUM    -1
#define XCLK_GPIO_NUM      0
#define SIOD_GPIO_NUM     26
#define SIOC_GPIO_NUM     27
#define Y9_GPIO_NUM       35
#define Y8_GPIO_NUM       34
#define Y7_GPIO_NUM       39
#define Y6_GPIO_NUM       36
#define Y5_GPIO_NUM       21
#define Y4_GPIO_NUM       19
#define Y3_GPIO_NUM       18
#define Y2_GPIO_NUM        5
#define VSYNC_GPIO_NUM    25
#define HREF_GPIO_NUM     23
#define PCLK_GPIO_NUM     22
```

Figure 5.5-2 ESP32 Cam Pin Configuration

5.6 Android Mobile Application Development

We developed an android mobile application in accordance to that user2 use cases. Using this application, the user2 will be able to track the user1 if he/she is out of the house. The user2 will easily locate him through this application as you saw that GPS Module in integration with ESP8266 module, they are continually sends latitude and longitude after at least 5 seconds if they change their location. Similarly by using this mobile application, the user2 is able to view the images sent by the user1 in a Send Images use case. We used Android Studio for developing this application. We have developed the application in pure java. The overall code or source code will be soon available at http://app.softwarism.com/source_smart_stick. The images sent though ESP32 Cam can be downloaded and viewed by this application now. You just need to sign to the application and you will able to view the picture if any.

5.6.1 Mobile Application Authentication Process

When you open this application, an activity of login page will appear and will ask you to enter your username and password if you have already got a stick for your visually impaired person and in case you have already registered in the app. The authentication process is achieved by integrating the application with MySQL database on online server. The integration is availed through PHP Scripts, which validates data entered by a user. You can't login without registration and you can't get registered without having a valid serial number and email address. The serial number is usually come with the stick. Multiple users can register in the application for a single visually impaired person. So in case someone else registered using your serial, then they can track your concerned visually impaired person.

5.6.2 Logging to the Application

The activity given in the figure below will appear once you launch the application for the first time. It is asking you to choose a language you want to use this application in. After choosing either Urdu or English, the login form will be available as shown in the figure 36 here. You have to enter your username and password. Once you enter then press the button "Login". After verification your login info, you are successfully logged in to your account.

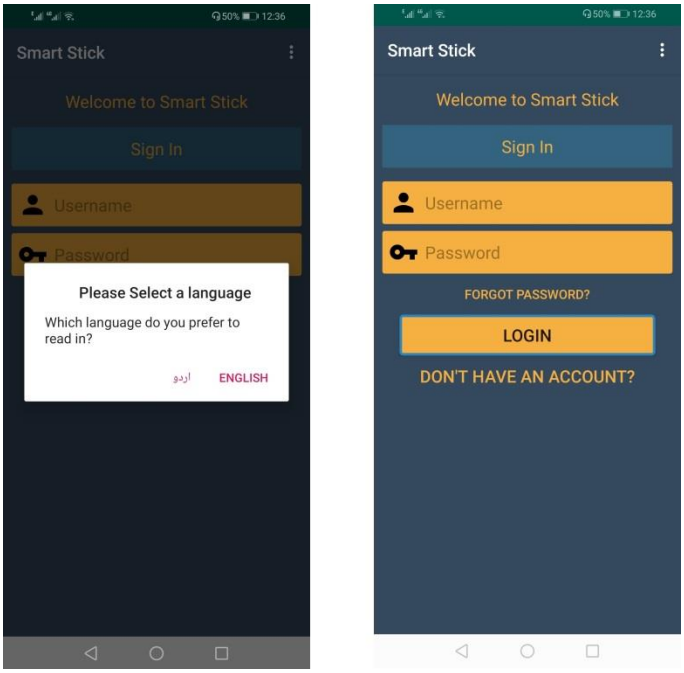

Figure 5.6-1 Language Selection and Login Activity

Figure 5.6-2 Logged in and Info Page

5.6.3 Locate the Visually Impaired Person and View Images

To locate the visually impaired person, tap on “Locate” below in the tab bar. A map with last known location will be appeared. To fetch the latest location if any, then tap on Fetch Location which will fetch the latest data from the server. To watch or view the last uploaded pictures by the user tap on Photos and then tap on Fetch Images Before taping on Next or Previous to view all the pictures. The new location will be fetched only if the stick has

uploaded any new location. Similarly new pictures will be only viewed once the user1 has uploaded any picture using ESP32 cam Module.

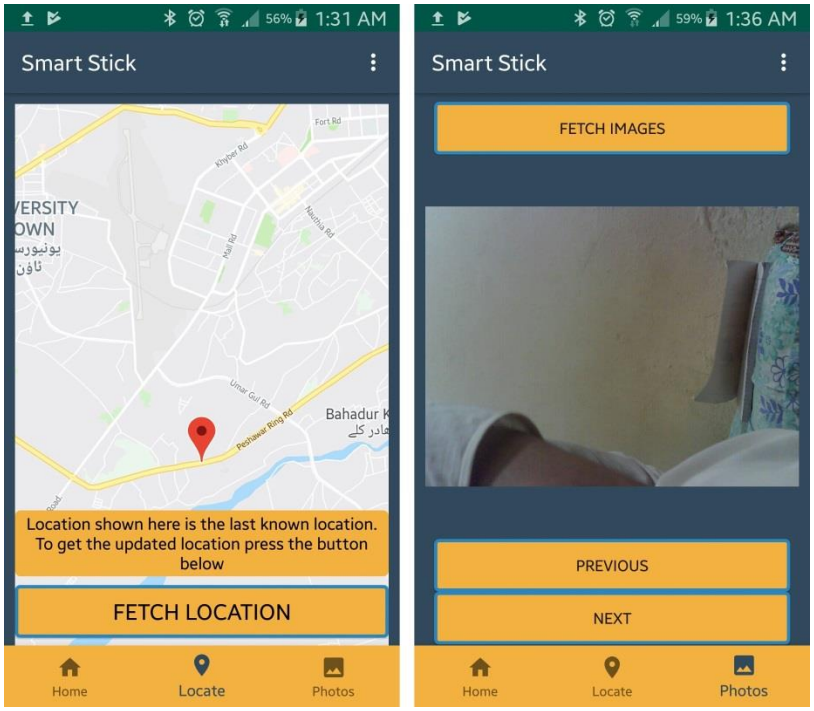

Figure 5.6-3 Locate and Photos

5.6.4 Signup, Password Recovery and Logout

While in the login activity, you can see there are two buttons besides “LOGIN”; The “Forgot Password” and the one showing “Don’t have an account”. The first one refers you to recover your password if you have forgotten. The second button refers you to sign up or register yourself if haven’t before. Both of the activities are shown in the figures given below. We have use implemented many rules or constraint on each field. These constrains prevent user to enter wrong or invalid data. For example in username field, the user can’t type a username already take. Similarly in email field too. The user2 won’t be able to register without entering a valid serial number as well. After signup to the application, the user2 will be redirected to the Home page or fragment. To recover the password user2 will tap on “Forgotten Password” which will lead him for the full recovery process. User can’t recover his/her password without having access to the email address as a 6-digit code will be sent to that email address. If an email that is not registered in the system entered during recovery process, the app will notify the user that this email belongs to no one in the database.

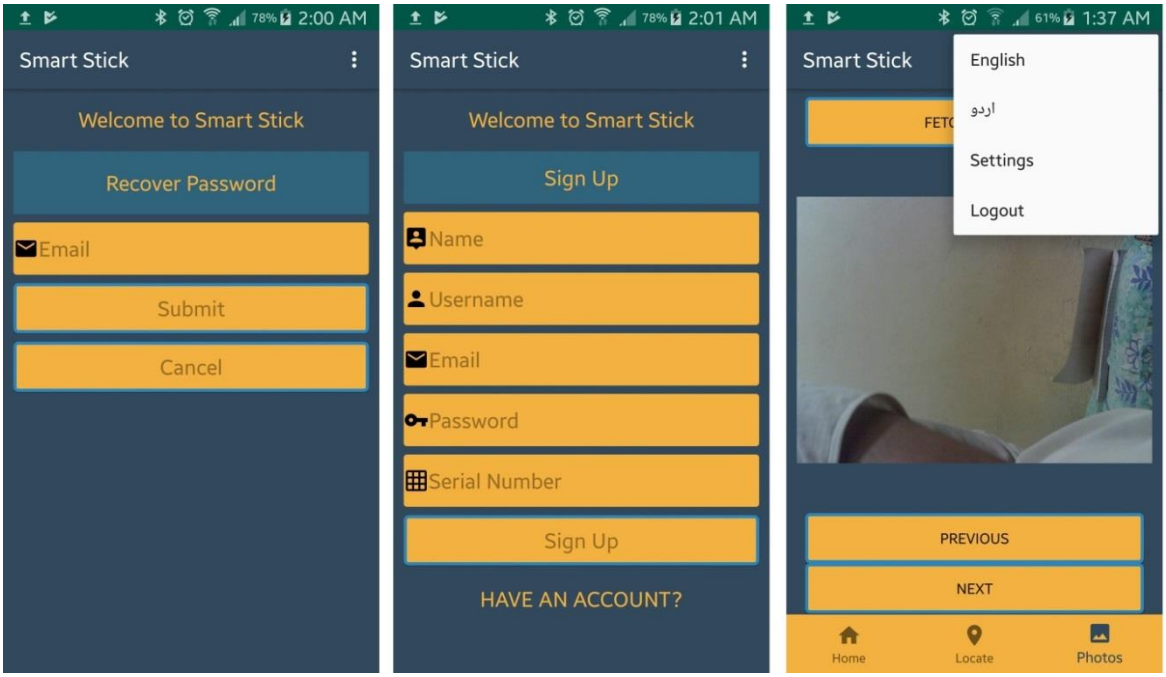

Figure 5.6-4 Password Recovery, Sign up and Logout

5.7 Summary

Now we fully understand that, what are the software and hardware configuration of the system we are working on. We know how different modules are integrated to make a full system (Stick). The obstacles detection and feedbacks from the system are discussed using a schematic diagram where three ultrasonic sensors, buzzer and vibrator are wired with Arduino. The deployment of the ultrasonic sensors should be done as shown in the figure 5.2.2. For the schematic diagram, if followed correctly, we have provided a sketch or Arduino programming. To send GPS data from the stick to the online, we have used ESP8266-01 module with a GPS module called GPS NEO-6M 0.001. Arduino of type Nano is used for that purpose. You may also use UNO or any other. TinyGPSPlus library is used for this purpose and on the server; we have kept a PHP script for receiving the data and storing it in the Database. For taking and sending pictures to the server we used ESP32-S cam and we programmed it using a programmer shown in the figure 5.5. Everything is done in the software side. We then started developing an Android Mobile application using Java and PHP together. The user2 can sign up and login to the application to view the uploaded pictures and to track the user1.

Chapter 6

Results, Analysis and Discussion

6.1 Introduction

A lot of makers don't realize the importance of current consumed by their projects and they don't know why we need to know about the current drawn by our projects. Here in this chapter, we will analyze and discuss things like power consumption or current consumption of each and every module we have used in our project and overall power consumption of our project, voltage required for the project, power supply, execution time, distance measureable by ultrasonic sensors, weight of our prototype etc. We will also discuss the power supply we need to use for our project. We will not only focus on the voltage required only, but we will also focus on the question "how much current our project draws?" Once you understand the operating power and current draw by each module, then you will be able to find the overall project power consumption. Knowing all these things will make you get the right power source or supply for your project. As a result we may reduce the chance of power supply failure.

6.2 Measurement of Power Consumption

We can measure power consumption of a module by either looking into its datasheet provided by its manufacturer or we can find it manually by using a multimeter. Before you measure something using multimeter, you better understand how to play with multimeter. For measuring the power consumption using multimeter, we will follow a few simple steps given below.

1. First of all turn the dialer to of your multimeter to the symbol A or DCA according to the possible current measurement. E.g. 200m if you want to measure less than 200mA.
2. Unplug the positive connection between your power supply and module.
3. Next connect the red probe from the multimeter to the + terminal of the power supply (e.g. Battery), and black probe to the modules plus (+) from which we disconnected it in step 2. This means we did connect our multimeter in series or in line with positive power supply.
4. Read the number on the display.

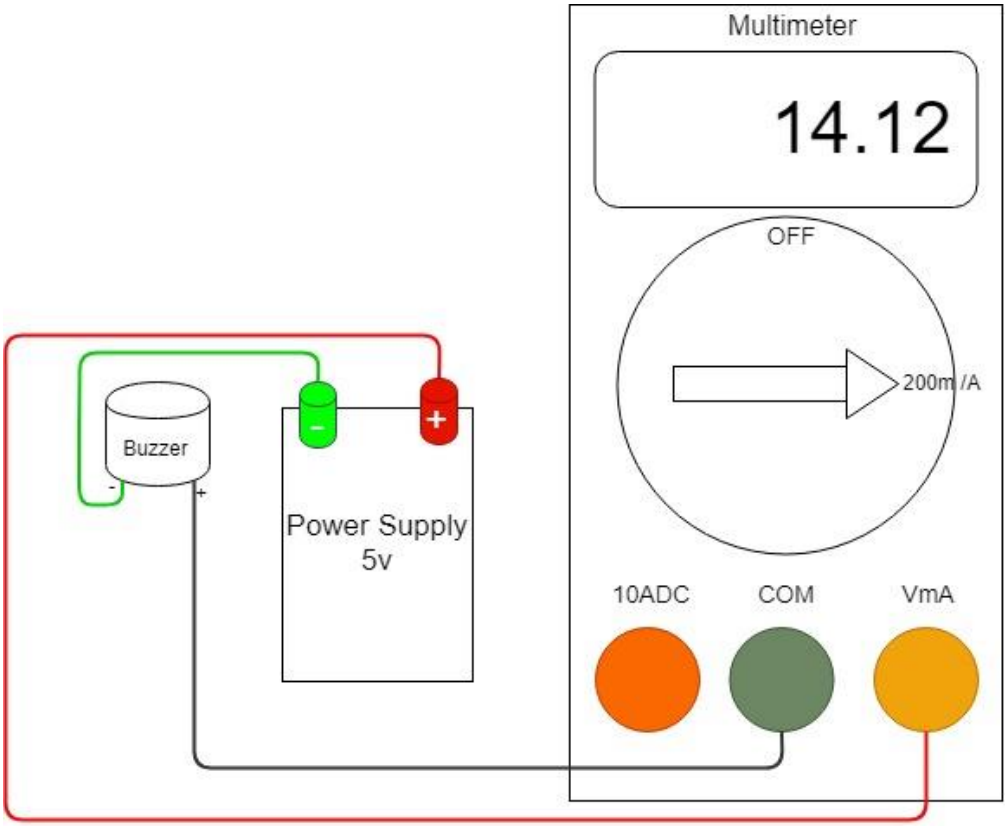

Figure 6.2-1 Measuring Current Consumes By a Buzzer Module

To figure out that how long it will last, we need to know the battery graded which is also called a capacity, and this capacity is usually in milliamp hours (mAh). We can simply calculate the run time of a battery for a particular current consuming or drawing, we will use formula given below.

$$Runtime\ (hours) = \frac{Battery\ Pack\ Capacity\ (mAh)}{Current\ Consumption\ (mA)}$$

So in case of buzzer with current consumption 14mA, and suppose we have a battery pack of capacity 500mA, the runtime will be 35 hours.

$$35\ hours = \frac{500mAh}{14mA}$$

It means that the batter will last in approximately 35 hours if it is connected to the buzzer with 14mA current consumption.

6.3 Modules' and Overall Project's Power Consumption and Voltage

Here we will analyze and discuss current consume by each and every module which are used in our project. We have given their current draw against each module in a table given below. After that we have calculated the overall and approximate power consumption of our project. After that we will go to the next step where we will analyze other factors like weight, measurement, timing and accuracy of modules or project's functionalities achieved yet in section 6.4. The given power consumptions in the table below are figured out either experimentally or taken from the datasheet given by the modules' manufacturers.

Table 6.3-1 Modules Power Consumption and Voltage Required

S.no	Name of Module	No. of Module	V Required	mA	Total mA
1	Arduino UNO	1	7-20	50	50
2	Arduino Nano	1	7-12	19	19
3	Ultrasonic Sensors	3	5	20	60
4	Buzzer	2	3-5	19	38
5	Vibrator	1	5	90	90
6	GPS Module	1	5	50	50
7	ESP8266-01 Module	1	3.3-5	80	80
8	ESP32-S Camera	1	3.3-5	150	150
Total				478	539

As we can see that the total and approximate mA of our project is 539 mAs. I can say that the ESP32 Cam isn't always on. We on the camera once we need to take a picture and send it to the server. It can take and send picture in approximately 30 seconds. It first boots up, connect to the internet, take picture and send the picture to the server and then we turn it off. It means that we shouldn't bring the whole current draw by camera into our account of measurement. For that purpose we will add only 30mA from camera to the account of measurement, which will decrease the number of mA.

$$539 \text{ mA} – 120 \text{ mA} = 419 \text{ mA}$$

We are using 11.1v 3C battery pack with a capacity of 1500 mAh and our project is approximately consuming 419 mA. According to these values and using above formula our project has a runtime of 3.57 hours. This calculation or runtime isn't precise. There are many other factors that have a big impact on the actual runtime of our project e.g. type and quality of our battery, temperature, modes of different modules. Some modules change their states after they are triggered.

6.4 Further Analysis and Discussion

Here we will analyze and discuss some other things related to module functionalities' accuracy, time taken to achieve the task by each module. First of all, the ultrasonic module we have used in our project, measures distance from 3 cm to 400 cm. In our project case, we have used 3 ultrasonic sensors. There are few things you have to keep in mind before you use these ultrasonic sensors. The module should be connected to ground first before connecting it to the electric. Otherwise it may affect the normal working or range it works in. We found that a thin or irregular object or surface may not echo back the waves transmit by the sensor. You may get a wrong distance calculation. The object is usually needed to be placed in front of the sensor.

The GPS module will take at least a minute in outdoor for connecting to the available satellites. Indoor it may takes much time. The ESP8266 will send the latitude and longitude data once a GPS data is updated.

The ESP8266 takes at least 5 seconds to connect to a Wi-Fi. It waits for bites coming through the serial. It receives all the bytes sent through serial and then it sends these bytes as a string though a GET http request to the server it is connected to.

The ESP32-S Camera will be off until a button is pressed. The camera connects to a Wi-Fi connection in approximately 4 seconds soon after you start it. After starting to take the picture it takes approximately 19 seconds. Starting, connecting and sending take approximately 27+ seconds. The time taken by sending the picture may exceed as it depends upon the Wi-Fi speed plus photo's size in Kb's.

6.5 Summary

In this chapter as we said in introduction part, we analyzed and discussed things like current consumption, and we said that why it is important to know power consumption of each and every module or power consumption of your project. For selecting the right type and source of power for your project, It is very necessary to figure out power consumption first. After that we discussed that how we will figure out the power consumption of a module. For figuring out the current draw, it is necessary to connect the multimeter in series. If you want to calculate the voltage, then you have to connect the red probe to the plus (+) connection and black probe to the negative (-) connection. You can also find out the current draw by a module in different stages in the provided datasheet of that module. We concluded a formula to calculate the runtime in hours if you have two known values; the battery capacity in mAh

and current drawn in mA. To get the runtime in hours simply divide the total capacity in mAh of the battery over the total current draw.

We also calculated the power consumption or current consumed by each module and made a total of current consume by our project. The total amount of current drawn by our project is 539 mA. Then we said that the different modules have different states like idea and sleep mode. That's why we subtract current drawn by the ESP32 Cam module. By dividing the capacity of our battery over the current drawn by our project, we found that our battery will last in at least 3.57 hours which is far enough for our purpose.

In our project the GPS module takes at least a minute to be in contact with the satellite which is better if we think about its price. The ultrasonic sensors can calculate distance from 3 to 400 cm. The more the object near to the sensor, the more accurate distance will be measured. Similarly the ESP8266-01 takes at least 5 seconds to connect to the Wi-Fi network. The ESP8266 module waits for the GPS data and sends it to the server. The camera will remain off until we want to take and send a picture. What you need to do is to press the button. Wait for at least 19 seconds, and after first beep, you can go and after second beep, the picture is sent to online server. Time required for sending a picture depends upon the internet speed as well.

Chapter 7

Conclusion & Future Work

7.1 Introduction

In last chapter, we will restate our work and we will summarize our main points. We will clearly mentioned everything, we have achieved in this project. If we have failed in getting some objectives of our project, we may reviews changes we made while carrying out our project. So in conclusion we will summarize objectives which are being accomplished and at the same time we will document those objectives for which we were trying to accomplish. In conclusion, we will also discuss all the negative and positive result we encountered in our project. These negative results will be our opportunity for a future work which will be based on them. Beside that we will also conclude that what we have learned from our project. What we are not able to do or what we couldn't achieve in our work, maybe achievable in future for other talented people. How can someone improve our idea should be discussed in future work.

7.2 Conclusion

We tried our best to make a prototype "smart stick" and we achieved most of the goals we promised for. If the proposed stick is constructed in an accurate way, it will fill the gap in between visually impaired person's life and sighted person's life by providing them strength of self-dependency. This proposed stick will help them to interact with the environment in a better way by detecting objects or obstacles around them. Once an object is detected by ultrasonic sensor a haptic or audible feedback is given back to the user within micro seconds. Each ultrasonic sensor generates different pattern of audible feedback. Everyone with visual impairments will be able to use the stick to make their life easier by making path clear for them. The user will be able to capture the surrounding using the camera and is able to send it to the family members' mobile phones. The proposed system can be provided to the visually impaired people in a very affordable cost. In today's world, most of us use smart phones especially android system, and using this system they will be able to track their visually impaired family member. We as students couldn't achieve proper integration of all the different components of the stick together. Further improvement can be brought by proper integration and by using GSM 3G Modules for sending data to the server.

7.3 Future Work

Some improvements that could be made to this stick are given as follows:

- Increasing the accuracy of ultrasonic sensors and implementing an approach that will increase or decrease the beeps or vibrating by approaching to the obstacles or vice versa.
- Using GSM 3G Modules for sending data to and receiving data from server.
- Using powerful microcontroller and power supply.
- Using parallel programming technique where multiple threads will be running in performing different task inside the stick.
- Decreasing the weight of the stick by implementing micro modules integrated on a single chip.
- Introducing pre-defined path rout which will guide the user using verbal commands saved in the system.
- Implementing AI techniques like face recognition and object recognition system in the stick.
- Make the stick waterproof and suitable for high temperature.
- Choosing a better battery with high capacity and low weight.

References

[1]. WHO: Blindness and Vision Impairment (http://www.who.int/news-room/fact-sheets/detail/blindness-and-visual-impairment)

[2]. The Lancet Global Health: Magnitude, temporal trends, and projections of the global prevalence of blindness and distance and near vision impairment: a systematic review and meta-analysis, Table 3 (https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(17)30293-0/fulltext)

[3]. World Access For The Blind: Blindness and Challenges (https://waftb.net/blindness-challenge-and-achievement)

[4]. Ranker: 14 common problems for blind people (https://www.ranker.com/list/obvious-things-blind-people-have-to-deal-with/justin-andress)

[5]. We Capable : Problem Faced By Blind People (https://wecapable.com/problems-faced-by-blind-people/)

[6]. Vision Aware: Dog Guides For People With Vision Loss (http://www.visionaware.org/info/everyday-living/essential-skills/an-introduction-to-orientation-and-mobility-skills/dog-guides-for-people-with-vision-loss/1234)

[7]. World Blind Union: The White Cane Information (http://www.worldblindunion.org/English/resources/Pages/White-Can-information.aspx)

[8]. An American Foundation for the Blind People: What is Braille (http://www.afb.org/info/living-with-vision-loss/braille/what-is-braille/123)

[9]. Mithiles Kumar, Faysal Kabir, Sahadev Roy. Low Cost Smart Stick for Blind and Partially Sighted People. International Journal of Advanced Engineering and Management, IJOAEM, 2017, 2(3), pp.65 - 68. <https://ijoaem.org>. <hal-01490750>

[10]. Discrete Distance and Water Pit Indicator Using AVR ATmega8 in Electronic Travel Aid for Blind By Manoj Badoni and Sunil Semwal (https://www.researchgate.net/publication/267369811_Discrete_Distance_and_Water_Pit_Indicator_using_AVR_ATmega8_in_Electronic_Travel_Aid_for_Blind)

[11]. Voice Enabled Smart Walking Stick For Visually Impaired by Akhila Jose, Greeshma, Meenu R Nair, Shilpa M J , Assistant Professor, Dept. of EEE, Mar Baselios Institute of Technology and Science, Nellimattom, Kerala, India

[12]. The Sonic Pathfinder: An Electronic Travel Aid for the Vision Impaired (http://members.optuszoo.com.au/aheyes40/pa/pf_blerb.html)

[13]. MiniGuide Mobility Aid : (http://gdp-research.com.au/minig_1.htm)

[14]. Psychology Dictionary: Psychology Dictionary (http://bit.ly/2ZsDXEZ)

[15]. Developing an Assistive Aid for Blind People Using IOT by M.Rajeshwari, G Sharmila – Assistant professor and students of "Department of Information technology, Panimalar Institute of Technology, Chennai, India"

[16]. G. Prasanthi and P. Tejaswitha "Sensor Assisted Stick for the Blind People." Transactions on Engineering and Sciences, http://bit.ly/328HdHa

[17]. E. J. Chukwunazo and G. M. Onengiye "Design and Implementation of Microcontroller Based Mobility Aid for Visually Impaired People"

[18]. R. Sheth, S. Rajandekar, S. Laddha and R. Chaudhari "Smart White Cane - American journal of Engineering Research"

[19]. G.Gayathri, M.Vishnupriya, R.Nandhini, and Ms.M.Banupriya "SMART WALKING STICK FOR VISUALLY IMPAIRED"

[20]. R.Jothi1, M.Kayalvizhi and K.Sagadevan "Smart Walking Stick for Visually Challenged People"

[21]. D.Sathya, S.Nithyaroopa, P.Betty, G.Santhoshni, ." SMART WALKING STICK FOR BLIND PERSON"

[22]. K.S.Manikanta1, T. S. S. Phani, A .Pravin "Implementation and Design of Smart Blind Stick for Obstacle Detection and Navigation System"

[23]. Introduction to Arduino: https://www.arduino.cc/en/guide/introduction

[24]. Types of Arduino Boards: https://www.elprocus.com/different-types-of-arduino-boards/

[25]. HC-SR04 Ultrasonic Sensor: https://components101.com/ultrasonic-sensor-working-pinout-datasheet

[26]. Meet Android Studio: https://developer.android.com/studio/intro

[27]. Tennessee Council of the blind: (www.acb.org/tennessee/white_cane_history.html)

[28]. Scientific & Academic Publishing: (www.article.sapub.org/10.5923.j.ajis.20170703.07.html)

[29]. Smart Cane Indication a Safe free Path to Blind People Using Ultrasonic Sensor (www.ijritcc.org/download/browse/Volume_4_Issues/February_16_Volume_4_Issue_2/1456809244_29-02-2016.pdf)