ISLAMIC UNIVERSITY OF TECHNOLOGY

Undergraduate Project

SMART CANE FOR VISUALLY IMPAIRED BASED ON IOT

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Declaration of Authorship

We hereby declare that the work which is being presented in the project entitled "Smart Cane for visually impaired based on IOT" in fulfillment of the requirements for the award of the degree of Bachelor degree submitted in the Department of Computer Science & Engineering, Islamic University of Technology is an authentic record of our own work carried out during the period from September, 2020 to March, 2021 under the supervision and guidance of "Tareque Mohmud Chowdhury", As, Islamic University of Technology.

The matter embodied in this project work has not been submitted for the award of any other degree.

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With Regards,

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ABSTRACT

There are numerous issues over which people have no control visual deficiency is one of such issues. It grabs the striking visual magnificence of the world from a person's life. Be that as it may, missing the excellence of nature gets one of the last concerns of such individuals as they need to confront various challenges to perform even the most nuts and bolts of undertakings in their everyday life. One of their most prevailing issues is of transport, like going across streets, going in trains, or other public spots. They always require human assistance to do so. But sometimes they are rendered helpless when no such assistance is offered. Their dependencies deteriorate their confidence. Traditionally they have been using the conventional cane stick to guide themselves by touching/poking obstacles in their way. This causes a lot of accidents and hence is dangerous for them and others. As this is a technologically driven era we decided to aid these differently abled people by coming up with a technology utilizing solution.

We call it the "Smart Stick". It is a device which guides the user by sensing obstacles in the range of stick. It will identify all obstacles in the path with the help of various sensors installed in it. The microcontroller will retrieve data and pass it on as vibrations which will notify the user about hurdles on the way. It is an efficient device and will prove to be a big boon for blind people. The proposed conceptual framework demonstrates an excellent generalization performance and accurate results which mean that the prototype has the capability to fulfill object detection, location identification and obstacle avoidance tasks efficiently in uncertainty environments.

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Chapter 1

Introduction

Modern technology advancement made the impaired person life easier. Early day's visually impaired people are completely dependent on their relatives or some pet like dog.

The technological advancement give the easiest solution to this problem. The smart stick having capability to detect the obstacle and communicate the person smartly through speaker or by vibration rhythm through vibrator motor and help the blind help in their way.

Blindness is caused due to poor vision in the eye which cannot be improved with the normal eyeglasses. The term "low vision" is used by the most of the professionals to relate that it is a permanently reduced vision which cannot be improved or corrected using eyeglasses, lenses or medicine. A comfortable system is the one which can guide people with low vision or visually impaired, through audio commands are referred to as Navigation System for Visually Impaired. Navigation can be made easier for them by providing smart cane so that they do not face difficulties while walking. A normal walking stick is used by impaired people for their movements in day-to-day activities. But they will be unaware of the object's presence. There are many new and enormous types of research have been done to develop and build a navigation assistance system for visually impaired. There are some of the limitations such as which is not accurate, not easily usable without the help of others, coverage and these issues are not easy to overcome in current technology. Designing a smart cane will be more reliable and self-reliant for their navigation purpose.

This cane is designed in such a way that which is affordable for all impaired people because most of the people are from the underdeveloped side and it becomes impossible for them to get a high cost navigation system.

1.1 PURPOSES:

A white cane is used by the people who are visually impaired to scan their surroundings for obstacles and also helpful for other traffic participants in identifying the user visually impaired and taking appropriate care. There are various kinds of wearable and new portable technologies have been developed to guide them for the navigation purpose. This proposed smart cane system will reduce their day-today complexity and helps them to move in this world freely without any guidance. The smart cane is developed in such a way that it will be more reliable, can be used independently and it is also easy to implement. The system is embedded with the headset through which the identified object will be sent as a voice to the impaired people. The cane is also attached with the GPS to detect the location and a person has to wear the headset so that information about the obstacle will be intimated. The main characteristics of the system include minimizing the workload among the user, comfortable with mobility, easy movement with the world. The obstacle is detected with the help of reflections from ultrasonic waves emitted by them. If the detected object range is found to be nearer to the cane then the strength of the object will be larger and also if the detected object range is in the longer distance then the strength of the vibration in the cane produced will be smaller. The smart cane is designed in such a way that it will be user detachable and which also can be recharged by using a lithium-ion battery.

In the present work, a low-cost yet durable and accurate smart stick has been developed which holds the following characteristics

- The designed stick is not only able to detect the front obstacles having knee-above height, but also able to detect the obstacles having a height below knee-level.
- The stick is also able to detect upstairs, downstairs and other similar dangerous hurdles in walking using multiple ultrasonic sensors with proper orientation.
- The stick alerts the person using vibrations along with sound in the ear of the person. We integrated a vibration motor with the stick and established wireless communication between the stick and the earphone set.
- With the aid of earphone, the person gets the exact distance of the obstacle. On the other hand, vibration in the stick also gets high when the obstacle gets closer
- The proposed system achieved very fast response time before hitting the obstacles as shown in the experimental result section.
- The stick is very ease of use and the system is fabricated on wooden to make it durable and to keep the orientation of sensors fix in the forward direction.
- The training of the product is not expensive or time taking.

The developed smart stick is basically an embedded system integrated with a microcontroller, ultrasonic sensors, vibration motor, Bluetooth modules and other necessary components to make it functioning. The working flow diagram of the stick is shown in Fig. 1

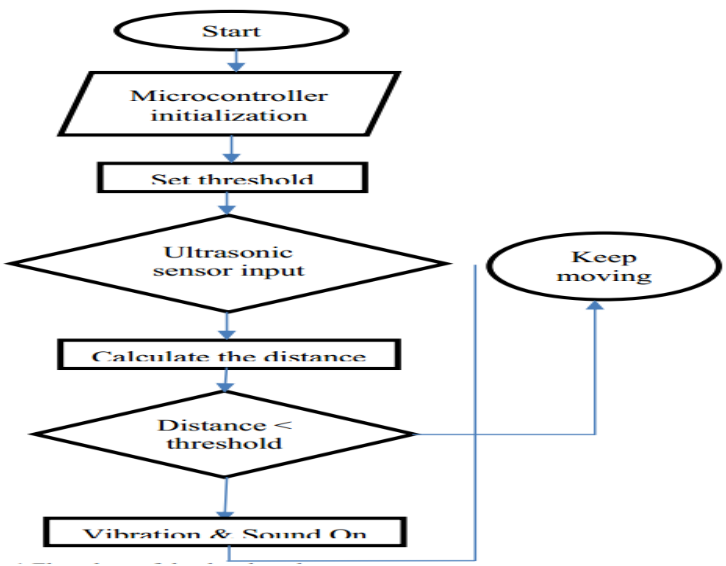


Figure 1: Flowchart of the developed system

1.2 Problem Statement:

This project reports an accurate coordination and communication among sensors, motor, controller and other components to build a smart stick for the blind people. Two main objectives of the developed stick were to increase the mobility and also to generate a wireless audio output after detecting an obstacle has been successfully implemented. The stick is able to detect static and dynamic obstacles of any height which are in front of the person.

Vibration and sound modules successfully alert the person and help to increase the efficiency for blind people to travel and also increases the safety.

The smart blind walking stick is successfully designed consistent with all the objectives achieved. One of the most important difficulties faced by the visually challenged person is constraints in independent mobility and navigation.

They primarily the white stick as mobility aid allowing them to detect close by obstacles on the ground. The detection of objects above knee height is almost impossible and is a major hindrance for them.

1.3 Problem Objective:

The main objective is to solve the problem statement above by building a prototype of a Smart cane for the blind and visually impaired people that become an assistive technology which can detect obstacles and getting information on their location through GPS (Global Positioning System). In order to help them on getting done with their daily routines without any problem, the build on obstacles sensor need to have latest microcontroller board. Arduino Mega is the old sub-board of main microcontroller Arduino. By using 1Sheeld board thus helps the circuit and program to give the feedback on obstacles and provide notification through vibration on the handle of the cane. Besides that, using 1Sheeld capabilities on connecting Arduino Mega board using Bluetooth and by taking advantage from smartphone that already built in with the GPS system.

Thus, we can cut cost to this invention and can helps other researcher to proceed with this prototype for future research. The open source code that been provided in this system thus helps other to get benefit from this project.

1.4 Scope of Project:

The project concentrates on sensor, notification and system that compatible to the devices and users need. This ultrasonic sensor (HC-SR04) will provide obstacle sensor at 2cm-500cm and automatically sends eight of 40 kHz signal to detect pulse of the current situation and signal back to user. If using a long range sensor like 2 metres, we need to add more budget to covers the high quality sensors.

The types of environment that need to test for this project is very important because we can ensure whether it may give interference to the user or the sensor to work well. Plus with, the health of the user may affect if uses too much power signal in it. Moreover, the sensor capabilities need to observe whether it could detect obstacles in rainy or windy weather. Besides that, the complexity of having many features in one devices can leads to an issue whether the weight of white cane affected. The vibration motor needs to provide vibration when detecting obstacles. The vibration process needs to get good feedback from the sensor. After that, it will send back the results at the handle of the stick. Besides that, the circuit need to be covered with case in order to prevent any short circuit occur. We need to make sure whether this GPS able to locate the blind people correctly in different kind of geographical area and indoor spaces.

Furthermore, this blind stick can be an assistant for academic purposes like teachers in special school. They can teach the blind kids to use well their white cane while monitoring them through GPS. Besides that, the GPS must able to send SMS to their top 5 contact list and authority in case of emergency issue like in missing or doesn’t know who to get help from. Besides, the negative stigma from Blind and Visually Impaired Organization about this stick needs to be change. We must help them to understand in order they able to adapt well to the current technology. Hence, the device must be in safety measure and provides notification without conflicting their main senses and makes it comfortable to be use in indoor and outdoor environment.

1.5 Project Limitation:

The process of achieving complete and perfect devices reflect to the scope of this project whether it is not costly and friendly use or not. After look into the requirement and things that need to be done to this project, I can conclude that this project have several limitation that can't be fix or change until there is enough budget or new technology created. First of all, the ability for the Blind Stick Navigator to work in rainy weather and low-power cellular base-station signal like in basement and etc.

Besides that, this 1Sheeld apps use touch screen on the smartphone thus blind people need to get extra assistant from community like authority, their guardian or people nearby in case of the smartphone in error state. Mobile credit data needs to be in sufficient balance in order to send the SMS notification to the smartphone. Moreover, the board need power source from battery or power adapter. It needs to be charges once they heavily used. Furthermore, the limitation of not having voice guidance like Google Voice or Siri that synchronize with 1Sheeld apps affect the issue of this user friendly device.

In addition, if Braille smartphone invented in future, I hope it can synchronize well with Blind Stick Navigator. Plus, it may help other researcher to study and enhance the devices for greater goods and adaptable to any situation that user experience through.

Chapter 2

Literature Review and Related Works

2.1 Literature Review:

Protected, free portability when performing ordinary undertakings is probably the best test looked by the outwardly hindered. Despite the fact that the quantity of outwardly impeded individuals is expanding with the maturing of populaces, as expressed above, endeavors to advance autonomous portability have been fruitless. It is accordingly critical to totally comprehend the necessities and prerequisites of the outwardly disabled prior to endeavoring to make new gadgets. In the first place, we examined the issues with white stick and afterward distinguished the regular arrangements given by the current electronic sticks. Then, the examination endeavored to decide new, genuine convenience issues dependent on the common electronic stick.

2.2 Problems with White Cane:

The white stick was presented during the 1940s and is the most well-known portability help for the outwardly impeded with around 5230,000 clients in the US (Leonard, 2002). It permits the recognition of hindrances before a client inside 1 m. Clients regularly tap the stick in a bend from left to directly as a long ways ahead as the stick's length. This tapping gives rich data about the surface and slant of the ground in the client's current circumstance (Collins, 1984). Be that as it may, there are a few issues with a white stick, like those as far as recognition and convenience.

In the first place, we explore the issue with the recognition range, which is restricted to under two speeds (Dowling, 2007) and for the most part permits the location of obstructions just a ways off equivalent to the stick's length (Jacquet, Bellik, and Bourda, 2006). This short location range meddles with the client's strolling speed, since it doesn't permit the client to unhesitatingly evaluate moving toward snags outside this reach. In this way, clients are needed to think and check snags since they can't expect hindrances at distances more noteworthy than two speeds. This cognizant exertion diminishes strolling speed (Ulrich and Borenstein, 2001). Also, Clark-Carter (1985) shows that strolling rate can be influenced by the degree of review data. For sure, an examination of the strolling pace of outwardly weakened individuals (Clark-Carter, Heyes, and Jowarth, 1986) showed that broadening the see data (3.5 m) utilizing a Sonic Pathsounder (Kay, 1974) sped up by 18% as contrasted and their strolling speed utilizing a white stick. This records for an expanded degree of certainty; the more noteworthy certainty the client has, the nearer they stroll to their favored speed. Manduchi et al. (2010) uphold the idea that strolling speed relies upon how unhesitatingly and proficiently a client strolls. Subsequently, strolling pace could be utilized as a proportion of the client's certainty and is expanded by broadening the see data (Clark-Carter et al., 1986).

Decreasing unintended contacts with obstructions has additionally been related with a speed up (Hartong, Jorritsma, Nave, Melis-Dankers, and Kooijman, 2004). An absence of review data with small notice (i.e., a restricted scope of identification) lessens strolling speed (Levesque, 2005) and furthermore prompts the expected risk (Clark-Carter, 1985) of crashes and tumbling from reaching unintended obstructions. For the most part, a tally of portability occurrences is characterized as the quantity of contacts with hindrances (Dwoling, Boles, and Maeder, 2005). Manduchi and Kurniawan (2011) detailed tht more than half of 289 visually impaired and legitimately daze members in a study experienced fall mishaps at any rate once every year, while 36% of the respondents expressed that mishaps bringing about falls had clinical results. Further, the most hazardous circumstances for outwardly debilitated individuals include quick hindrances (Pelli, 1986). An identification scope of just 1 m is close for the discovery of quick articles since it doesn't furnish the client with suffient response time (Singh et al., 2010); stick clients require quick response times as a result of this restricted location range (Dowling, 2007).

Next, the identification zones covered when utilizing a white stick can represent another issue from an ease of use viewpoint. Since a white stick doesn't identify chest area level hindrances, clients are inclined to dangers including expanded dangers of falls and crashes.

Considering these conditions, as recently noted, outwardly debilitated individuals with white sticks experience mishaps including head-level obstructions (Manduchi and Kurniawan, 2011). It is essential for the wellbeing of outwardly impeded clients to give a few methods for snag location above knee-level and in an all-inclusive reach (Kanagaratnam, 2009).

In particular, most of old individuals with visual weaknesses show that their judgment according to moving impediments has gone through a continuous weakening in light of their age (Rubin and Salive, 1995), which prompts diminished execution with maturing (Czaja and Sharit, 1998). Based on this proof, outwardly disabled old clients can find it difficult to altogether check for impediments by tapping the ground. Further, this requires ceaseless tapping and they handily become tired from these rehashed arm developments (Dowling, 2007), weakness happening undeniably more rapidly (Lacey et al., 1995) than for more youthful clients. At last, reaction speed is contrarily connected with age (Birren, Woods, and Williams, 1980). Hence, it is harder for old individuals to try not to quick move hindrances since this requires a quick response time. In whole, a white stick may prompt an expanded peril of impact and a higher use of energy and time.

2.3 Typical Solutions Using Smart Cane:

Electronic versatility helps for the outwardly debilitated have prospered trying to tackle the above issues with the white stick. In this examination, we dissected 7 existing savvy sticks to recognize regular answers for these issues, zeroing in on impediment recognition capacities. The determination depended on Roentgen et al. (2008), who checked on 146 electronic versatility helps. Among the 146 frameworks, first we recognized 21 gadgets that are as of now accessible, while all the others vanished from the market. Out of the 21 gadgets, we chose the 12 gadgets that upheld hindrance location, limiting the other fourteen guides that didn't have the capacity.

We frstly analyzed the shape of the selected electronic aids. Out of the 12 aids, six were canes and the rest were handheld (e.g., clipped onto a belt or worn on the palm) or wearable devices (e.g., head mounted or worn around the neck). For this study, we did not focus on the handheld aids, as our goal was to improve the smart cane devices. These six smart canes came in two forms.

In the first type, a detection device is mounted on the cane to form a stick, making this a detachable unit, for example, the BAT “K” Sonar (Bay Advanced Technologies [BAT], n.d.), Teletact (Damachini et al., 2005), Tom-Pouce (Farcy et al., 2003; Farcy, Leroux, Jucha, Damaschini, Gregoire, & Zogaghi, 2006), Vistac Laser Long Cane (Vistac, n.d.) and UltraCane (Sound Foresight, n.d.). In the second type, the devices have detection sensors built into the canes. Canes such as the LaserCane are of this type.

Next, we examined how well the existing mobility aids address the outlined problems and found that a smart cane typically provides elderly users with unique functionalities. As for the obstacle detection problems, smart canes such as the UltraCane or BAT “K” Sonar, typically use ultrasonic sensors, infrared sensors (e.g., Tom-Pouce), or laser sensors (e.g., LaserCane, Teletac, or Vistac Laser Long Cane). These electronic sensors may drastically improve the detection range and angle problems, as well as avoid the nuisance of continuous tapping.

The typical electronic cane uses sensors to acquire information about the environment around the user, which enables the detection of obstacles above knee-level and in an extended range, a function that can be accomplished by attaching ultrasonic, laser, or infrared sensors (Kanagaratnam, 2009). For example, a typical cane like UltraCane (known as BATCane) detects obstacles up to head-level and at long distances using ultrasonic sensors, while canes like the Laser Long Cane use three laser beams to detect head-level obstacles (Manduchi & Coughlan, 2012). The Tom-Pouce emits infrared beams that allow the detection of head-level obstacles (Damaschini, Legras, Leroux, & Farcy, 2005). All three types of canes alert the user to the presence of an obstacle at a certain distance and up to head-level through a vibration alert, but they use different types of sensors.

Further, both infrared and ultrasonic sensors usually detect obstacles within a wide range around 30° above the ground (Jacquet, Bourda, & Bellik, 2004). The sensors may address the continuous tapping issue. To scan an area in front of them, a user should constantly move a laser cane from side to side due to the detection of narrow ranges. In contrast, a user does not need continuous tapping with an infrared or ultrasonic cane because it can detect a wide range. Infrared sensors, which use infrared light to determine the distance to a reflected object, are known to be disturbed by sunlight and dark objects and do not work accurately outdoors (Kanagaratnam, 2009). Ultrasonic sensors, which use sound instead of light, can be used outside in sunlight and are less affected by target materials (Eric, 2008). As such, most smart canes are equipped with ultrasonic sonar devices (Damaschini et al., 2005) because these pose the least limitations.

All the above approaches were expected to improve the existing problems with white canes and help improve visually impaired users’ walking speed, and fall and obstacle avoidance. For example, smart canes usually provide advance vibration alerts using ultrasonic sensors that can detect obstacles at around 30° for a wide range, at a distance of over 2 m and above-knee level. This provides extra time to prepare to avoid obstacles with confidence and this extended obstacle detection range eliminates the need for continuous tapping. Moreover, white cane users should not face a significant challenge when switching to a smart cane because of the similarities between white and smart canes.

Chapter 3

METHODOLOGY

We have used several Methodological for sake of better implementation of the system, some of them are described below.

3.1 Overview:

In this research methodology, researcher should choose the fitting system for this venture. The approach picked will direct the scientist in completing the task effectively and accomplishing its goals. A technique for discovering issue and thoughts dependent on the cautious utilization of a current item. Client research on issue discovering technique based by means of seeing through client experienced of an item and target creating change to or an upgrade item. Conceptualizing strategy will rapidly produce a wide scope of thoughts and gathering through certain procedure for handling an expressed issue. Agenda is for assessing arrangement current interaction against beforehand set up measures or necessities. Cycle examines in this task is on equipment improvement through guide of charts from planning until end result. To finish up the philosophy for this task, it depends on System Development Life Cycle (SDLC) of the Prototype Model that will be significantly center around arranging, plan, execution and testing.

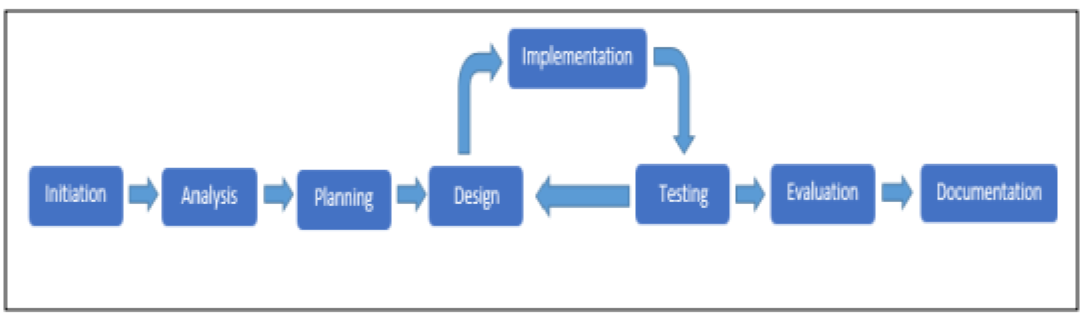


Figure 2: The SDLC for Prototype model.

3.2 Planning:

Planning time is very important because we have 15 weeks to complete this final year project. This project working progress contains overlapping task on some weeks and student must follow the timeline to ensure this project is executed properly and on schedules. By identifying all the information that been gathered earlier will ease the process of planning for the particular software and hardware requirement needs.

3.3 Method Used:

In the method of collecting information and data, a lot of sources had been referred to. Most of the information was gained Final Year Project from previous students of UniKL and some of it is from the journal and article in the internet about blind people assistant tools.

3.3.1 Hardware Requirement:

All the hardware component that I will be list is very crucial to the project.
Without the required component, the project won't be a great success. Planning and providing the requirement is a must in every kind of project.

Hereby is the list of the components that will be used for this project:

- Arduino Mega 2560 R3
- U-Blox NEO-6M GPS Module
- Ultrasonic sensor HC-SR04 – Ultrasonic Sensor Mounting Bracket
- USB cable
- Water Sensor
- Battery button connector cable
- Mini BreadBoard
- Switch and jumper Wire
- IR infrared Obstacle Avoidance Sensor Module

3.3.2 Software Requirement:

In the software requirement, the software tools that suite with the hardware is Arduino programs along with 1Sheeld Android apps. The Arduino programs are divided in three main parts like structure, values and functions. Thus, it helps me to categorize which part of code suits the section that I needed. While, in the smartphone of the user, there will be 1Sheeld apps that helps the microcontroller board to use the features of GPS and GSM in that smartphone. Arduino main software version 1.6.3 is used for configuring process and uploading the code from Windows Operating System to the Arduino Uno R3 board via USB cable.

3.4 Design:

After collecting all the data and analyze it into my understanding, I have come out with an idea on how the Smart Cane will look likes. The placement of the component is an intention to make the component to react properly in the angle of head and ground levels. It will react to obstacles and send direct feedback to the user.

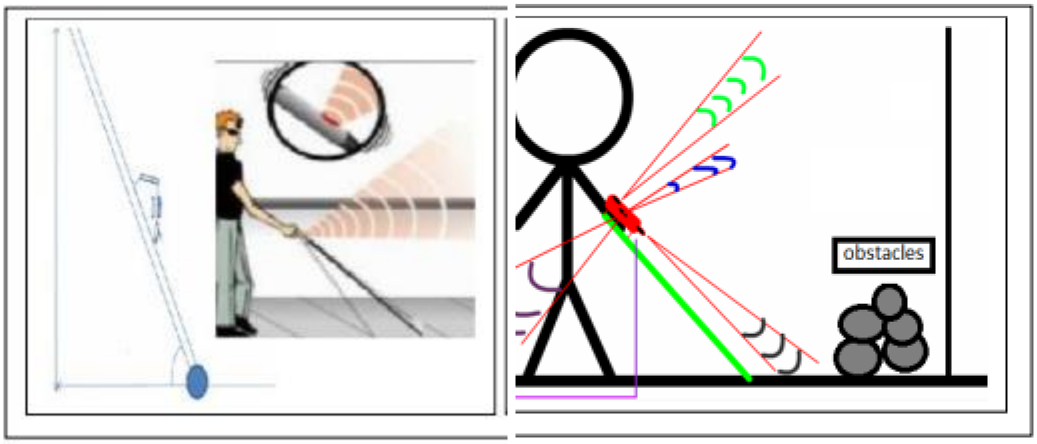


Figure 3: Smart Cane for visually impaired (Overview).

3.5 Implementation:

3.5.1 Block Diagram:

The circuit required 5v power supply to operate well. We can power it via power adapter or 9v battery and power bank because it is easily detachable. The total power cost need can also be adjustable via processor in processing unit. Besides, Arduino Mega will process the feedback and send notification to the user smartphone in case they want the function of SMS to be on. While, the ultrasonic sensor will send notification along with vibration to the handle of the stick. Thus, Arduino Mega will become the main part of the system to work well while other component needs to function well and provide instance feedback to the system and the user.

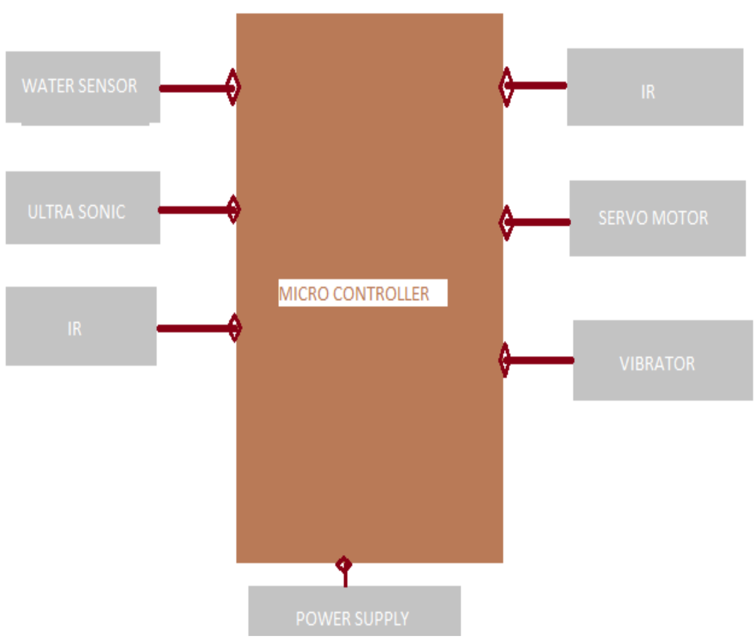


Figure 4: Block diagram of the Smart Cane.

3.6 Budgeting:

The project has come out with the estimate cost and list of component needed and focus on not exceeding the extra budget while considering on how middle-class citizen or blind people able to support or not. Each price for each of the component is based on the current 2021 market price in Bangladesh currency.

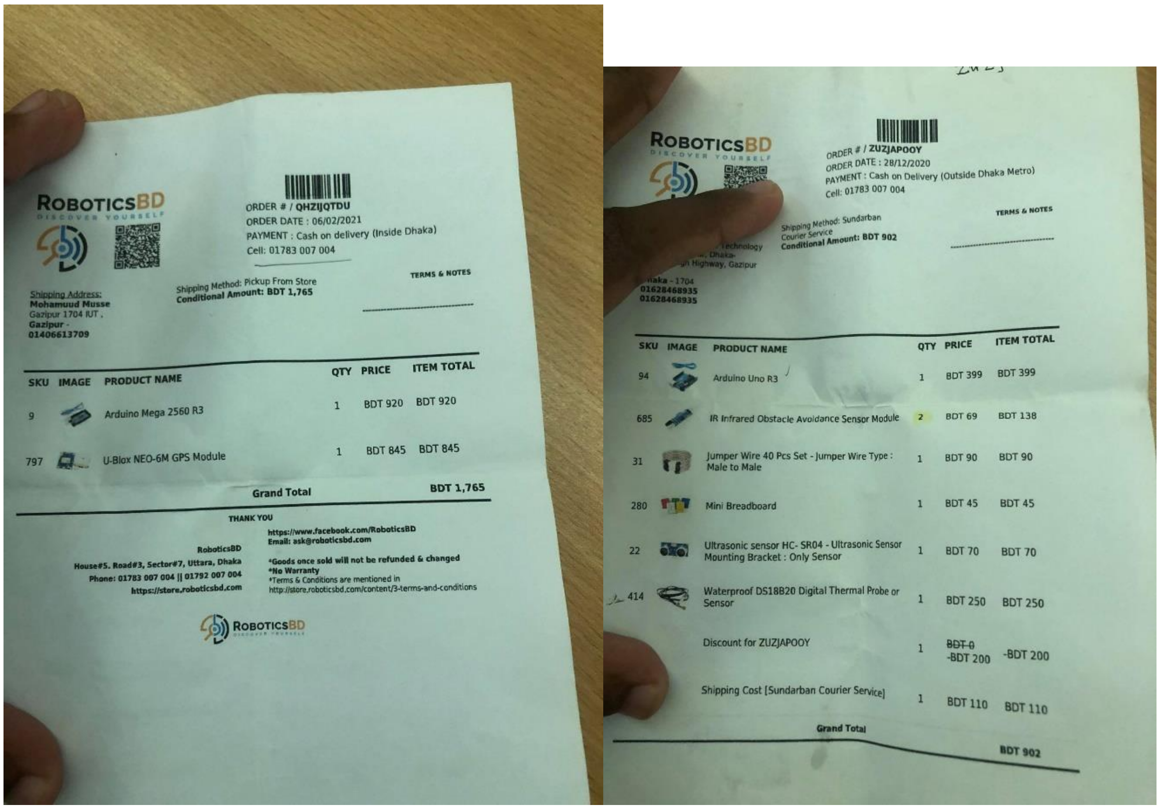


Figure 5: Budget cost

Chapter 4

Prototype Development

4.1 Stage of Prototype:

In this chapter covers about the prototype development of Smart Cane. A prototype is a model used to test and evaluate a design. Based on SDLC prototype model, in the design, implementation and testing part, the process involves is to produce hardware development, software development hardware and software integration. The component that involves with this project is been figured and by doing an analysis and list important thing to make it usable with the software and application of the project.

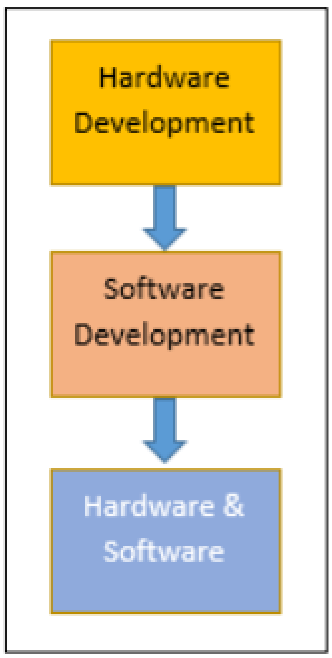


Figure 6: Prototype Development Process.

4.2 Hardware Development:

4.2.1 Arduino Mega 2560 R3:

The Arduino Mega is a microcontroller board based on the ATmega2560. It has 54 digital input/ output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a resent button. Known for its capabilities in handling more complex projects, the **Arduino Mega 2560** gives your projects plenty of room and opportunities. It's recommended for 3D printers and robotics projects with its 54 digital I/O pins, 16 analog inputs, and a large space.

Figure 7: Arduino Mega 2560 R3

4.2.2 Water Sensor:

A water sensor in an electronic sensor that is designed to detect the presence of water in the path of blind people and provide an alert in time to avoid chances of slipping and drenching of the blind people. Fig. 1. Shows the water sensor used in our smart stick.

4.2.3 Ultrasonic Sensor:

An ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listing for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the ultrasonic sensor and the object. We are using this sensor in our stick to detect the obstacles like pits, pebbles, and cars etc. Fig. 6 and Fig. 7. Shows the ultrasonic sensor used and its working respectively.

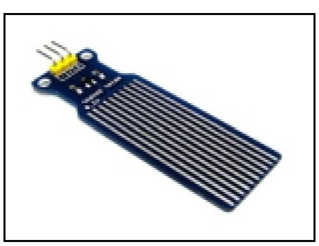


Fig 8: Ultrasonic Sensor

Fig. 9. Water Sensor

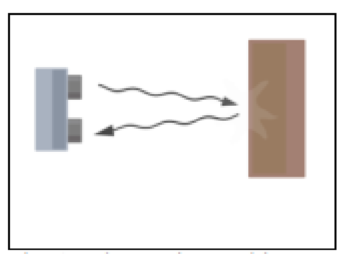


Fig.10. Ultrasonic Working

4.2.4 U-Blox NEO-6M GPS Module:

We are using the U-Blox NEO-6M GPS Module in our stick to get the real-time location of blind people. is a well-performing complete GPS receiver with a built-in 25 x 25 x 4mm ceramic antenna, which provides a strong satellite search capability. With the power and signal indicators, you can monitor the status of the module.

Fig 11: U-Blox NEO-6M GPS Module

4.2.5 IR Infrared Obstacle Avoidance Sensor Module:

The IR sensor module consists mainly of the IR Transmitter and Receiver, Opamp, Variable Resistor (Trimmer pot), output LED in brief. IR LED Transmitter. IR LED emits light, in the range of Infrared frequency. IR light is invisible to us as its wavelength (700nm – 1mm) is much higher than the visible light range. When the module detects an obstacle in front of the signal , the green indicator light on the board level , while low-level continuous output signal OUT port , the module detects the distance 2 ~ 30cm, detection angle 35 °, the distance can detect potential is adjusted clockwise adjustment potentiometer to detect the distance increases ; counterclockwise to adjust the potentiometer to reduce the detection distance .active infrared sensors to detect the reflected , and thus the shape of the reflectivity of the target detection range is critical . The minimum detection distance which black, white maximum; small objects from a small area, a large area from the Grand.

Fig 12: IR Infrared Obstacle Avoidance Sensor Module

4.2.6 Battery:

We are using 12 V rechargeable Li-ion battery. It is a type of rechargeable battery in which lithium ions move from the negative electrode to the positive electrode during discharge and back when charging. Li-ion battery uses an intercalated lithium compound as an electrode material, compared to the metallic lithium used in a non-rechargeable lithium battery.

4.2.7 Buzzer and Vibrator:

To notify the user about the hurdle arriving on his path we are using buzzer and vibrator which is operated by motor driver L293D.

4.3 Software Development:

4.3.1 Arduino (IDE):

C language is used to program and create lists of instructions for a microcontroller/computer to follow. The C program is executed through C compiler before turn it into executable program for the computer easily read the instructions.

The executable that comes out the compiler will machine-readable and executable form. Previously has been mentioned that, by using Arduino Software (IDE) makes it easy to write code and upload it to the board. The version that been used is Version 1.8.13.

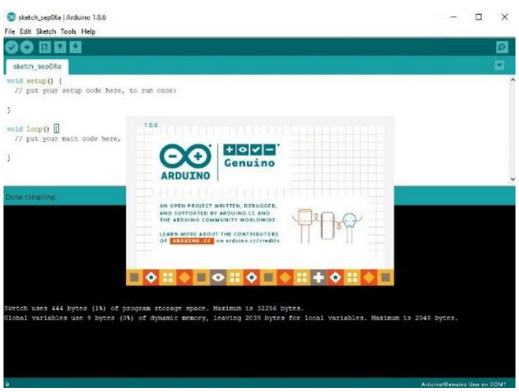


Fig 13: Arduino (IDE) v1.8.13

4.4 Data Flow Diagram:

In the first place, power is provided to Arduino Mega 2560 by 9V battery. Furthermore, ports are instated. And afterward ultrasonic sensor (front) is detected the article somewhere in the range of 2cm and 30cm. On the off chance that the item is found under 30 cm, the signal will begin alert with postpone 1 second. In the event that the article isn't found, the left ultrasonic sensor is detected. In the event that the item is found under 30 cm, the signal will begin alert with postpone 1.5 seconds. In the event that the item isn't found, the privilege ultrasonic sensor is detected. On the off chance that the item is found under 30 cm, the bell will begin caution with defer 1.9 seconds. In the event that the article isn't found, the IR sensor is detected. On the off chance that the item is found more noteworthy than 20 cm, the bell will begin alert.

On the off chance that the article isn't found by the IR sensor, the framework will begin naturally. Figure.6 is the stream outline of Smart Blind Walking Stick System.

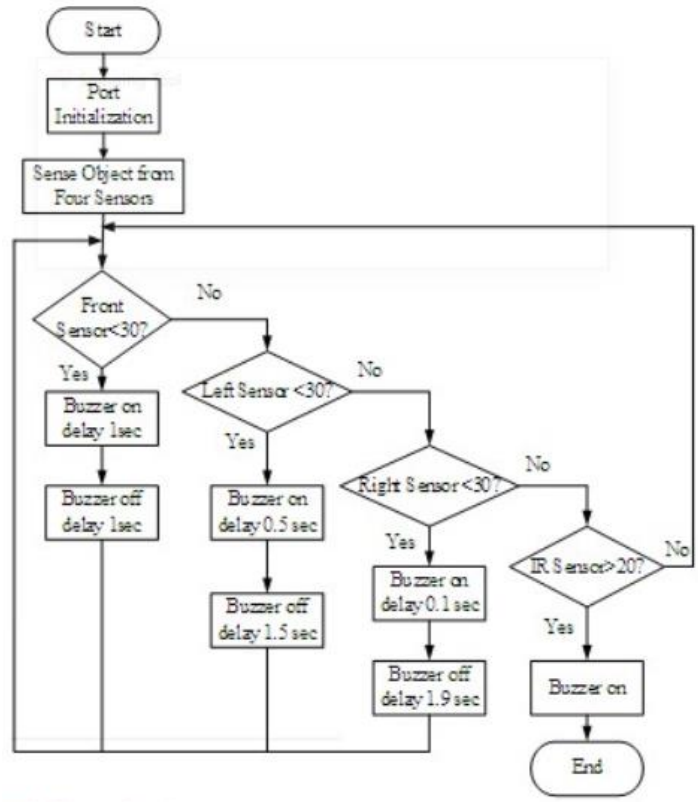


Figure 14: Data Flow Diagram

4.5 Use case Diagram:

In the Unified Modeling Language (UML), a use case diagram can summarize the details of your system's users (also known as actors) and their interactions with the system. To build one, you'll use a set of specialized symbols and connectors.

In figure below the Blind person is actor, Where Blind person turn on device to the system, it sense environment around the user, then it does corresponding action according to their own. Whenever it moving with stick walking around with device it also sense the environment and detect collision if there is.

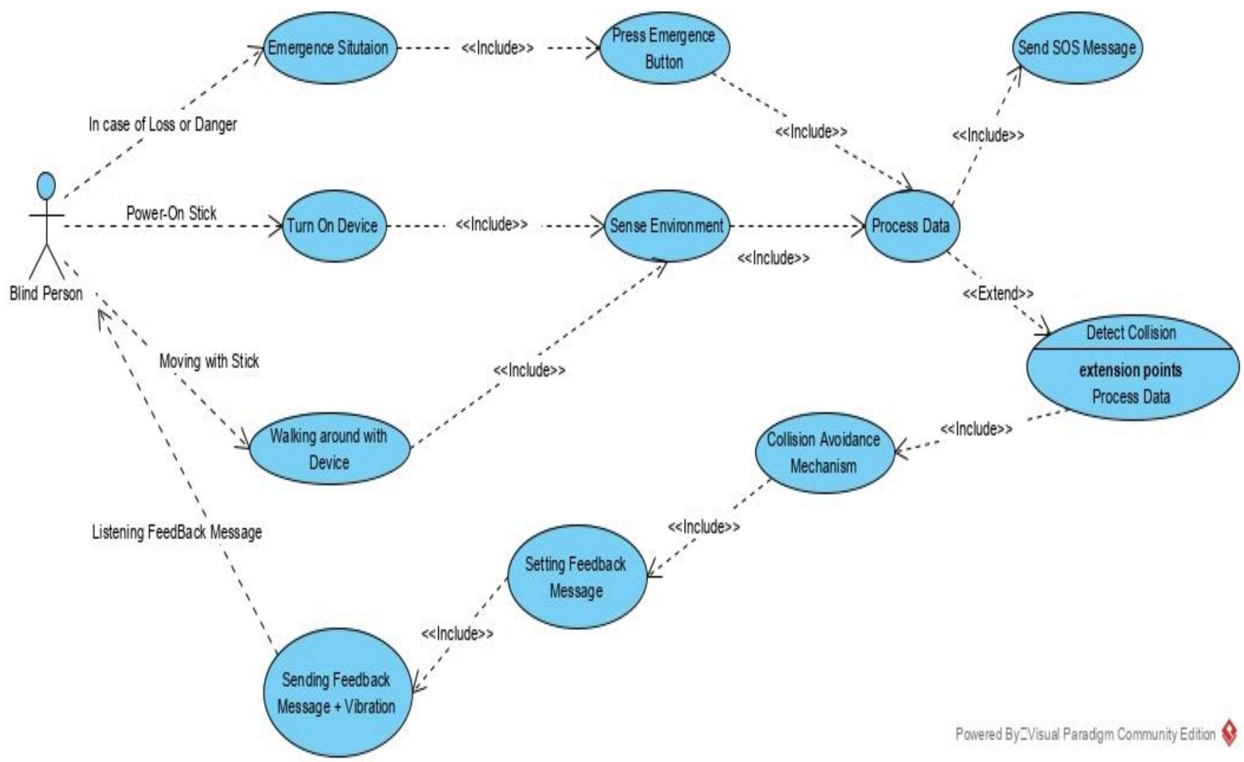


Figure 15: Use Case Diagram

4.6 Activity Diagram:

Microcontroller used to determine the direction and distance of the objects around the blind. It also controls the peripheral components that alert the user about obstacle's shape, material and direction.

In our design microcontroller can sense three main types, 1) Water Detection, 2) Change of Level, 3) High impact (HI). Along with these it does the all corresponding work needed to do the stick. It sense the environment and detect the water if there is and vibrators the stick, it sense the change of the level stick, detect level whether is up or down, if it detect obstacle it makes vibration. In the case of sensing the high impact, it detect if there high impact it also check the low impact and considers both case HI + LW and HI.

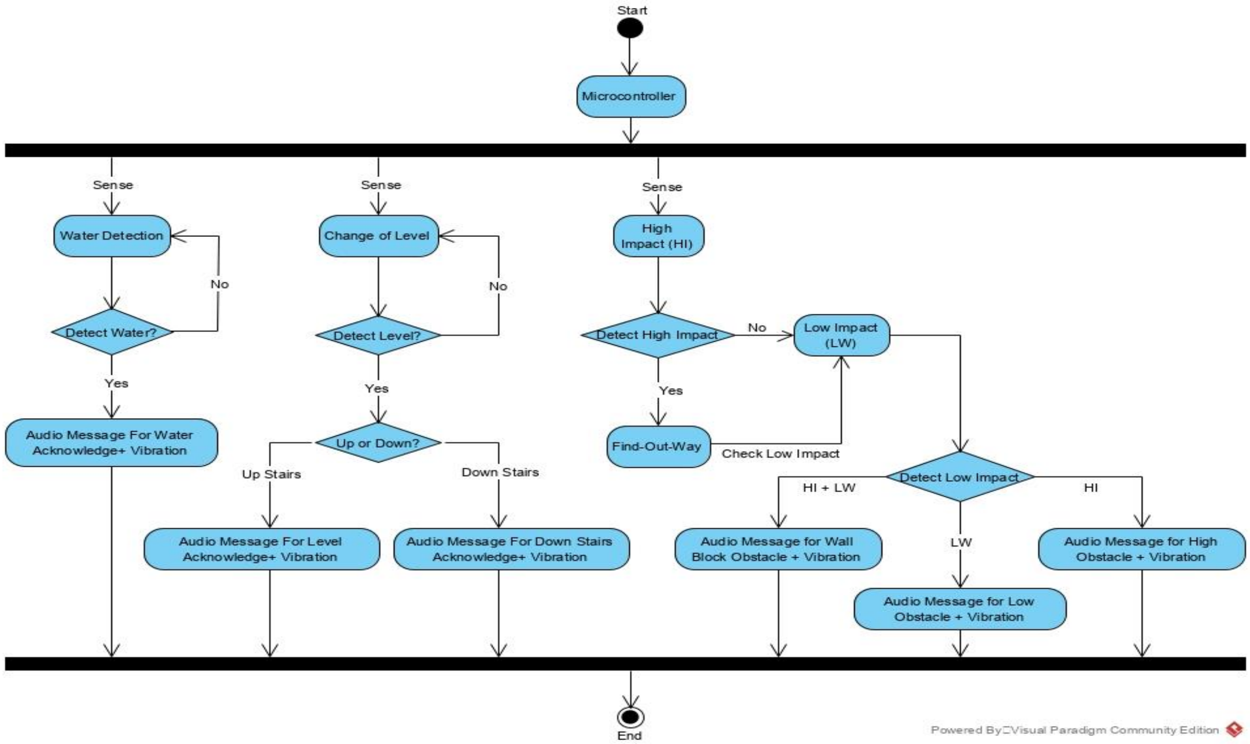


Figure 16 Activity Diagram

Chapter 5

Experiment and Results

It was possible to finish the prototype of the cane for people with visual disabilities, implementing a box capable of containing the respective plates and circuits, serving as a great help, to optimize the space needed in the cane, and not to inconvenience the user. See figure 5.

Validation of the electronic device was carried out with experimental tests, among 15 people (10 blind people completely and 5 blind people at 80%) with ages between 22 and 55 years, both men and women participated. The tests were conducted with Bluetooth headphones, handling different obstacles at different distances, as can be seen in Figure 6, which could be interpreted that the most optimal measurements that coincided in several people in the established measurement range, gave as result approximations of the range 0.2 m to 1.1 m.

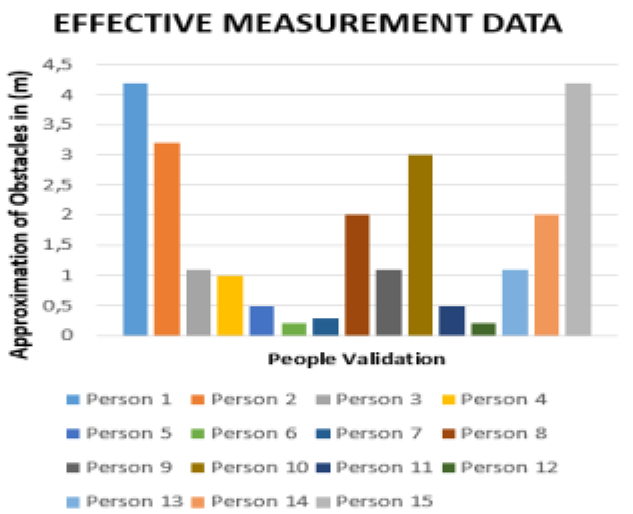
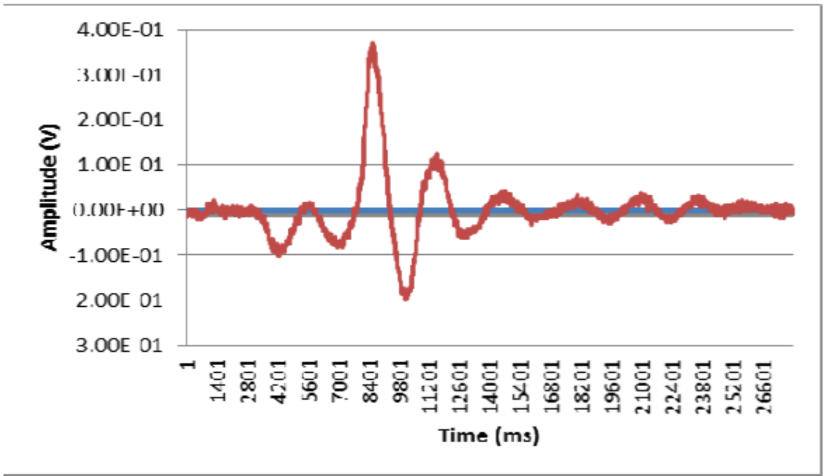


Figure 17: Validation tests performed on 15 blind people

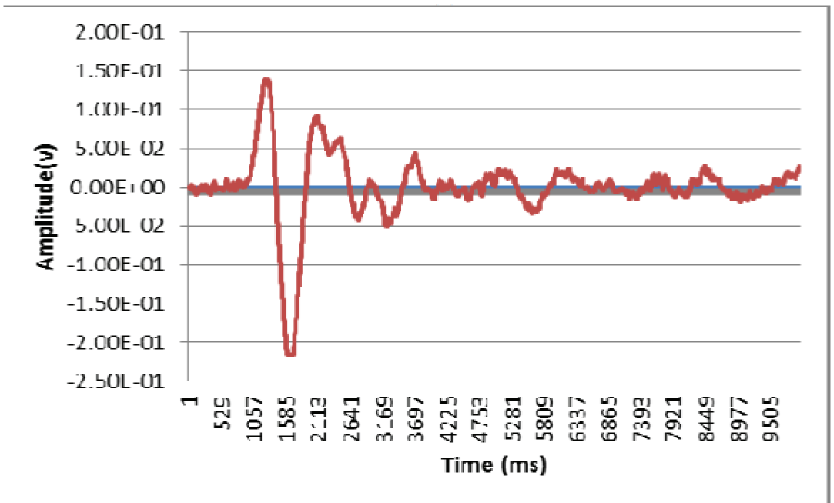
5.1 Stairs detection experiment:

Two experiments are done; the firs was a validation test in lab and the second was a real test outside and inside buildings. In the lab valid test, a simple stairs models are built with 2 steps and output of inclined sensor is connected to oscilloscope to notice the variation in received signal. In the case of stairs presence a different form and amplitude signal than the transmitted signal is received as show in Fig.7a and Fig.7b.

The received signal in case of upward stairs ranged from 0.198V to 0.73V with average 0.087V while downward stairs range from 0.138V to -0.215V with average -0.038V. When the MCU computes the average, it checks any negative or positive variations as show in Fig.8



(a)



(b)

Figure 18: Received signal in inclined infrared sensor (a) Stairs up signal case (b) Stairs down signal case

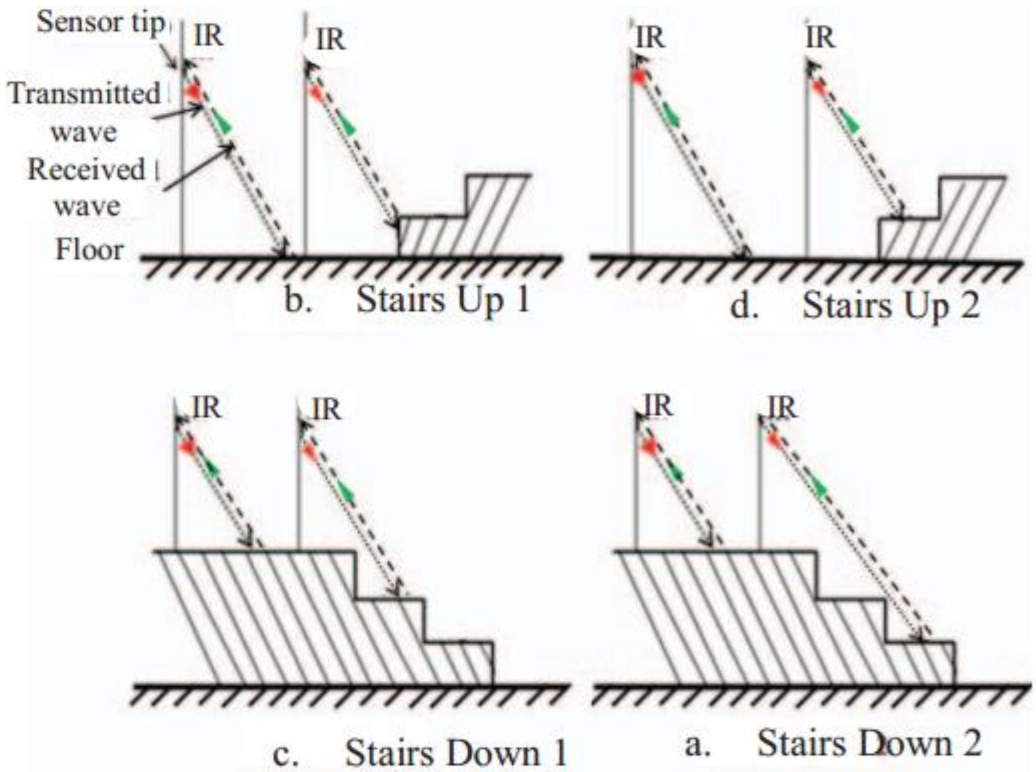


Figure 19: Inclined infrared sensor in environment

Additionally MCU can detect how far the stairs are from the blind by checking the amount of variation of average received signal which increases the blind approaches the stairs.

5.2 Obstacle detection experiment:

Obstacles are either low obstacle located on the floor in the path of the blind or high level

Obstacles in front of him. In lab, different types of obstacles at various distances and heights are placed, and then the sensor is connected to oscilloscope to observe the received signal variation. In the case of no obstacles on floor or in front of him, we receive almost no signal. The environment noise show on the oscilloscope as a very weak signal as shown in Fig. 9a. In case of an obstacle exist in front of him a received signal by horizontal sensor with amplitude higher than that received signal by inclined sensor in case of low obstacle on the floor as shown in Fig.9b and Fig.10c

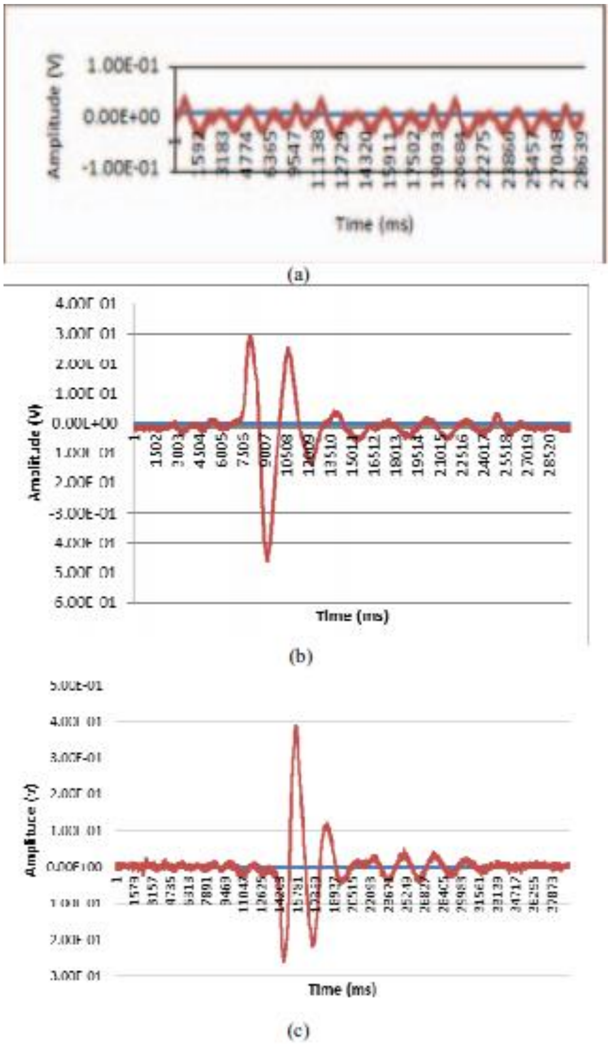


Figure 20: Received signal in infrared sensors (a) No obstacle (b) Obstacle in front of the blind (c) Obstacle in the floor

We also checked the detection using the speech warning message kit and were able to validate the product on of corresponding speech message.

Real experiment was held by a group of 4 blind people to test the obstacles detection using the smart stick. Six obstacles with different heights were placed in their walking path.

Most of obstacles were detected and the appropriate messages were heard by them as they reported although some were not taking enough space away from the obstacle.

Therefore, they sometimes touched the obstacle edge so these instances were considered as unintended error. The results of complete avoidance of hitting detected obstacles are shown in Fig. 10.

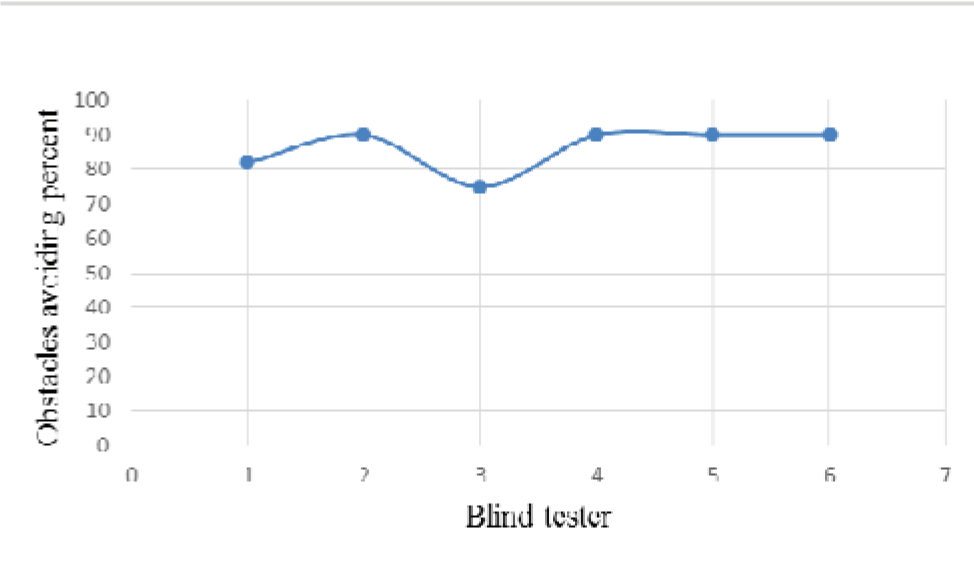


Figure 21: Obstacles avoiding percent vs blind tester

5.3 Testing:

5.2.1 Sensor testing:

In order to get the specific number of distance measurement towards obstacles, the test being done by using two different kind of stick. The first blind stick original length is 85 cm that shows the obstacles is detected through ultrasonic sensor HC-SR04 when blind people approach obstacles 100 cm of body level and 40 cm of ground level for the steep and stairs. While the second blind stick with length of 45cm will detect obstacles 85 cm for body level and 55 cm of ground level. By considering mobility aspect, this differentiation between the two blind stick is being done because of Blind Stick Navigator is not easily fold like the traditional white cane. After couple of times test to get suitable distance, the result can be seen in the image below.

5.2.2 Vibrate feedback Testing:

The obstacles is detected via ultrasonic sensor, the sensor will send back the new output to the board and microcontroller will process it according to the sketch and will send the feedback to the relay and will result to DC motor being turn on.

If the obstacles detected at body level phase, the DC motor will vibrate according to this pulse that have delay 200 milliseconds (0.2 sec). While for the obstacles that detected at ground level phase will automatically vibrate continuously and stop if the obstacles not approachable anymore.

5.3 Results

5.3.1 Sensor Results:

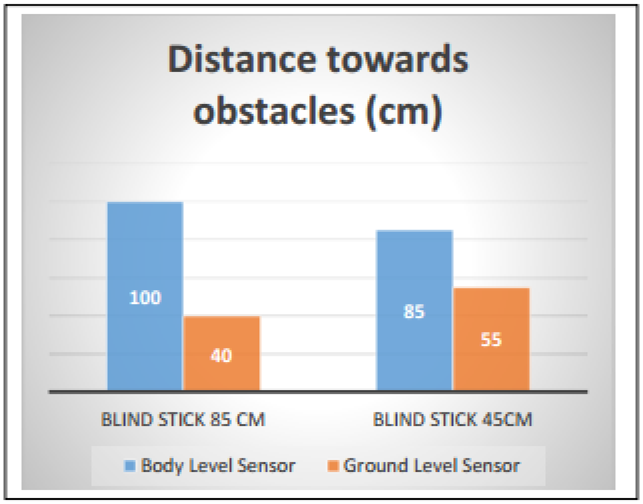


Figure 22: Specific measurement for two type blind stick.

5.3.2 Vibrate Feedback Results:

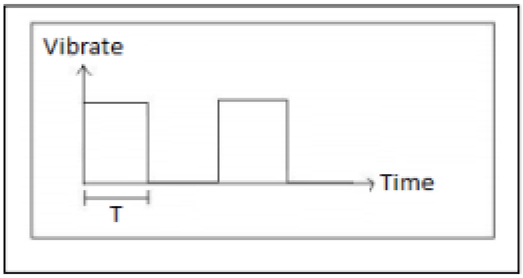


Figure 23: Pulse response for body level.

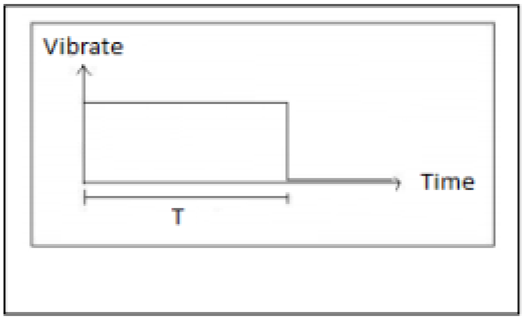


Figure 24: Pulse response for ground level.

To have an in depth analysis a scenario has been set up to gather the performance of the prototype. The prototype is lacks of durability to stay longer in action if the power that been supply to microcontroller board is around 7-10V. It can be seen when the prototype is connected with 9V battery and only the board is actively working while the vibration feature seems not working smoothly. Due to that by adding another power source through the DC power jack thus helps the prototype to work smoothly along with 9V battery and last about 6 hours. Means, this prototype need a constant power that averagely provide around 11-15V. If more voltage than 15V being supply to it, the microcontroller will damaged or crash due to the heat. The field test shows that this prototype working excellence (10) on dry condition and really bad (1) on rainy condition. While it, perform good (6) on both condition that is in building and on streets. Moreover, by doing a survey among citizen, shown that this prototype device is a needs and good to be implement to blind people. Thus, blind assist tool makes the people connected to each other. Good technology comes from good idea.

Chapter 6

Conclusion

6.1 Introduction:

This chapter discusses the suggestion of future work for the project and conclusion will be made according to the project development.

6.2 Conclusion:

The main purpose of this study to produce a prototype that can detect object, or obstacles in front of the user and feeds warning back, in forms of vibration to users. From the tests carried out on its functions reveal that the developed prototype which is named Smart stick has achieved its objectives. The issue arises regarding the un-suitable vibrate motor is by providing a servo motor and high quality vibrate motor in future. It's support with movement of stick in rightward and backward with a good vibrating mechanism. In addition, it is hereby suggested that the project be continues and further developed in the area of software and hardware enhancement, thus let hope inspire humanity but let not idealism blind you.

6.2 Suggestion:

In order to improve the project function and implementation in the future, several suggestions are proposed: This study would recommend that a power source for the prototype that rechargeable via solar technology for a better mobility and durability. Besides that, a good solid and waterproof case or wrapper thus help this stick to work on rainy situation and drop test. The advance technology of VirtualReality (VR) can be taking as future research and development to enhance more the alert and awareness of the blind people.

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