DESIGN OF NAVIGATION SYSTEM FOR VISUALLY IMPAIRED PEOPLE

A THESIS SUBMITED TO THE GRADUATE SCHOOL OF APPLIED SCIENCES OF NEAR EAST UNIVERSITY

By
ADEDOYIN HUSSAIN AHMED

In Partial Fulfillment of the Requirements for The Degree of Master of Science in Computer Engineering

NICOSIA, 2019

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Approval of Director of Graduate School of Applied Sciences

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ABSTRACT

The work presented forward is to provide an effective low cost system to allow path planning for the visually impaired. With the increase proportion of people with need (old, disable) in the society, the work presented is a navigation system platform which will make a prominent role to provide a durable and provident remote real time and online care for the user. The online mode is to detect the obstacle and guide the visually impaired about the appropriate road path. The system uses sensors based detecting system for obstacle detection and sends back audio or buzzer sound as response which informs the visually impaired about its position by using a fuzzy systems approach. The main method used by every visually impaired is the walking stick for detecting obstacle which is limited, it does not protect areas near the head, this online system will allow the visually impaired to obtain information about obstacles near the head and also correct road path on which to move. When used with a walking stick, the visually impaired is totally protected against obstacle and navigation is made easy into the environment. The real time mode which is the audio guide for the visually impaired allows the visually impaired users to simply touch a button, say is intended destination to the caregiver, and be guided correctly with appropriate path planning including GPS and live video feed guidance. The overall system dished out is portable and can be carried and operated by a visually impaired user in which the user communicates with the environment easily.

Keywords: Audio guidance; real-time; navigation; visually impaired; sensor based detecting system; vibro-tactile; near head area; caregiver; movement detection; navigation system; augmented object

ÖZET

İleri sürülen çalışma, görme engelliler için yol planlamasını mümkün kılmak için düşük maliyetli bir sistem sağlamaktır. Toplumdaki muhtaç insanların (yaşlı, sakatlar) oranının artmasıyla, sunulan çalışma, kullanıcıya uzun ömürlü ve güvenilir bir uzaktan gerçek zamanlı ve çevrimiçi bakım sağlamada önemli bir rol oynayacak bir navigasyon sistemi platformudur. Çevrimiçi mod, engeli tespit etmek ve görme engellilere uygun yol yolu hakkında kılavuzluk etmektir. Sistem engel tespiti için algılayıcı tabanlı algılama sistemi kullanır ve bulanık bir sistem yaklaşımı kullanarak konumu hakkında görme engelli olduğunu bildiren yanıt olarak ses veya sesli uyarı sesini geri gönderir. Görme engelliler tarafından kullanılan ana yöntem, sınırlı olan engelleri tespit etmek için bastondur, başın yanındaki alanları korumaz, bu çevrimiçi sistem görme engellilerin başın yanındaki engeller hakkında bilgi edinmesini ve ayrıca yolun yolunu düzeltmesini sağlar. Hangi hamle. Bir baston ile kullanıldığında, görme engelli tamamen engele karşı korunur ve gezinti çevre için kolaylaştırılmıştır. Görme engelliler için sesli rehber olan gerçek zaman modu, görme engelli kullanıcıların sadece bir düğmeye dokunmalarını, örneğin bakıcıya hedeflenen hedefleri bulmalarını ve GPS ve canlı video besleme kılavuzu dahil olmak üzere uygun yol planlamasıyla doğru şekilde yönlendirilmelerini sağlar. Yıkanan genel sistem portatiftir ve kullanıcının çevre ile kolayca iletişim kurduğu, görme engelli bir kullanıcı tarafından taşınabilir ve çalıştırılabilir.

***Anahtar Kelimeler**:* Ses rehberliği; gerçek zaman; navigasyon; görme engelli; sensör tabanlı tespit sistemi; vibro-dokunsal; baş bölgesinin yakınında; bakıcı; hareket algılama; navigasyon sistemi; artırılmış nesne

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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LIST OF ABBREVIATIONS

3G:	Third Generation
API:	Application Programming Interface
APP:	Application
CPU:	Central Processing Unit
CSS:	Cascading Style Sheets
ETA:	Electronic Travel Aids (ETA)
ENISA:	European Union Agency for Network and Information Security
GPRS:	General Packet Radio Service
GPS:	Global Positioning System
HA:	Home Agent
HTTP:	Hyper Text Markup Language
ICT:	Information and Communication Technologies
ID:	Identifier J2ME: Java 2 Micro Edition
JME:	Java ME, A Java Platform
JSON:	JavaScript Object Notation
MCU:	Microcontroller Unit
MAvBT:	Mobile Application via Bluetooth Wireless Technology
NIST:	National Institute of Standards and Technology
PAD:	Portable Assistive Device
PCB:	Printed Circuit Board

PDA: Personal Digital Assistant

PIC: Peripheral Interface Controller

PSD: Position Sensitive Detector

RAM: Random-Access Memory

R-JSON: Reverse JavaScript Object Notation

RFID: Radio Frequency Identification

S3: Simple Storage Service

TOF: Time of flight

US: Ultrasonic Sensor

VIP: Visually Impaired Person

WHO: World Health Organization

CHAPTER 1
INTRODUCTION

Visually impaired, can also be called vision impairment or vision loss, is a reduce in the ability to see, it causes non fixable problems by regular means, like glasses. It also includes those with decreased ability to have a clear vision because they might not have access to glasses or lenses. Visual impairment is said to be a top corrected visual intelligence of worse than 20/40 or 20/60. While the word blindness mostly for complete or almost complete vision loss. Visual impairment causes difficulties for people with normal daily activities such as driving, walking, socializing, and reading.

The most regular cause of vision impairment worldwide are refractive uncorrected errors (43%), cataracts (33%), and glaucoma (2%). Known refractions errors include near sighted, presbyopia, astigmatism and far sighted. Cataracts are very common force of vision lose. Other effects that can cause vision problems globally can be childhood blindness, age related macular degeneration, corneal clouding, diabetic retinopathy, and some number of infections. Vision impairment can also be caused by brain problems, some like premature birth, due to stroke, or trauma among others. They are known as cortical visual impairment. Screening grownups without symptoms is of no relevant benefit. Diagnosis is done through examining eye exam.

Vision impairment is a serious issue that wean a human of approx. 80–90% unceasing and has a serious cause on professional, social and personal ideality of life. WHO gauges the amount of VIP to be 285 million; most are over 50 years of age, although in recent societies; the knowledge of blindness and needs are poorly identified for VIP.

By 2015 there is said to be about 940 million individuals with some grade of vision loss. Two hundred and forty-six million has vision that is low were as thirty-nine million are blind individuals. Thus, most common individuals having vision that’s poor are set be present in developing world and with the age of 50 and above. The level at which visual impairment has decreased since the 1990s. Visually impaired individuals meets serious health problems, mostly as a result of diabetes. In addition, diabetes is combined with other health problems which are associated to it like nerve damage, bone infections, and kidney failure.

Those kind of health problem requires them to visit hospitals and health services often. Unluckily, in recent times they are stopped from making use of them on same terms as others individuals. A couple of health organization seem to give attention to blind people needs while planning their surroundings. Hospitals of late are very large which are also complicated organizations, were very small audience are given to providing a path way for visually impaired people in complicated surroundings, and which would be difficult in bargaining individually.

1.1 Thesis Problem

In new times' approaching everyday-life environments for people with disabilities or aged individuals catches the interest of the public. Individuals having visual problem or disabilities, i.e., part or totally blind, are mostly face difficulties with places which are not modified for their condition for example, train terminals and bus stations, hospitals, public offices, educational buildings, and shopping centers. Various everyday objects which are in most modernized environments becomes real obstacles or problem for visually impaired people, with this their physical integrity is at great risk. Regular objects like chairs, tables and stairs, prevent movements for the VIP and can mostly cause grievous havoc.

Visually impaired individuals run in to serious problems in living a single life this is due to the decreased figure of the area. New everyday surroundings create a big difficulty for the VIP to figure the environment without taking help from people. Recent programs for training VIP individuals urges them to cram a big scale of information at various points like shopping malls, university, bus terminals. which leads to the rise in personal lamentation. It can be mostly said that the inconvenience of moving without restraint and independently can cause the implementation of a person in the society.

1.2 The Aim of the Thesis

The usual method for navigating of a person with vision lose is by using a walking stick or guide dogs or a walking cane. Walking cane is said to be a mechanical simple device designed in detecting stationary objects on uneven surfaces, ground, and holes with a simple tactile-force output. The proposed device is light and portable but the ranges are limited and is not reliable for protecting the individual from obstacles to head area. A lot of scopes has been put forward for this difficulty, which includes paving blocks, handrails, slopes and not steps elevators. This research work we put forth by presenting the paper, which is based on using modern technologies to modify the visually impaired mobility.

These tools are helpful in local navigation: collision avoidance and local path planning. This research work describes a system for a navigating tool for visually impaired people.

1.3 The Importance of the Thesis

This research work plays a significant importance at solving and enhancing the ability to provide a quality system for navigation for visually impaired person and people with disabilities giving them an administrative control and facilitate the means to operate successfully.

Other importance is

- To accurately detect obstacles in space.
- To make navigation convenient for the VIP.
- To detect from the ground level then to head level.
- To have a low range in cost.
- To have a very low power consumption rate.
- To provide appropriate path planning to user

1.4 Limitation of The Study

Although, advancement or scopes given are timid in particular situation and can be difficult in relating with the visually impaired to live in many areas at present. Mostly individuals with low visual information, there are a lot of limitations in the environment in is everyday life. These individuals have huge amount of problems in acquiring environmental information. Moreover, obstacles that doesn’t seem dangerous to normal people can become very damaging to them. Although they make use of blind stick to get familiar with the environment, it is still difficult for the VIP to move around in most of the areas and also not capture the entire area.

Another limitation is the option is the providing of the best travel guide presented to the visually impaired is a dog used as guide. Which is based on the communication with the VIP and the dog, most info is passed by tactile output by handles fixed on the dog. The VIP feels the dog's attitude, gets the problem and also give him right order. But dogs for guide is mostly not affordable, it's said to be at the price of a good car, and the average time is limited for the dog, which is on an average of 7 years.

Various proposals have been put forth to address this difficulty in indoor and outdoor environments. Although most of them have limitations, since it involves many issues e.g. accuracy, usability coverage and interoperability that cannot easily be addressed.

1.5 Overview of The Thesis

The research work we put forth in this work is to make use of modern technologies to advance the visually impaired mobility. This research work is based mostly detecting obstacle, guidance and path planning in concise to reduce navigating difficulties associated to their. Navigating through somewhere which is not known becomes a big time difficulty when we can't even rely on our eye. Dynamic objects bring noise while moving, visually impaired can build the ability to hear and to help localize them. Although, they are limited to the sense of touch like when the objective is determining the position of an object location. The most frequent used method for navigation of VIP is making use of the walking stick or walking cane.

One of the main objectives of this research work is by providing, real-time, relevant navigation information that makes the user or visually impaired to make accurate and timely decisions on which path to follow through in space.

CHAPTER 2
RELATED RESEARCH

2.1 Macro/Micro Navigation

Many propositions have been made for individuals with vision impairment in the field of mobility assistance and location. These book focus mainly on environments that are outdoors and some of the preceding ones.

The outdoor study on the communication in the environments majorly are the problem of users inclined during macro-navigation and micro-navigation. Micro-navigation examining the information being delivered from the immediate material environment, and macro-navigation examines the difficulties of dealing with the environment which are distant. In the cases the use of global positioning systems has been quite useful in recognizing the user's location**.**

The study concentrated on the indoor surrounding recommends different ad hoc technologies and strategies to drop off useful information to the user. Nonetheless, a certain part of them are suitable enough for visually impaired people. For instance, Sonnenblick created a navigation system that works in the indoor environments through the use of infrared LEDs. The LEDs should be located in places where the blind person pass strategically to enable them go through their activities (e.g., rooms and corridors), then it can act as a guideline for them. Radiations coming from the LED lights is captured and understood by a special device for it to transform to a meaningful message to aid the movements of the user. The major disadvantage of this solution is the use of an infrared receptor in place of a device that has a large coverage capacity such as an infrared camera. Because the infrared signal has to be captured to identify the user's position, the receptor device must point directly to the source of light (e.g., the LEDs), thus losing the prospect of an even integration between the device and the environment.

Hub, Diepstraten and Ertl created a system to determine the position of objects and individuals in an indoor environment. That system involved the use of cameras to detect objects and sensors to recognize the direction of movement of the user. The major limitation of that proposal is the accessibility of the implementation technology, since the system involves a special device to enable the user's interaction with the environment. This system

also pre-establishes possible camera locations, which also creates several disadvantages; for example, the detection process involves that the person points out his cane at the eventual obstacles.

2.2 Navigation with Objects Tracking

Hub, Hartter and Ertl went further on their previous proposal, and they included the capability of tracking various types of mobile objects, e.g., people and pets to the system. Then, using an algorithm corresponding to human perception, they tried identifying such tracked objects by comparison of their color and shape, with a set of known objects.

Treuillet and Royer suggested an interesting vision-based navigation system to guide visually impaired people within their indoor and outdoor environments. The positioning system uses a body mounted camera that takes pictures from the environment periodically, and an algorithm to match (in real-time) particular references extracted from the images, with the help of the 3D landmarks already stored in the system. This solution shows very good results to find people in memorized paths, but it is not useful within environments that are been visited for the first time. The same thing occurs with the proposal of Gilliéron et al.

There are different studies done in the area of artificial intelligence and robotics, which recognizes indoor scenes in real-time. Some of the solutions allows the creation of reference map dynamically, e.g., the vision-based systems suggested by Davison et al and Strasdat et al, or the ultrasound positioning system developed by Ran et al. Though they have been proven accurate and useful in different fields such as robotics, the automotive sector and wearable computing, they request that the blind person carry a computing device (e.g., a nettop) to examine the surrounding and process the information in real-time. Since, there's a need to be with the cane at all times, making use of not especially wearable appliances destroys the appropriateness of the solutions. In this case the solution provided by Hesch and Roumeliotis is interesting peculiarly because they implemented the white cane that is a basic tool for the visually impaired. However, the solution has two major difficulties: (1) the mounted sensors in the cane (3-axis gyroscope and a laser scanner) are quite heavy and large, as such the user's movements are limited, and (2) the laser scanner sensor in the cane is directional, as such has similar difficulties with the infrared-based solutions discussed previously.

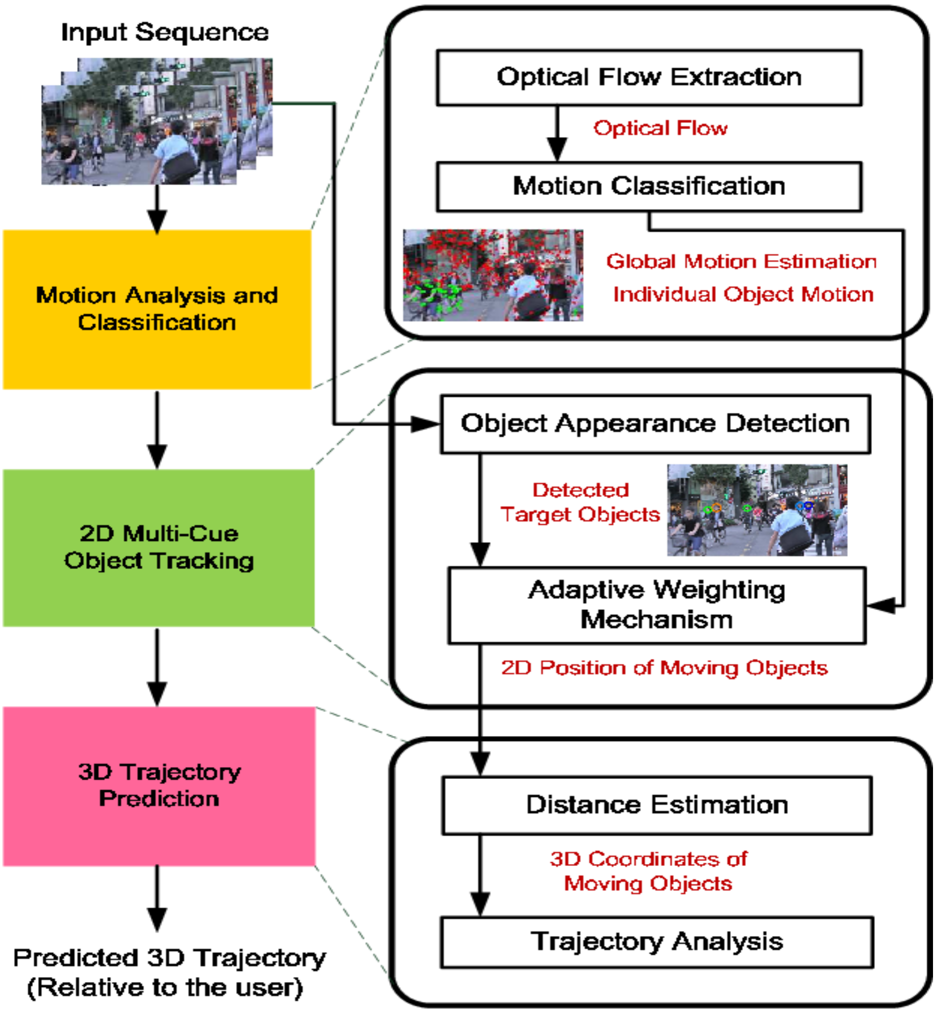

Figure 2.1: System block diagram

2.3 Navigation with Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) is the commonly used technology for guiding the visually impaired in indoor environments. For instance, the authors suggested a system that works on Smartphone and allows the visually impaired to pass a planned route designed on the floor. The solution combines the cane with a portable RFID reader attached to it. By making use of this cane, the user can use a specific path, poised by RFID labels, on the floor of a supermarket. Kulyukin et al proposed a similar solution, displacing the cane with a robot that is a guidance to the visually impaired person.

Another RFID-based solution in support of the movement of visually impaired people was recommended. This system that is named BIGS (for Blind Interactive Guide System), is made up of a PDA, a RFID reader, and several tags distributed in the floor. Making use of these elements, the system will recognize the present position of the PDA's user, calculate the user's direction, utter voice messages and realize voice commands. The major difficulties of using RFID-based solutions are two: (1) reconfiguration of the aligning area (e.g., it now has a new setting) requires extra time and effort unlike other solutions, like vision-based systems, and (2) the users are guided typically through predefined paths.

A certain number of researches have been carried out to detect the position of the user and carry out the tracking of the object in the indoor environments as support of the present computing systems. Though they have shown to be useful to estimate the users' position, they do not address the problem of obstacles recognition in real-time systems. Therefore, they are partially useful in addressing the stated problem. Hervás et al introduced the concept of tagging-context for distributing awareness information about the environment and for providing automatic services to the augmented objects used in these environments. Finally, an interesting work regarding a network of software agents with visual sensors is presented in this system uses several cameras for recognition of users and tracking of their positions in an indoor space. However, these last two works do not address the particularities involved in the supporting of such navigation for the visually impaired.

Checked with barrier escape, little is known about finding a way with vision impairment, and there is no equivalent technology in the success of the cane or guide. GPS technology that has been used for the speech-based navigation for the visually impaired in finding their way outdoors. Though indoors, away from the windows, the GPS signals are not quite reliable, neither do they provide the adequate spatial determination in locating rooms and the other fundamental locations. While various location systems are workable for indoor applications, none of them has seen any monumental acceptance. Their difficulties are due to cost and other limitations include the installation and the necessary maintenance of the active sensors, or the dependability of the devices depending on the detection of the features in an un-instrumented environment (e.g. detection of existing WI-FI signals or using computer vision). Detecting the location for visually impaired users constitute greater challenges. For it to be useful, the system needs to be dependable since error detection and verification by visually impaired is more difficult. This cancels majority of the unassisted dead-reckoning techniques and visual-scene analysis. Because the population of the users is quite small, systems depending on the installing and maintaining of a vast array of beacons or sensors or those that require the extensive and purpose-specific mapping efforts are not easy to justify on the economic grounds. Systems making use of fiducial and informational markers expects only a minor change in the infrastructure, and they have seen a certain level of commercialized application; nevertheless, these systems needs a user to visually pinpoint the bookmarks and point a camera at the makers. An approach for adapting this system for blind users is to make the bookmarks prominent to a machine vision system. Coughlan and Manduchi thread this path with colorful bookmarks that can easily be detected with the camera on the mobile phone. We also took a similar approach but it is in the infrared range to avoid the usage of bold bookmarks that can be unfavorable to the philosophy of the environment.

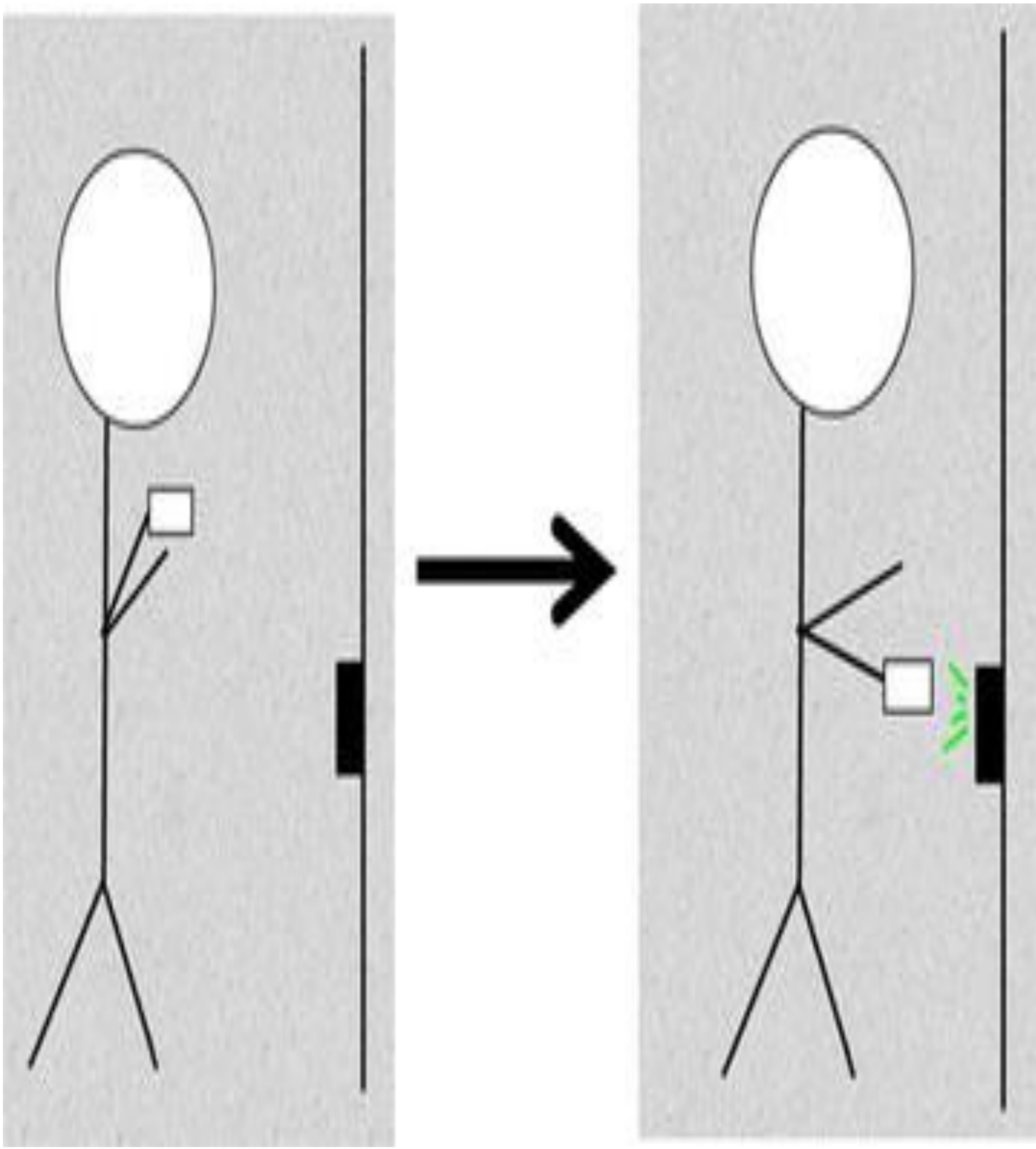

Figure 2.2: Radio frequency identification (RFID) system overview

CHAPTER 3
METHODOLOGY

3.1 System Architecture

The system conceptual model that entails the behavior, structure, and more views of the system is said to be the architecture of the system. The description is formal and it represents the proposed system as a whole, unionized in a way that supports reasoning about the systems structures and behaviors.

The architecture of the system consists of components of the system and the systems developed, that will work together to utilize the overall system.

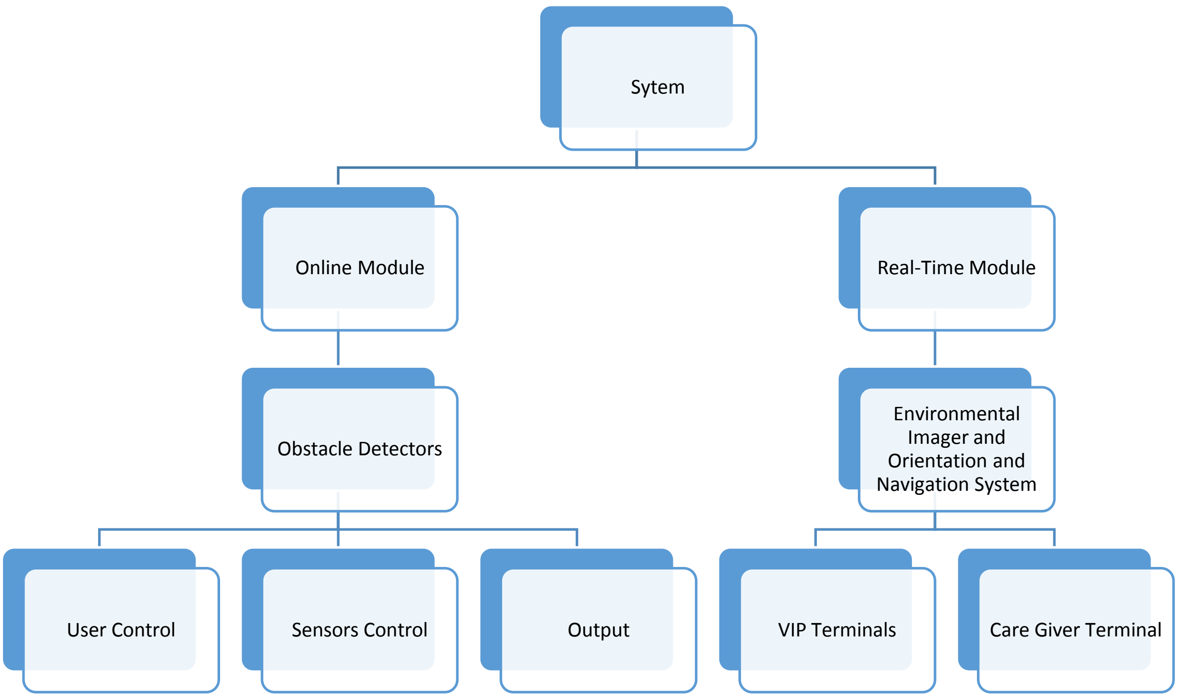

Figure 3.1: The developed system architecture

3.2 System Description

Basically, a blind individual makes use of a walking stick as a guide for them to protect himself/herself against hindrance. Almost all area of the environment is protected with the stick, mostly areas near to the ground like stairs etc. The proposed system can be said to be specifically designed by guarding the area to the head and also near his legs areas. The system is designed to give full, total navigation and path planning to the individual about is environment. It guides the individual along obstacle free path and also gives information about appropriate or obstacle free/ clear path, including distance between obstacles, with the use of sensors based fuzzy system. It also as a Tele-assistance/Tele-guidance system which is a remote human guide, in which the visually impaired uses a camera and GPS to aid real time assistance and also real time path planning.

The proposed system is developed in two modules, Online and real time module. The online module can be sub-classed as Obstacle Detection which is the first part of the Electronic Travel Aid (ETAs) that is Obstacle detection with fuzzy system while the real time module can be sub-classed into VIP's and caregiver's terminal which is the second and third part of ETAs that is Environment Imager and Orientation & Navigation Systems (ONSs).

Online can be sub classed into

- Obstacle Detection with fuzzy system

Real-time module can be sub classed into

- VIP's terminal
- Remote caregiver's or caregiver terminal

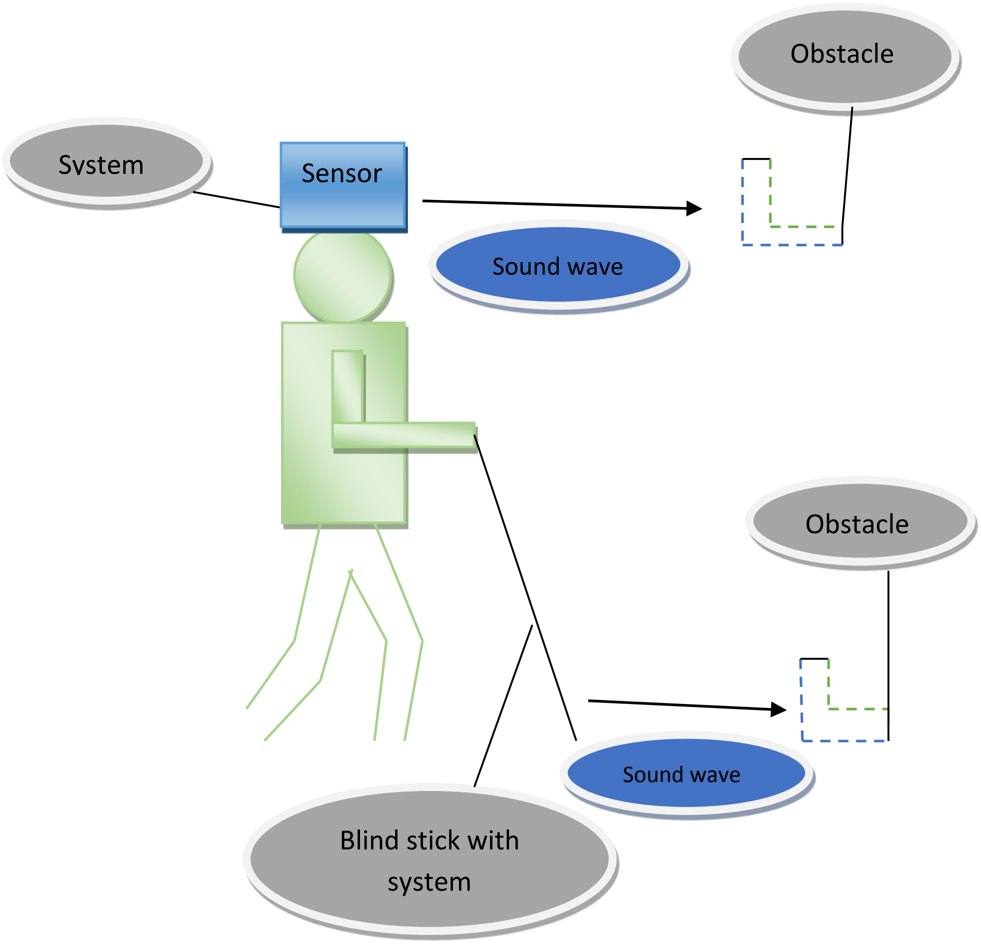

Figure 3.2: The developed system description of online module

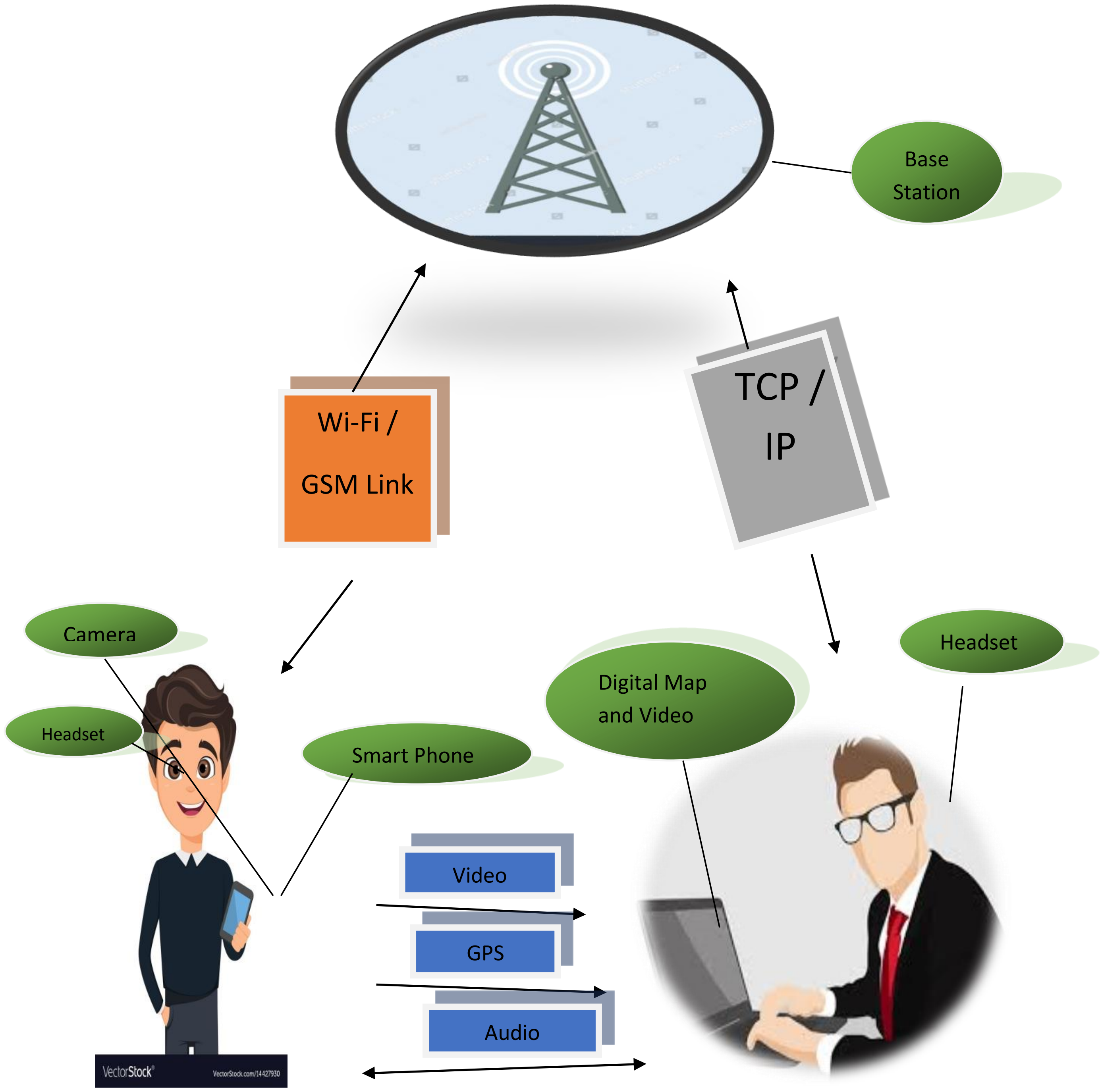

Figure 3.3: The developed system description of real-time module

3.3 Online module

The online module can be said to be the subset of the first class of ETAs which are obstacle detection or are device worn by visually impaired it scans the environment and surroundings in closed spaces. The devices are tasked to assisting VIP by intercepting objects placed in their path. It is necessary that the prototype designed has to comply with the size suitable for the system for installing successfully and for data and testing collection. Thus, the layouts designed for both printed for circuits boards can then be prolonged to add interconnection with multiple layers suitable in accordance to the components for the system.

This Section comprehends the activities for hardware installation of the main components which are ultrasonic microcontroller, sensors with the use of fuzzy guidance system and so on, will be discussed in detail. The next few sections describe the development of hardware and designing of the system, it also includes discussions compilation of all other components needed for each part.

The Online module will also possess some of these characteristics to the user

- Will be able to detect obstacles.
- Will be able to detect distance between user and obstacles.
- Will be able to provide a good path way to the user.
- Will also make the user interact with is surrounding.

The logical structure of our system is segmented to these precise sector: User Control, Sensor Control, and Output.

3.3.1 User control

User control entails switches which will allow the visually impaired to select the System's operation mode. The mode of operation is through Audio and buzzer. These operations are offered to the VIP in taking output by himself on his own accord. Meanwhile, it might not be preferable for him in getting the output in one mode he can rely on the other mode.

Likewise, when more of noise presents itself in the surrounding the buzzer operation might not be portable for him. Another switch which is also controlled, that is the initializing

switch. Initializing switch can be pressed when the visually wants to terminate the operation.

3.3.2 Sensor control

This decides when to alert the sensor to place a measurement, also receive the output value from the given sensor and simplifies it and controlling the sensor value. Essentially, that is creating a sensor module. Therefore, that is making use of US with fuzzy system for detecting and providing appropriate path. The angles are divided using knowledge base from fuzzy analysis. This includes If-Then rules from knowledge base that entails on how the user will avoid obstacles depending on the state the obstacle and user at different scenarios. The primary idea is to evade the obstacle using simplest path. During implementing the rule base the input variable for the right, left angles and the distance variables, turn angle will be output variable for the user with the sensor.

Table 3.1: Summary of sensor toward obstacle detection

Sensor	Characteristics
Ultrasonic sensor	- The process signal is simple because of gradual speed in air for transmission medium which collate to speed associated with light. - The wavelengths are comparatively not long 8.2mm. it entails for utmost resolution in directing measurement for straight distance. - Also the sound wave is uninterrupted by color of the object and can also get the measurement of the length from a sensor to object that is transparent just like as object made of glass. - US are relatively protected against the effects of airborne dust as well light, that will make it very good for making measurements outside.

3.3.3 Output

Output given to the visually impaired consists of the indication when obstacles is included to the user and providing appropriate path to the VIP. Basically they are two output modes, buzzer mode and audio mode. User as the privilege to pick any modes of preference in relation to the convenience of the VIP. Sometimes buzzer is preferable, mostly when there is more noise into the surrounding. Audio is mostly used relatively when environmental noise is minima and whereas buzzer might irritation to the VIP.

Table 3.2: Designed specifications of the online module system

Item	Specification
Effective distance of obstacle detection	1.5 meter
Effective width for walking pathway	0.5 meter
Sensing Environment	Indoor and outdoor
Types of obstacle	Plastic, Plywood, Concrete, Glass, Wood
Shapes of obstacle detected	Circle, Rectangular, Cylinder
Minimum size of obstacle detection	6cm
Alerting medium	Buzzer, Audio message

3.4 Block Representation

This block representation of the system is provided below. There are specific functionalities completed by these block. The block representation is described as follows.

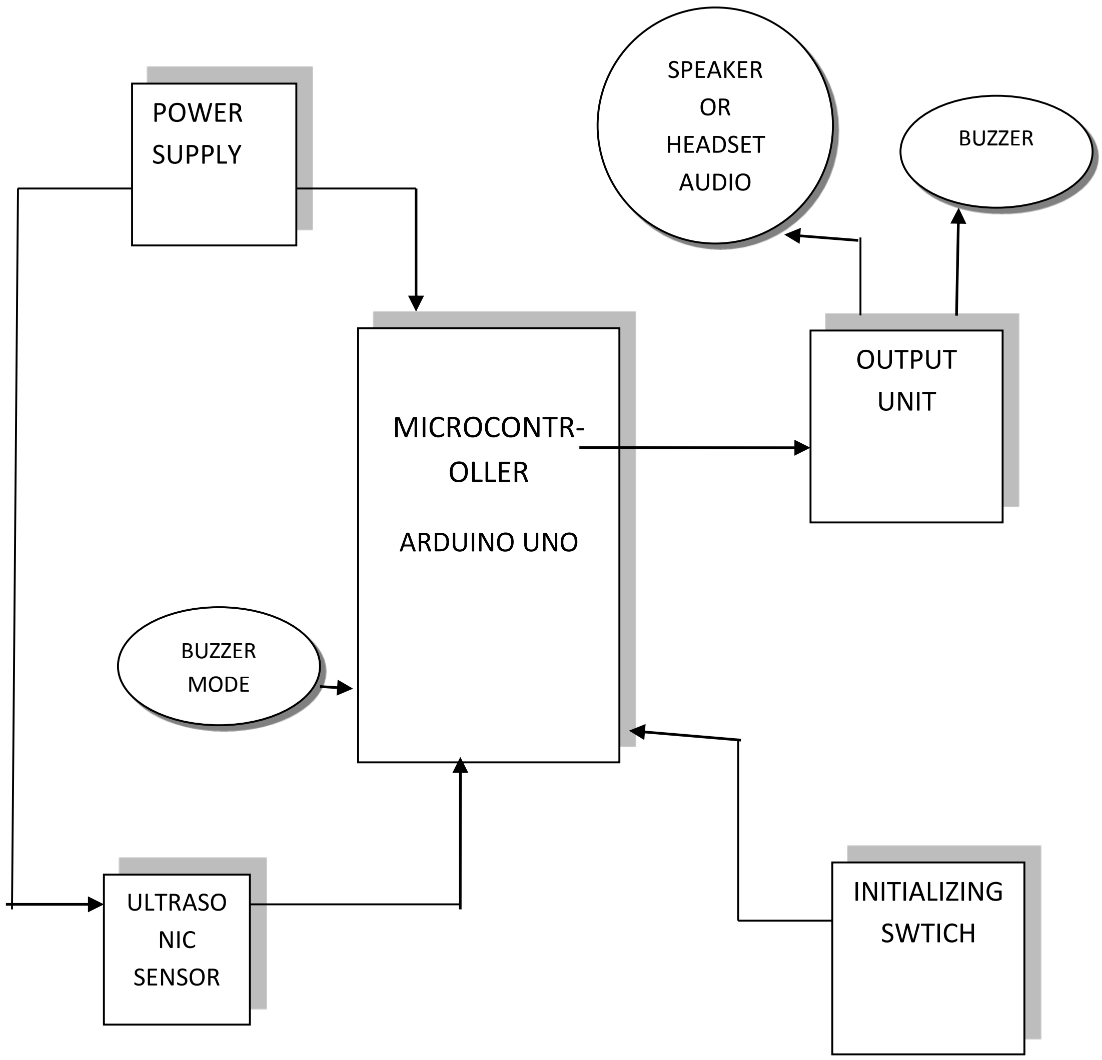

Figure 3.4: Block diagram of the online module

3.5 Hardware and Design of Online Module

The processes in building a detection circuit hardware, Thus, there are various elements involved. In all the items given possess their personal functionality for it to implement the commission of the total circuit in the detection system. Thus hardware might have a straight connection associated with the user because it is all interconnected with the system. Designing the hardware circuitry was executed after considering the development of the wearable device in accordance with accurate path planning. The hardware development for wearable detection system for obstacles includes the transmitter and receiver. Transmitting entails, the ultrasonic sensor as detecting and microcontroller unit (MCU). The receiver comprises of second MCU, communication mode for receiving instructions and the alarming unit like audio messages and buzzer.

3.5.1 Power supply

The supply of power for our system is given by 9V battery. The MCU is given supply of 5V of current. A 5V is generated by using a voltage regulator. 5V is fed to the sensor module. Generally, the sensor module we are making use of is a US sensor. They are both needed and are fed with the power supply.

Figure 3.5: Connector and battery power supply

3.5.2 Switches

They are interconnected to the microcontroller. Switches are implemented as way of turning on the selection, of how our system performs. The modes are audio and buzzer mode.

3.5.3 Sensor mode

The sensor module is designed by using US. The ultrasonic sensor is mounted on the chassis motor. This sensor module transmits a sound wave into the surrounding continuously. When it detects an obstacle, sound waves are sent back to the sensor. Meanwhile the sensor collects reflected wave and give appropriate signal by the sensor. This signal is interpreted by the microcontroller in its right form, which are the output to user. Thus, there are sections covered by the use of the sensor mode. It detects free path against object, second which is front direction object and the last one is for sided object using a fuzzy knowledge based system. The sensor system can be placed anywhere on the user to detect and provide obstacle free path.

Table 3.3: Ultrasonic sensor specifications

Sensor	Ultrasonic
Range	0.15-6.45m
Range around obstacle	0.15-6.45m
Resolute	2.54cm
Width	±30º
Mass	4.3g

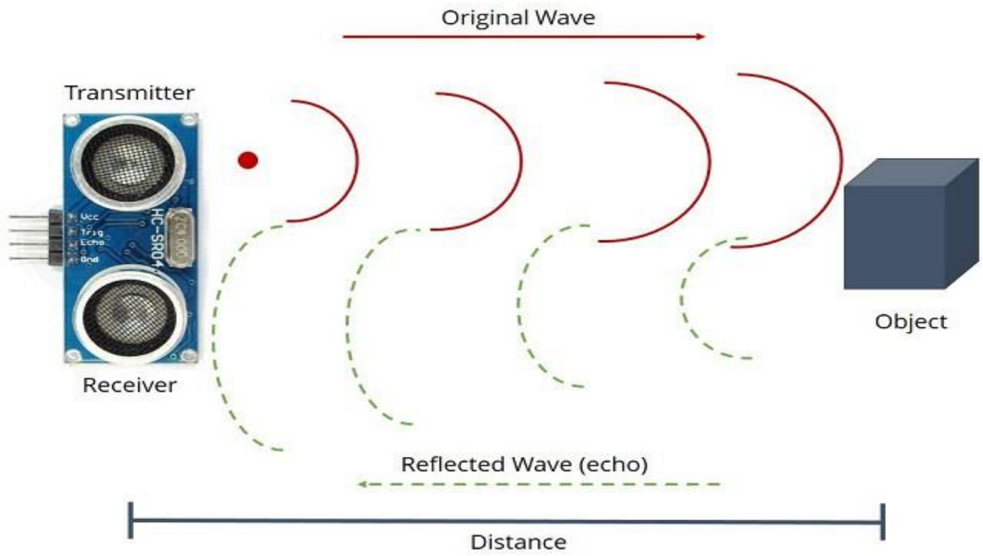

Figure 3.6: Ultrasonic sensor and mode of propagation

3.5.4 Microcontroller

The microcontroller unit which is the ATMEGA328P microcontroller. This is basically the main component of the system. Each instruction given applied towards the proposed system are decided by MCU. The MCU acquires signals given by the sensor and translates into the right form, and are used by the output mode to guide or signal the VIP about near space or is environment.

ATMEGA328P MCU is a Microchip Technology family and are also used for this system type due to the dominant form in the industry, and cost is low, availability, abundant of information, versatility, ease in programming, easy to use, portable size and compatible for wireless types of application. Thus, it as a broad variety of functionality which facilitates the microcontroller to physically introduce anywhere on user to perform all the possible functions. MCU also works with minimal cost kits for development that are presently available at the technical market just like ESPIC40C.

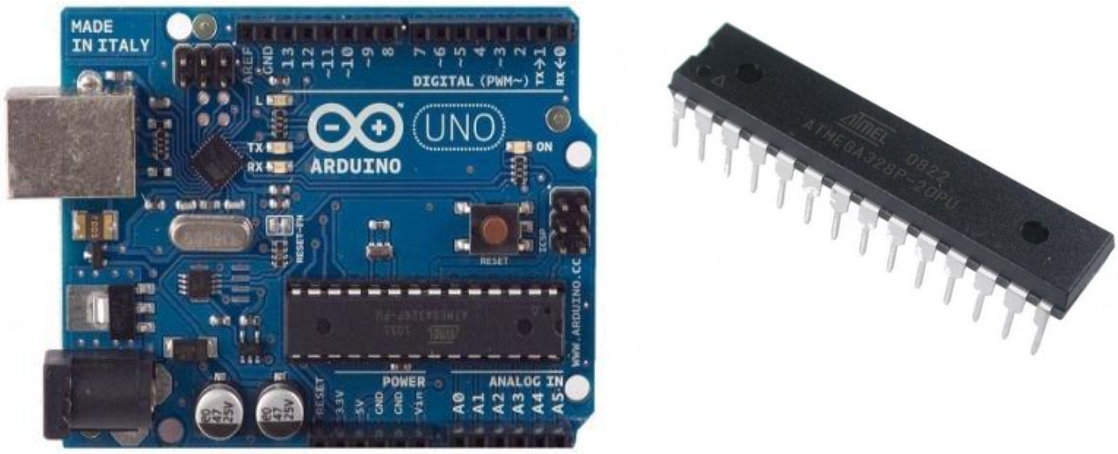

Figure 3.7: Atmega 328P microcontroller

3.5.5 Output unites

This output unit controls output given to the VIP. It entails circuitry, power supply, drivers necessary for interfacing audio, buzzer to the MCU. Thus its stated that we have to use disjoint power unit as for interfacing Audio with the use of an SD Audio Synthesizer, because using the same supply, provided to the microcontroller the electro motive force produced by the Audio Synthesizer will probably spoil the MCU unit.

3.6 Commissioning and Testing of the Online Module System

ATMEGA328P microcontroller, individually unit are tested also as an integrated system and also output unites. One main advantage given by the US is its little beam angle also its accurate line of sight. Ultrasonic operates on echo principle, studying of reflecting properties is important. Thus, we carried out studies on the reflecting properties of US on various surfaces. The tests are performed on a static body, concrete wall and so on. Evaluating the system, thus we put forth a method of testing. By covering a person from seeing, each situation is simulated that's the difficult parts in accurate navigation of the individuals. If the individual makes movement with the system, he becomes totally guarded from objects about the environment. Thus area below the head are protected by making use of stick or walking cane and area to the head is also guarded by sensing objects by the use of the system. MCU is implemented to define full program and then are simulated in Proteus GUI. The project cost is minimal for the project with using the inexpensive but durable component, because most VIP men are sighted to low income class.

The obstacle detection is implemented by making use of knowledge based rule from fuzzy analysis. The knowledge rule entails If-Then statements that set forth the user system should guard against the object and provide appropriate path way. Making use of rule base the recent value of the input variables that is the turn angle (ta) value, the proposed system can be resolute. Determining the turn angle given to output of the rule, a safe angle is adjoined with the turn angle in order to get a real turn angle for system for protection from the obstacle. The object safest boundary is gotten for the right and left side of the system. In determining the value of the variables of the input it is performed as follows. After calculating right, left distances given for the obstacle and user, the respective right ar and left al angles derived at ease. The angle which is the region is safe are used in detecting the final left and right angles. Which is concurred on right and left angles (al and ar) and also right and left distance (dl and dr) and an If-Then rule for a relative decision on turn angle for the user is derived. Fuzzy inference is implement in the calculation of the turn angle for the output (Abiyev et al., 2010).

$$ta(k)=F(al,ar,dl,dr) \tag{3.1}$$

Rule 1: If dr=M and ar =S and dl=L and al = M then ta = PS
Rule ii: If dr=M and ar=M and dl=S and dl=S then ta = NS
Rule iii: If dr=S and ar=M and dl=L and al= S then ta = NS
Rule iv: If dr=M and ar=L and al= M and dl=L then ta = NS

Where Z, S, M, VS, L, VL these linguistic terms denote zero, medium, very small, large and very large, NVL, NL, NS, Z, NM, PS, PM, PL, PVL are negative very large, negative large, negative small, zero, negative medium, positive small, positive medium, positive large, positive very large. These terms entail the input and output variables values.

3.6.1 Fuzzification

The construction of a fuzzy model in the navigation of the online user system is considered in most given possibilities in obstacle detection. Stated earlier by using the angle and the distance input rule base and variables for the turn angle values will be gotten. For the given variables which the sets are derived. These is determined by using the lowest and highest values of given parameter and t values are divided into three parts.

Describing defined fuzzy values of the angles, turn angle and distance parameters. For making it simple, in rule base, thus the output, input variables are measured. This data can easily be transformed to be the variables with required value range. Knowledge base put forth uses fuzzy IF-THEN rules which includes fuzzy values for parameters which are the antecedent, consequent parts of the rules. In this research work, fuzzy sets of triangle type are used to represent the values of each parameter.

$$\text{IF } x_1 = A_{1j} \text{ and } x_2 = A_{2j} \text{ and and } x_m \text{ is } A_{mj} \text{ THEN } y_j = B_j \tag{3.2}$$

In a rule base the If-Then state divides space of input into sets of fuzzy base regions, the subsequent section entail system behavior in those regions. Thus, the specific difficulty is finding antecedent rules for the particular part, in a way that will represent the systems behavior in a given in consequent related part. input i, rule j triangular type membership functions (MF) with have uncertain means which are implemented to represent fuzzy values of the given parameters.

The triangular MF has we know as the given formula. Where l, r, c is given as left, right and center of the given triangle MF respectively. Thus, we can use the formula for implementing MFs.

$$\mu a(x)\begin{cases} 0, & x < l \\ \frac{x-l}{c-l}, & l \le x < c \\ \frac{r-x}{r-c}, & c < x \le r \\ 0, & x > r \end{cases} \tag{3.3}$$

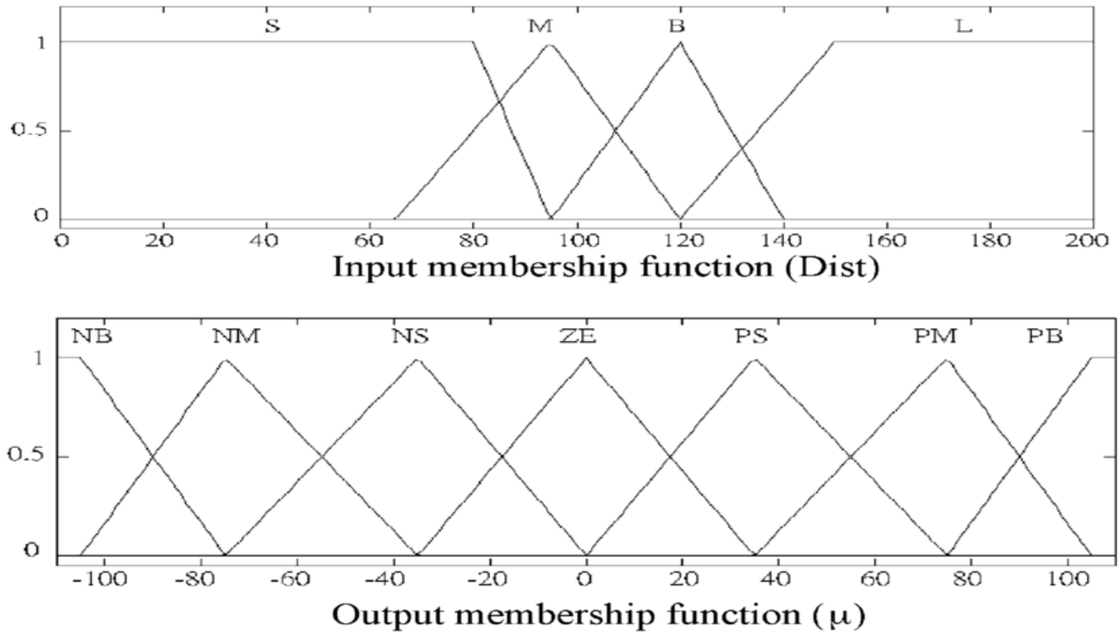

Figure 3.8: Membership functions for output and input variables

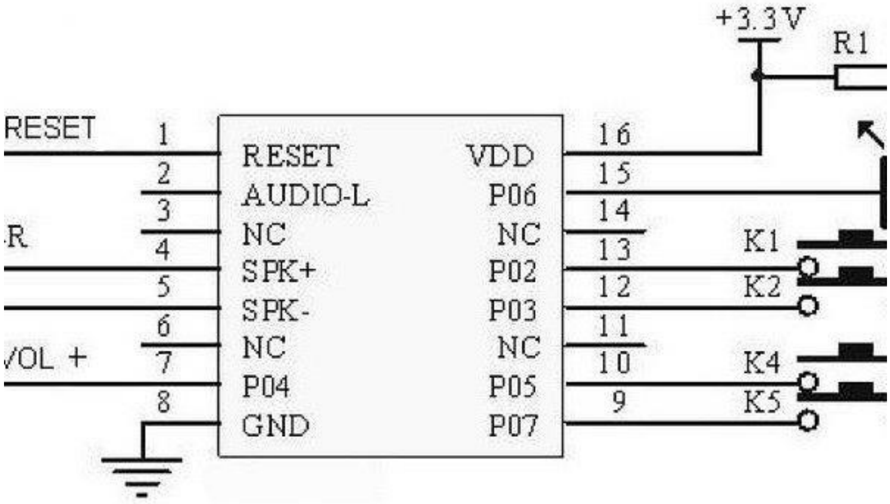

Figure 3.9: Circuitry

Table 3.4: Detection of obstacle facing the variable of the length with their corresponding angles

Lengths(m)	Angles(º)
1.4	10
1.3	11
1.0	15
0.9	16
0.7	20
0.5	27

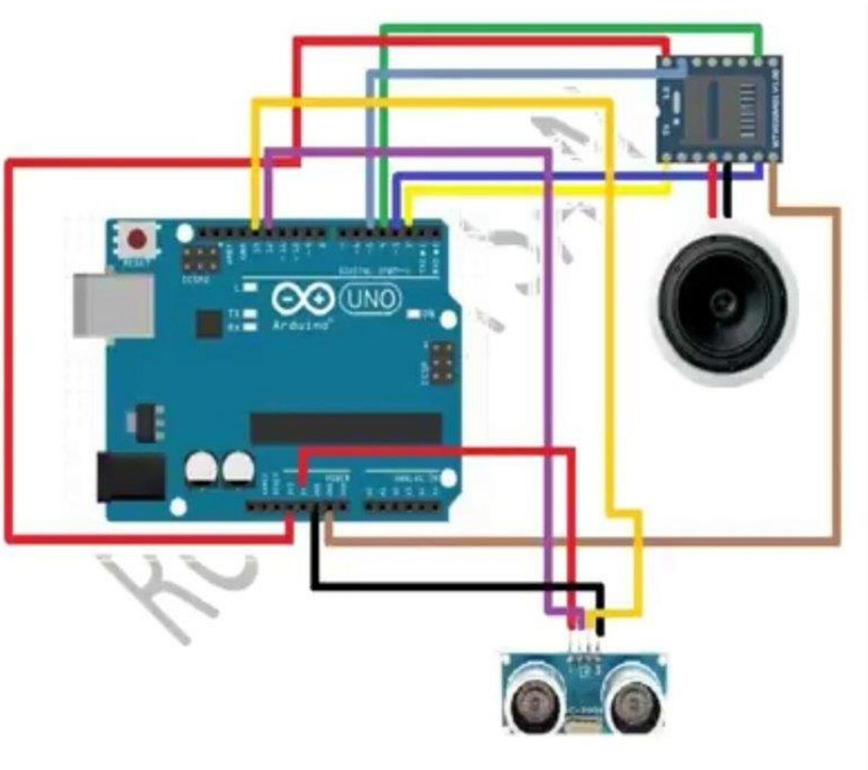

Figure 3.10: Testing circuitry board

3.7 Real Time module

The Real Time module can be said to be the subset of the second and third class of ETAs which are Environment Imagers and Orientation & Navigation Systems (ONSs) which scan the surrounding in close and near spaces. This system presents getting of distanced spaces and acquires data from a larger base distributed networks for example GPS, Digital Maps, and through expanded access to the Internet and wireless communication networks (e.g. RFID, Wi-Fi, and GSM). The innovative class associated with the ONSs is determined on guiding the visually impaired through a remote human guide which is known as Tele-assistance/Tele-guidance systems. They are given the assignment to assist the visually impaired to cut off objects on their path and grants appropriate path planning. It is very necessary that this designed system should comply with the size of the system for successful installation, testing and data collection.

The Real Time module will also possess some of these characteristics to the user

- User will have a speed dial to call customer care.
- User will have a locator (GPS) on so customer care can get user location.
- Customer care will navigate user through satellite view and appropriate path planning.
- User will also have a camera so customer care can see in real time.
- User will also have an emergency speed dial.

The Real Time system comprises of two modules, caregiver's terminal VIP terminals.

3.7.1 VIP's terminal

The visually impaired initiates a Wi-Fi call from the application installed on is phone to the configured caregiver if he is in need of support. The visually impaired gets guidance by voice instruction using head phone. The VIP will be able to initiate a video call when the tele-guidance session starts; Visually impaired person will also able to start the video live stream which the care giver can see from is terminal. The caregiver will get the notification about call initiation and termination. He will also have the advantage to configure one more persons as a caregiver. Thus if any of those higher in priority are not around, the call automatically will be given to anybody available.

VIP's terminal comprises of four elements

- **Smart Phone:** this creates connection with caregiver terminal. It contains an application with a speed dial to establish a call to the care giver. It also uses the already present sensors like GPS, Proximity sensor and network connectivity which are used to provide caregiver with accurate real time data about VIP.
- **Camera:** The camera connected to the mobile device is affixed on the chest area of the VIP. Thus, It provides in time video stream of the field of view of the visually to caregiver.

- **Bluetooth Head phones:** A Bluetooth set is used for implementing voice communication or normal head set.
- **Cane:** Smart Cane consists of tactile braille cell; it is being developed as part of this project.

3.7.2 Caregiver's terminal

The caregiver can make use of a workstation, tablet as terminal. It gets and initiates the Wi-Fi call and live stream from the mobile device given to the VIP and gets VIP's real-time location coordinates with use of GPS. VIP can configure one or more as his caregiver, this system will provide caregivers to be able to mediate time and load in the assistance through availability of status info. Thus, it will be studied if there will be adequate need for the caregiver to be override the visually impaired at particular instance.

3.8 Mobile Application System for Visually Impaired

Most common mobile devices that are purchased with applications bundled in form like a pre-installed software like, email, calculator, mapping program, browser, and other apps for purchasing music, other media, or more applications. Pre-installed applications can be removed by an uninstall process, thus leaving more space for storage for desired ones.

Whereas we are building a mobile application for the VIP's and which will be installed by the care giver. Then the VIP with the click of a button will be able to speed dial the caregiver and speak is preferred location and be guided by the care giver.

3.8.1 Android

This is a mobile operating system which is built by Google, especially on a well modified version of Linux kernel as well other open source software, which is designed primarily for touch screen devices like smart phones and tablets. Thus google has further built Android TV for televisions and Wear OS for wrist watches, each with a specific user interface. We will be developing an android app for the VIP.

3.8.2 Android advantages

Android is the most utilized portable working framework. It is utilized by more than billion individuals. Android is additionally the quickest developing working framework on the earth. Android has billions of clients. Various clients increment the quantity of utilizations and programming under the name of Android.

Some other advantages are as follows

- Multitasking
- Ease of notification
- Universal chargers
- More phone choices
- Removable battery
- Widgets
- Better hardware

3.8.3 Program language

List of the programming language used in the Android apps.

- Java
- Kotlin
- C/C++

3.9 Application Features

It is a simple application that possesses just a configured button; with the click of the button it automatically places a Wi-Fi call to the care giver. The care giver gets the request and picks the call and they both establish a communication channel and the VIP can terminate the call at any time at his will. It will be an easy to use application carefully built for the VIP.

3.10 Web Application System

In general distinction between a dynamic web page of any kind and a "web application" is not clear. Web sites most preferred likely to be referred to as web applications are those which have common functionality to a desktop software application, or to a mobile application. HTML5 introduced definitive language support for making apps that can be loaded as web pages, and continue to function while offline.

In this case we are going to build a web application for the care giver terminal and it will house a live video stream and GPS coordinate gotten from the portable device module which the VIP will have on him and also have a satellite view for easy guidance which will be given to the VIP. The care giver will have administrative control over the terminal.

CHAPTER 4
SYSTEM IMPLEMENTATION

4.1 Stakeholders

As stated in earlier chapters, the performance of the system and the accuracy of the obstacle detection system built is dependent of all the hardware components that serves as the transmitter and the receiver for the online module while on the other hand both the caregiver and VIP are required for the real time module. In accordance with specifications, the system design at transmitting side should to detect obstacles present on the pathways so as to get the alarms activated for the output in receiving end. Thus, is to be at a large rate with no loss of signal or message to ensure that there is a smooth and also successful transmission of the alarm system. However, the algorithm built for the hardware should be remarkably intelligent and strongly powerful for it to be able to achieve a high detection rate. Nevertheless, good skills of programming need to be applied to enhance multitasking functions like detecting obstacles, switching mechanism, and alerting system.

At this stage of this report, the proposed system has been completely designed and is fully functioning so this chapter would take you through the complete system and highlight the specifications and uniqueness of the system to the stakeholders.

4.2 Usability of Online Module with VIP

Ultrasonic sensor module, ATMEGA328P together with the output undergo individual tests as an integrated system. Advantage of ultrasonic sensor is its sharp line of sight and small beam angle. As ultrasonic sensor executes a principle based on echo, studies on its reflective characteristics is very important. The reflection properties were studied on different surfaces, such as, on a concrete wall, wood, metal, and static human body. Smooth surfaces were detected at a maximum range of the ultrasonic sensors. Metal surfaces generates the highest reflections followed by the concrete walls, the wood and then human body. In the system evaluation, a test method was proposed. By covering the user's eye, the difficulties in navigation were simulated. Any movement by the individual with the system, then he is totally protected from surrounding obstacles. A walking stick is used in securing the areas below the head and the areas close to the head are protected by obstacle sensing in the system.

To make a complete programming we use microcontrollers and then it is simulated on Proteus to find the efficiency. There is a low in cost in the system by using efficient yet cheap components like a buzzer and an audio module because majority of the visually impaired belongs to the lower class of income.

4.3 Online Module Algorithm and Process

There is a distinct goal in the proposed system, and that is obstacle detection and sending an alert to the VIP through means such as a buzzer and an audio message.

These algorithms for full process of the system, which is analyzed as follows:

- Start.
- Initialization of port.
- Microcontroller
  - Call to read US.
- If US ≥ 200 (value of threshold)
  - If Yes, then go to 5.
  - If No, return to 3.
- US enabled by Microcontroller.
- US is ready to detect an obstacle or threshold.
- MCU gets signals dished from sensors and then calculates US sensor distance.

- The microcontroller ADC converts the analogue distance value or threshold into digital value.

- The digitized data (distance) or threshold are being sent by the MCU to wireless transmitter module.

- A module which is the wireless transmission read the code and send data in digital form.

- The receiver gets the soften signal, and does a form of demodulation, which is then passed to the microcontroller.

- Decoding and conversion of the value of the distance to TTL logic level data are being done by the microcontroller.

- The distance value is being displayed by the microcontroller and initiates the alarm in relation on the value of the given distance.

- Alarms are being triggered by the microcontroller (buzzer or audio) based on the individual interest.

- End.

This is a continuously process done until when the VIP stops the device. The alarm types at different range of the system is going to be activated at different ranges of distance as given to the user which depends on the walking distance. The setup of the alarm can be sectored into four as below:

- If it psses 1.5m; no alarms.

- The measured distance is from 1.2m or below 1.5m; alarms will be activated in little condition.
- When the distance is 0.8 or lower to 1.2m; it will be on a moderate scale.
- When the distance is given by 0.4m or lower than 0.8m; it activated at a higher rate.

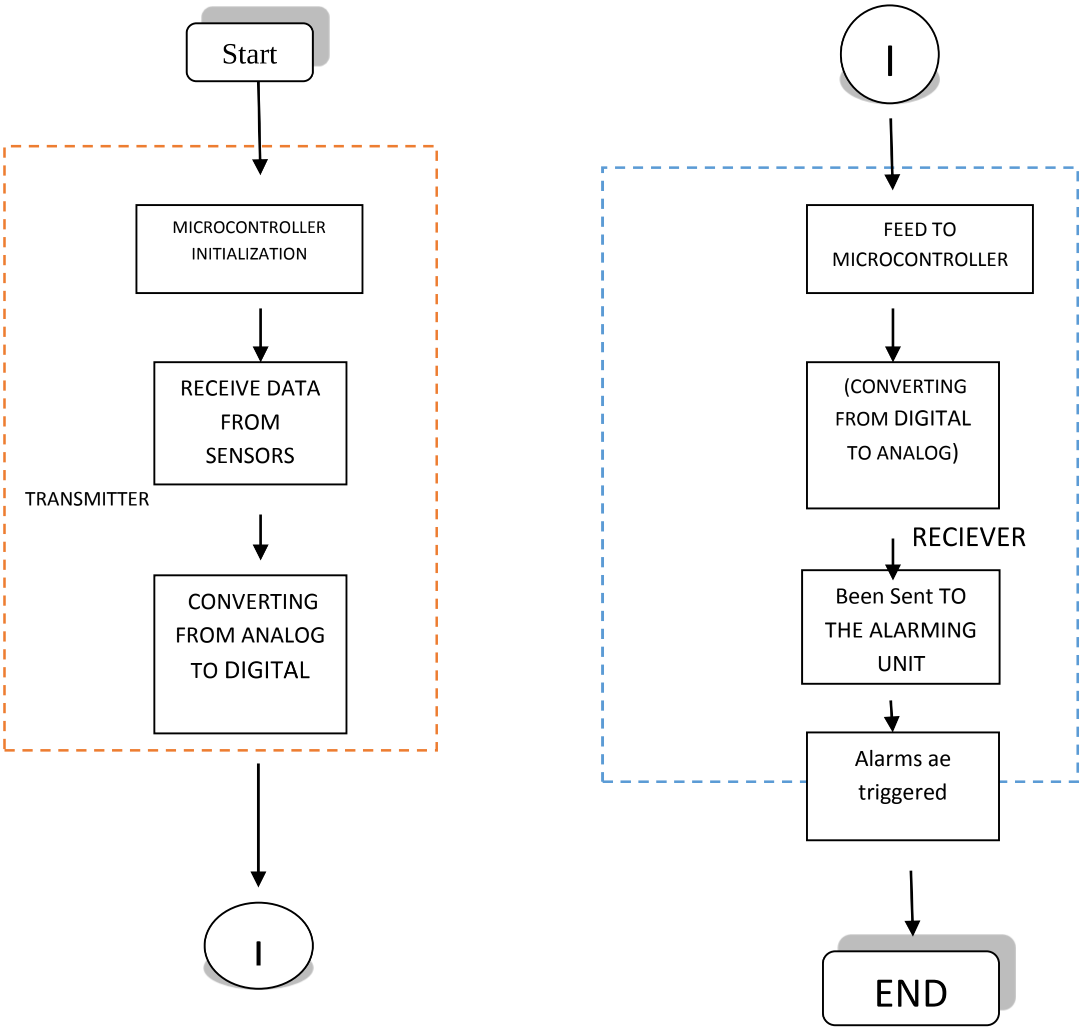

Figure 4.1: Flow chat indicating systems process

4.3.1 Fuzzy implementation

For avoiding the obstacles successfully, some rules are implemented. The establishment of the rules with the relation respectively between user positions and sensor values in accordance to linguistic values. The control surface can there be plotted to visualize variations in the VIP position given the sensor values. Fuzzy implementation helps in evaluating the relative part of every given rule. The degree of (DOF) of the rules are gotten using IF THEN operator. The output MF is there by gotten at DOF level. Where L-S(Large step), M-S(Medium step), S-S(Small step)

Table 4.1: Changes in left user position

L-SENSOR/ R-SENSOR	Near	Medium	Far
Near	L-S	S-S	S-S
Medium	L-S	L-S	M-S
Far	L-S	L-S	L-S

Table 4.2: Changes in right user position

L-SENSOR/ R-SENSOR	Near	Medium	Far
Near	S-S	L-S	L-S
Medium	S-S	M-S	L-S
Far	S-S	M-S	L-S

4.3.2 Sensitivity of sensors and angle detection

The system has been distinctively being tested in evaluating the functionality in regards with the hardware and software performance and implementation in terms if it is capable of accessing, thus it creates durable output and accuracy. This can be prominent in ensuring that each specific component is working properly and as a whole system. These tests have been carried out in determining the response in sense of sensors in distance towards the detection of obstacles at various distances as well as angles. As the state may be, the angle is referred to position of the sensor that which is against the obstacle the front. The distance is said to be the measurement between the obstacle and the sensor position.

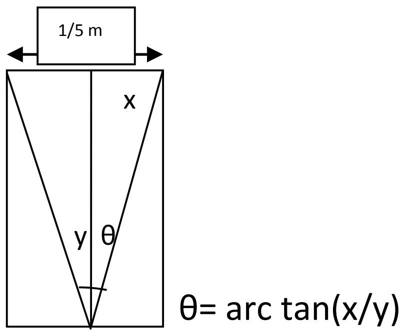

Figure 4.2: Measurement process for the distance using ultrasonic sensor

Table 4.3: Percentage of the accuracy of detection toward different shapes of obstacle

Obstacle form shape	Distance	Calculated distance (cm) Indoor	Calculated distance (cm) Outdoor	Percent of effectiveness (%) Indoor	Percent of effectiveness (%) Outdoor
Rectangular	50	50.42	48.70	99.16	97.40
	70	69.15	67.00	98.79	95.71
	90	90.44	87.20	99.51	96.89
Circle	50	49.42	52.02	98.84	97.40
	70	69.96	69.96	99.93	99.97
	90	90.25	90.22	99.72	99.52
Cylinder	50	49.96	50.25	99.92	99.71
	70	73.64	69.79	94.80	97.25
	90	92.53	91.21	97.19	97.93

4.4 Usability of Real Time Module with VIP

In testing the ability to use the system, we will be conducting an experiment by covering the user eyes as this is part of the experimental study with the system and also analyzing the camera images and gps component.

Testing the visually impaired:

- **1st step:** VIP starts a phone guidance session which is then followed voice instruction for the remote caregiver to navigate by the click of a button on the application installed on is phone. A speed dial will be initiated. The VIP says is intended destination.
- **2nd step:** VIP initiates a live stream and location of VIP will be sent to the care giver.
- **3rd step:** VIP follows guidance which the caregiver navigates with adequate path planning.
- **4th step:** User terminates the call.

Testing caregiver:

- **1ststep:** Caregiver receives a tele-guidance Wi-Fi call from the VIP and guides him through voice instructions. He checks VIP through database to confirm VIP. And tell VIP to turn on is smart device.
- **2nd step:** The remote caregiver guides VIP and navigates user through the right path. And gets the VIP location and navigates him to his desired destination. Through satellite view and live stream with the help of his smart mobile device belonging to the VIP.
- **3rd step:** Caregiver gets indication of call termination.
- **Test step**: Caregiver acknowledges termination.

Considering the requirements like user criteria, the performance, and the ability, usefulness and economic feasibility, thus it can as well be said that the system considers most of them. In concern with the last requirement that is economic feasibility, it is clear that the cost is low including the hardware is used. This system is able to manage on a large scale where as the only disadvantages will be the lack of connectivity.

Figure 4.3: Calling application

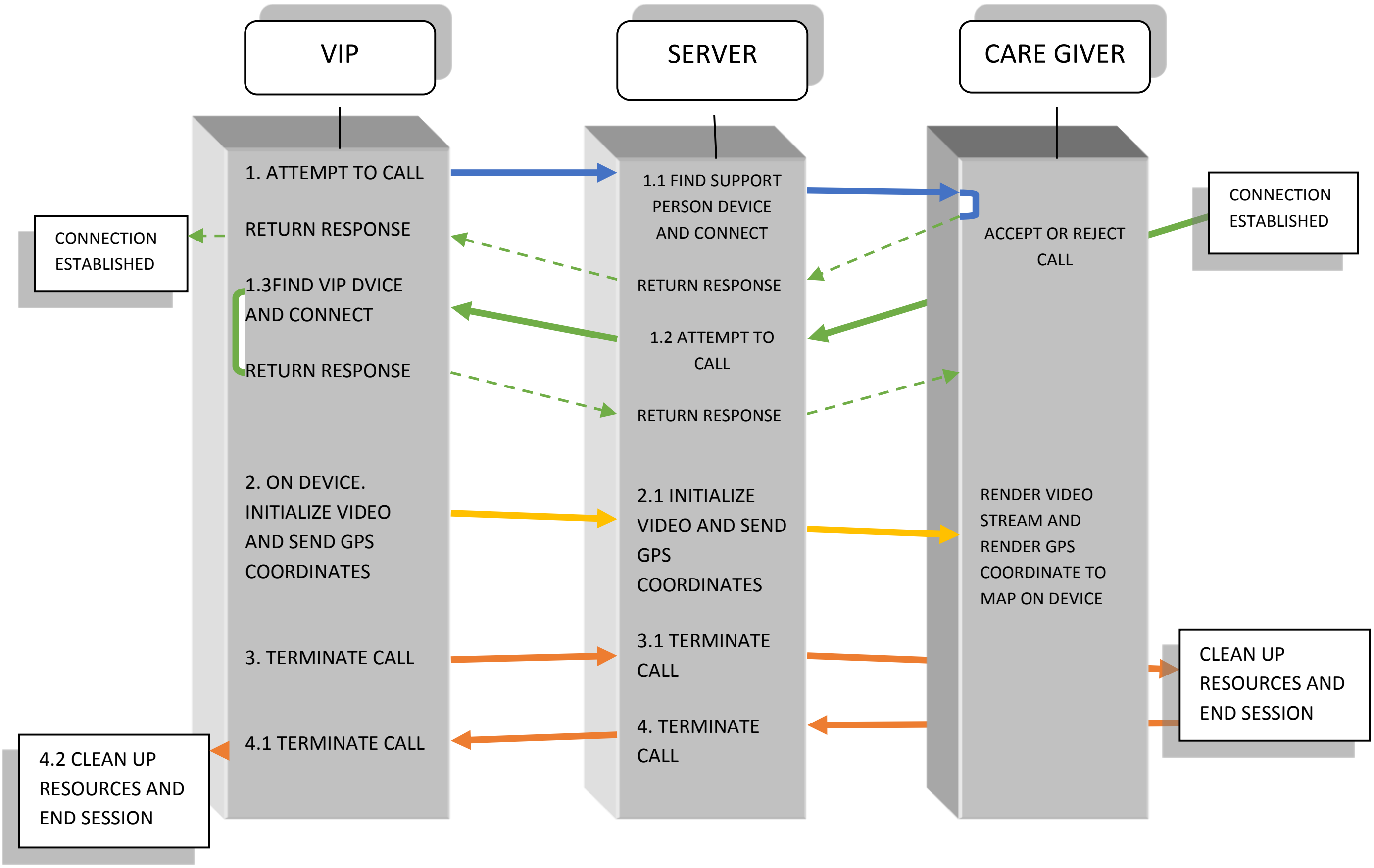

Figure 4.4: The communication and response schematic of real time module

4.5 Vision based implementation

In the given location estimate calculated from the output can still be deviated against the actual real values. Thus, as a solution in enhancing the estimation of the location, we are going to put forth information of the approach of the system in regards to vision base. The method is going to be combined with a given location estimate. Thus, in the solution of the base vision, walking path and the boundaries will be gotten using some methods. These images were captured from the camera that is on the VIP to get a precise image since we will be navigating the VIP with it, getting a quality of the image is key as not to make the image blurring where processing the image might a more difficult task.

4.5.1 Detecting pathway

The images presented from the VIP will be analyzed in detecting the pathway. Here we made use of some simple separation technique. Colors from both pathway and side walk will be definitely different in comparing them both. Then we extract the region pertaining to the pathway from the image after which we filter by bilateral filtering method. The sensitivity of the image to light can be decreased by use of HVS component value, the images were being converted to HSV color in prior to the extraction of the pathway color region

4.5.2 Detecting sidewalk

After implementing the separation techniques done to the images here the goal is to detect the boundaries which is the side walk, hence boundaries detection might restrict users within a centered walking pathway. Hough transformation is being implemented when having a boundary line that is ideal, although Hough transformation can end up being complex in detecting boundaries lines where they various boundaries that are uneven in the path, which the implementation of this are commonly in practice. A solution we are going to use a technique to approximately detect accurate line using method that is edge detection and the one is last square method. The dominant area is settled in down part related to the image. Hence to reduce the stress and difficulties we just go straight to the dominant position which is the down side of the image. The image was accomplished by diving the images into portion like the left and right images. Then we can has well detect the boundaries side by using a canny edge detection method in combing with a mask tracking

Figure 4.5: The Original image and pathway detected image

4.6 Fuzzy controller

The end gain is to guide the user along appropriate path against obstacle or along an identified pathway. The user will definitely be controlled by giving adequate guidance and direction and an adequate manner that will suite is preference, a control pattern was designed to accomplish this task. This angle will take angle of the boundary presented θ and the change in the angle of the boundary line θ as control input, Although the user cannot be effectively guided using values because it will be very difficult to comprehend the difference between the input and the output. This issues helps in regards to the development of a user control input system. In this case a fuzzy logic knowledge control can be used for the gain of this purpose. In particular, a control set of commands will be issued in accordance to the obtained control input values. We are going to use a verbal command in this situation in the system behavior. This vision system limits individuals to the identified path while the GPS system updates their location toward the destination.

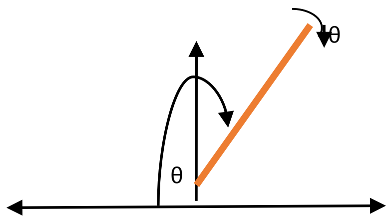

Figure 4.6: Pathway boundary line notation

4.7 GPS Based Implementation

Navigation via gps might be a complex process. It includes these stages: route planning, following a decisive path, orientation, and overcoming the object on road paths. Thus the give algorithm for navigating along the path is part of a developed google based application for mobile phone which realizes route planning, and navigation along a path. Thus it uses an ongoing Wi-Fi voice call, to avoid hazards and obstacles on the path.

GPS receivers gets information in regards to the location of the individual during intervals of one sec. thus navigating on a path it not that necessary to confirm the location of the user after each seconds, there is little or no significant for the movement process distance. The given distance Dth, which will check the position of the user.

The algorithm of the overall process is described below:

1. Start
2. GPS positions filtering.
   It makes use of the following like: GPS data pre-processing, to simplify and filter the GPS tracks.

3. Selecting the time variance for confirming the user location.
   The check of new position, the gps as to generate valid data with accurate longitude and latitude

4. Navigation starts.
   Preceding the activating of the navigation mode, individual will be able to load the requested track. In creating a new path, thus the user must put forth voice names regarding the waypoints. Thus, in loading a path, the app is informed by the selected track.

5. Select the starting point.
   This is the user current location.

6. Select the End point.
   This is the user final destination.

7. Navigating to the next waypoint.
   They are various method of voice navigation for the VIP such as using cardinal points.
8. End.

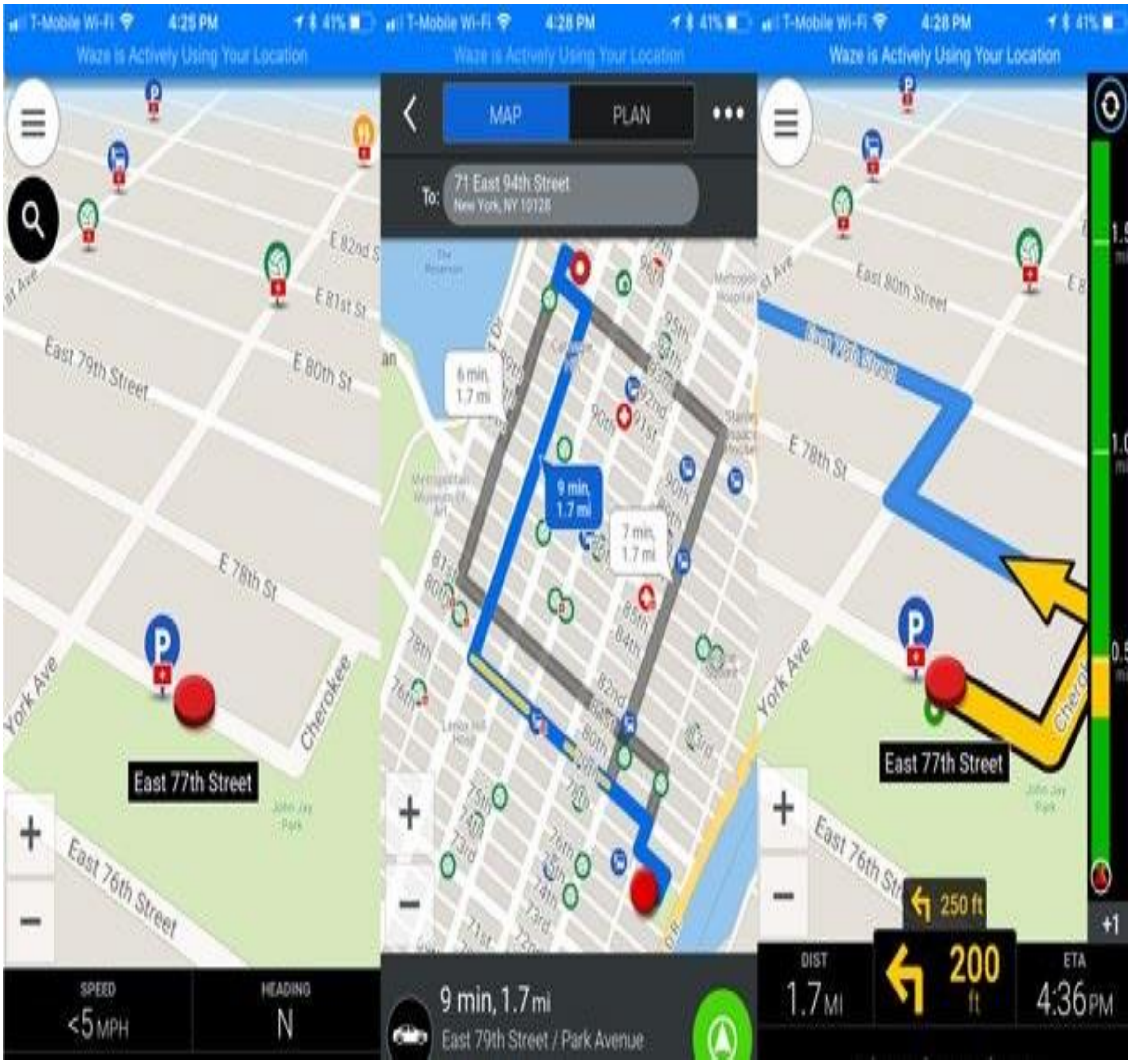

Figure 4.7: Navigation path view

CHAPTER 5
CONCLUSION & RECOMMENDATIONS

5.1 Conclusion

In this work of research presented, we introduced and described a complete and secured navigation method or system for visually impaired individuals. One of advantages of the system is, it makes the user aware about obstacles of right side, left side and front side effectively. We are using the privileges of walking stick and also detection by sensor with fuzzy analysis and real time module provides a complete or total protection navigating into the environment and also the right path planning. We made the inclusion of a walking stick into the system because it is said to be the most common mode of walking for visually impaired people so that it can be very convenient for them. There are following advantages:

- Accuracy in detecting of obstacles of right, left, and front side.
- Convenience for the users.
- Detection from the ground to the head level.
- Low in cost.
- Very low power consumption.

In this research paper, the tele guidance method of navigation with the VIP demonstrated. This method is settled with the idea that the individual can be rendered help by audio information from a caregiver which receives a life stream video from the camera which is smart mobile device with the given VIP. Thus the premise for using of the total system testing for VIP and caregiver to implement the system are all being presented. The quantitative evaluation to research attitude given by the VIP including navigation assisting tools were also put forward.

In short, the research on this system has carefully been endeavored and managed which makes the effort of the targeted work that comprehends the transformation of conceptual ideas in a device possible for the VIP. This is really an intriguing journey, After the conclusion for performing all possible tasks mentioned here, this research paper is undoubtedly life changing encounter that enables mastering a comprehensive spectrum associated with engineering skills and expertise.

5.2 Recommendations

Due to the availability in examining, developing, and implementing this thesis, there are relevant areas for further research in the future that may be carried out are discussed in this section. I recommend that this research work should be taken serious and implemented with immediate effect. For the sake of knowledge expansion, consideration in future research is listed below.

The main aim will mostly be on how to put forward and negotiate the circumstance if connection is not available, reduction in the mechanism in communication delay, and if several miscommunication or the availability of connection is lost between the VIP and the caregiver. Based on the measures while making this study, the listed are the future research which I suggested:

1. The system put forth presently give accurate detection, but to give intelligent guiding in terms of obstacle avoidance, implementing a developed newly neuro-fuzzy control algorithm into programming the microcontroller is highly recommended.
2. Excellent guidance system for navigation in outdoor, the developed system could combine with RFID.
3. Considering the power consumption put forth in the developed system, battery monitoring circuit can be presented in the system. Low supply of current will affect the obstacle detection accuracy.
4. New devices for sensing, technologies integrated chips can be presented in the developed system.

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APPENDICES

APPENDIX 1
SENSOR DATASHEETS

■ Features

- Less influence on the colors of reflected objects and their reflectivity, due to optical triangle measuring method
- Distance output type (Detection range: 20 to 150cm)
- An external control circuit is not necessary Output can be connected directly to a microcomputer

■ Features

- For detection of human body and various types of objects in home appliances, OA equipment, etc.

■ Absolute Maximum Ratings

Parameter	Symbol	Rating	Unit
Supply voltage	V_{cc}	−0.3 to +7	V
Operating temperature	V_O	−0.3 to VCC +0.3	V
Output terminal voltage	T_{opr}	−10 to +60°C	°C
Storage temperature	T_{stg}	−40 to +70	°C

■ Recommended Operating Conditions

Parameter	Symbol	Rating	Unit
Operating Supply Voltage	V_{CC}	4.5 to 5.5	V

■ Outline Dimensions

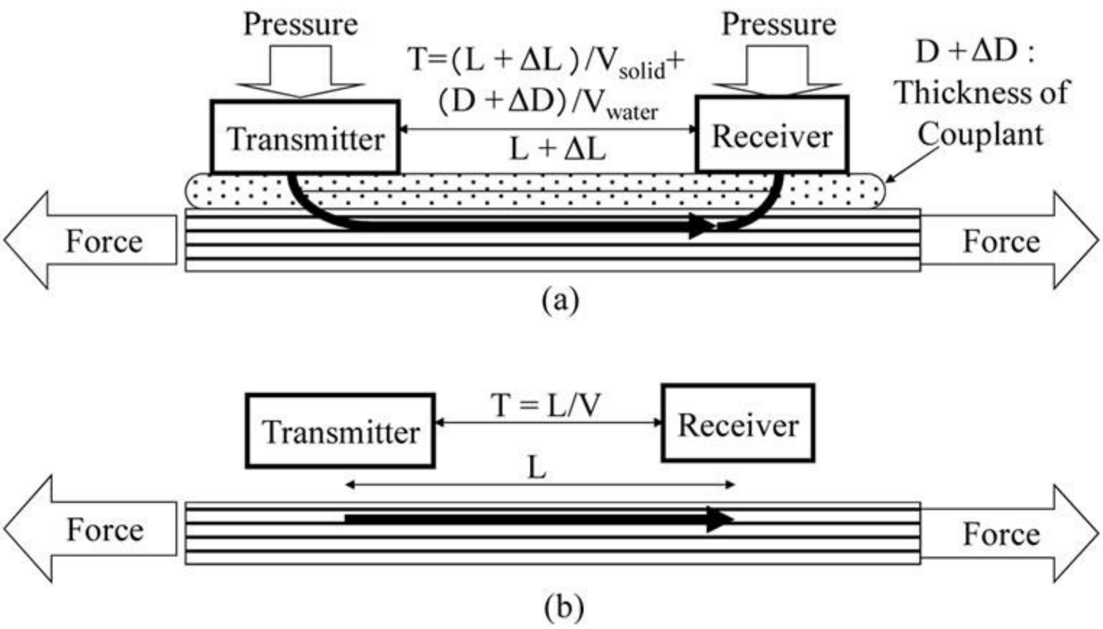
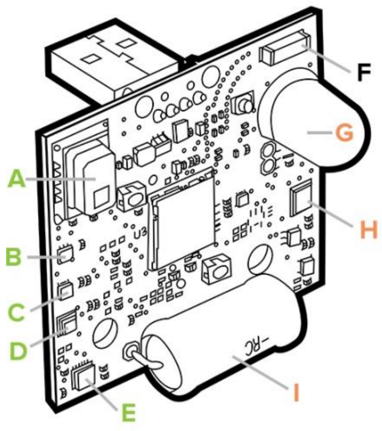


Figure 1: Outline Dimensions Ultrasonic Sensor



ID	Name and Sensor	Chan.	Freq.
A	GridEye AMG8833	16	10Hz
B	Color/Illum. TCS34725	4	10Hz
C	Magnetometer MAG3110F	3	10Hz
D	Temp/Baro/Hum. BME280	3	10Hz
E	Accelerometer MPU6500	3	4kHz
F	2.4GHz WiFi (RSSI)	1	10Hz
G	PIR Motion AMN2111	1	10Hz
H	Microphone ADMP401	1	17kHz
I	100mH Inductor (EMI)	1	.5MHz

- Digital Components
- Analog Components

Figure 1.2: Outline Dimensions Sound Sensor

APPENDIX 2
MICROCONTROLLER DATASHEET
PIC16F887 MICROCONTROLLER – DEVICE OVERVIEW

The PIC16F887 is one of the latest products from Microchip. It features all the components which modern microcontrollers normally have. For its low price, wide range of application, high quality and easy availability, it is an ideal solution in applications such as: the control of different processes in industry, machine control devices, measurement of different values etc. Some of its main features are listed below.

- RISC architecture
    - Only 35 instructions to learn
    - All single-cycle instructions except branches
- Operating frequency 0-20 MHz
- Precision internal oscillator
    - Factory calibrated
    - Software selectable frequency range of 8MHz to 31KHz
- Power supply voltage 2.0-5.5V
    - Consumption: 220uA (2.0V, 4MHz), 11uA (2.0 V, 32 KHz) 50nA (stand-by mode)
- Power-Saving Sleep Mode
- Brown-out Reset (BOR) with software control option
- 35 input/output pins
    - High current source/sink for direct LED drive
    - software and individually programmable pull-up resistor

  Interrupt-on-Change pin
- 8K ROM memory in FLASH technology
    - Chip can be reprogrammed up to 100.000 times
- In-Circuit Serial Programming Option
    - Chip can be programmed even embedded in the target device
- 256 bytes EEPROM memory

- Data can be written more than 1.000.000 times
- 368 bytes RAM memory

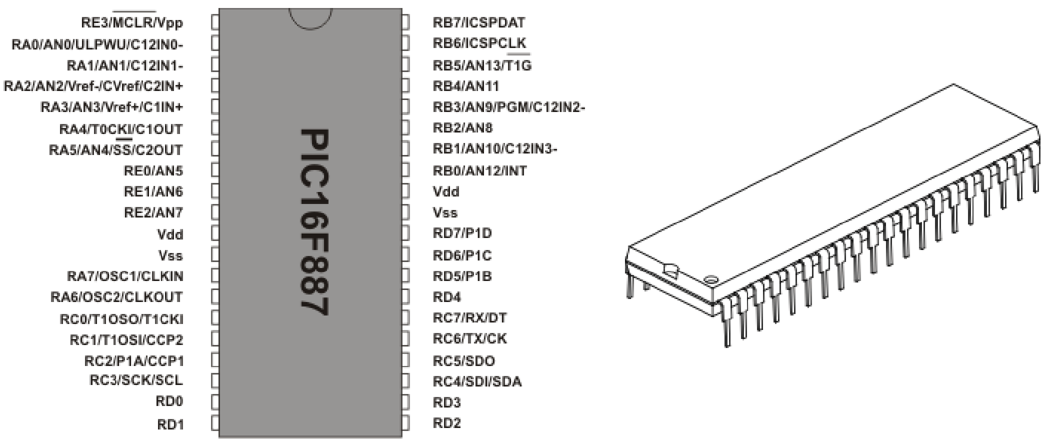


Figure2: PIC16F887 PDIP 40 Microcontroller

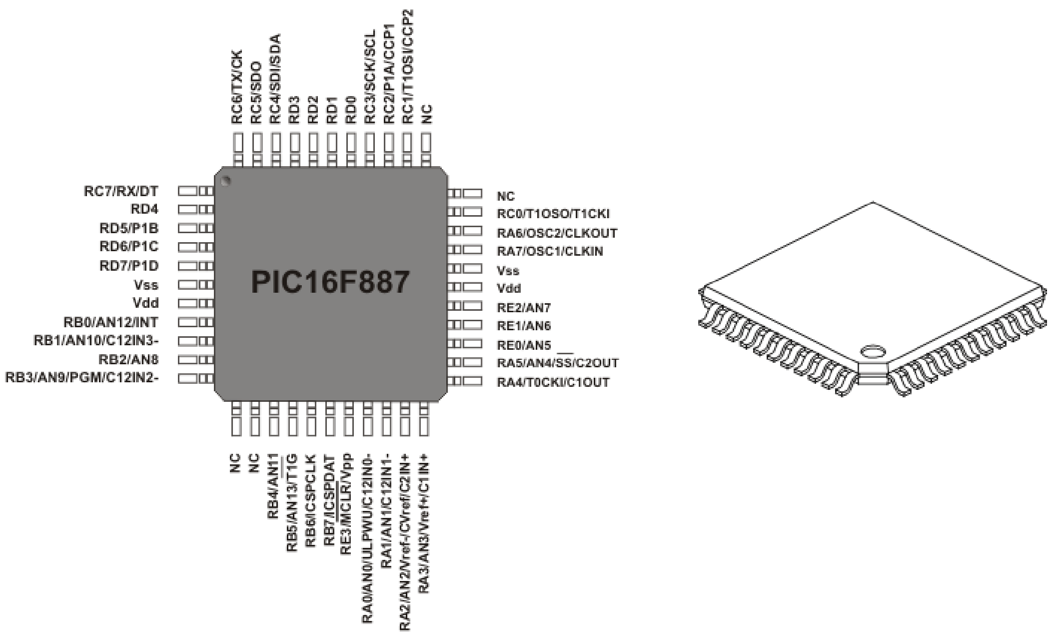


Figure2.1: PIC16F887 QFN 44 Microcontroller

APPENDIX 3

SOURCE CODE

MICROCONTROLLER PROGRAMMING

```
/******************************************************************/
/* OBSTACLE DETECTION SYSTEM */
/* MSC. RESEARCH AT NEAR EAST UNIVERSITY */
/* FILE : Main RxBoard.c */
/* DATE : 15,DECEMBER 2018 */
/* CPU : PIC16F887 */
/* Description : */
/******************************************************************/
//HEADER FILE*****************************************************
#include //BITS
CONFIGURATION***************************************************
__CONFIG(0x2FF4);
 __CONFIG(0x3FFF);
//FUNCTION
DECLARATION*****************************************************void
Initialize(void);
void msDelay(unsigned int);
void Display(unsigned char);
unsigned char RemoteRead(void);
void LCDWrite(unsigned char);
void Putchar(unsigned char);
void PutBit(unsigned char);
void PutHex(unsigned char);
void PutHex2(unsigned int);
void Print(const char *);
void PrintInt(unsigned int);
void LCDInit(void);
```

```
unsigned int eeprom_readw(unsigned char);
void eeprom_writew(unsigned char, unsigned int);
//MACRO DEFINITION*********************************************** #define
LO 0
#define HI 1
#define HSEC 50
#define TMRKEY 30
#define TMRBUZ 30
#define TMRVIB 200
#defineLED1 RB0
#defineLED2 RB1
#defineLED3 RB2
#defineLED4 RB3
#defineVIBR RD7 //Vibrator
#defineBUZZ RD6 //Buzzer
#defineSW1 RE0
#defineSW2 RE1
#defineSW3 RE2 //Voice Module
#defineVCLK RC3
#defineVDAT RC1
#defineVRST RC0 //LCD
DEFINITION******************************************************** #define
RS RB5 //LCD Command/Data 0:Command
1:Data
#define EN RB4 //LCD Enable 0:Disable 1:Enable
#define LDATA PORTB //LCD Data Port
#define LCDBIT4 //4-bit lcd data bus
#define LSHIFT 0 //LCD Shift Bit
#define LMASK 0b11110000 //LCD Mask Data for 4-bit Mode
#define CLS 0x01 // Clear screen.
#define COB 0x0F // Cursor ON, blink.
```

```
#define DON 0x0C // Display ON.
#define LINE1 0x80 // LCD Line 1
#define LINE2 0xC0 // LCD Line 2 //MOVEMENT
DIRECTION******************************************************** #define
REMSW1 'A'
#define REMSW2 'B'
#define REMSW3 'C'
#define SYNC0x00
#define HEADER 0x40
#define HEADERL 0x41
#define HEADERR 0x42
#define ADCMAX 6
#define DATMAX (ADCMAX)
#define BUFMAX (1+DATMAX+1) //(Header+DATMAX+CheckSum) //Range #define
RNGMAX (ADCMAX*3) //Voice #define VFMIN 0x0000 //Min File #define VFMAX
0x01FF //Max File
#define VVOLL 0xFFF0
#define VVOLH 0xFFF7
#define VPLAY 0xFFFE //Play-Pause
#define VSTOP 0xFFFF
#define RXCNT 48
#define BUFLEN 24
#define DATLEN 18
#define TMRRXD 3
#define RANGE1 50
#define RANGE2 100
#define RANGE3 150 //PUBLIC

//Vcc to 5 volt +
//Trig to pin 12
//Echo to pin 13
```

```
//Grd to Grd
//Piezo to pin 9
//GRD to GRD

#include "Ultrasonic.h"
Ultrasonic ultrasonic(12,13);  //12,13 are pin assignements
int buzzPin = 9;  // positive connection of the piezo
int delay1 = 25;
void setup() {
Serial.begin(9600);

}

void loop()
{
  Serial.print("cm     :");
  Serial.print(ultrasonic.Ranging(CM));
  Serial.println("");
    //delay(100);



  if(ultrasonic.Ranging(CM) > 0 && ultrasonic.Ranging(CM) <= 5)
   { tone(buzzPin, 100 ,100); delay(100);}
  if(ultrasonic.Ranging(CM) > 5 && ultrasonic.Ranging(CM) <= 10)
   {tone(buzzPin, 100 ,100); delay(100);}
  if(ultrasonic.Ranging(CM) > 10 && ultrasonic.Ranging(CM) <= 20)
   {tone(buzzPin, 15 ,100); delay(50);}
  if(ultrasonic.Ranging(CM) > 20 && ultrasonic.Ranging(CM) <= 30)
   {tone(buzzPin, 14 ,100); delay(50);}
  if(ultrasonic.Ranging(CM) > 30 && ultrasonic.Ranging(CM) <= 40)
   {tone(buzzPin, 13 ,100); delay(50);}
```

```
  if(ultrasonic.Ranging(CM) > 40 && ultrasonic.Ranging(CM) <= 60)
   {tone(buzzPin, 12 ,100); delay(50);}
  if(ultrasonic.Ranging(CM) > 60 && ultrasonic.Ranging(CM) <= 90)
   {tone(buzzPin, 11 ,100); delay(050);}
  if(ultrasonic.Ranging(CM) > 90 && ultrasonic.Ranging(CM) <= 120)
   {tone(buzzPin, 10 ,100); delay(50);}
  if(ultrasonic.Ranging(CM) > 120 && ultrasonic.Ranging(CM) <= 200)
   {tone(buzzPin, 9 ,100); delay(50);}
  if(ultrasonic.Ranging(CM) > 120 && ultrasonic.Ranging(CM) <= 200)
   {tone(buzzPin, 8 ,150); delay(50);}
  if(ultrasonic.Ranging(CM) > 200 && ultrasonic.Ranging(CM) <= 300)
   {tone(buzzPin, 9000 ,150); delay(50);}

}
```

CALLING APPLICATION

/***/

MainActivity.java

```
package com.codinginflow.phonecallexample;

import android.Manifest;

import android.content.Intent;

import android.content.pm.PackageManager;

import android.net.Uri;

import android.support.annotation.NonNull;

import android.support.v4.app.ActivityCompat;

import android.support.v4.content.ContextCompat;

import android.support.v7.app.AppCompatActivity;

import android.os.Bundle;

import android.view.View;

import android.widget.EditText;

import android.widget.ImageView;

import android.widget.Toast;


public class MainActivity extends AppCompatActivity {

    private static final int REQUEST_CALL = 1;

    private EditText mEditTextNumber;
```

```
@Override
protected void onCreate(Bundle savedInstanceState) {
    super.onCreate(savedInstanceState);
    setContentView(R.layout.activity_main);

    mEditTextNumber = findViewById(R.id.edit_text_number);
    ImageView imageCall = findViewById(R.id.image_call);

    imageCall.setOnClickListener(new View.OnClickListener() {
        @Override
        public void onClick(View v) {
            makePhoneCall();
        }
    });
}

private void makePhoneCall() {
    String number = mEditTextNumber.getText().toString();
    if (number.trim().length() > 0) {
```

```
            if (ContextCompat.checkSelfPermission(MainActivity.this,
                    Manifest.permission.CALL_PHONE) != 
PackageManager.PERMISSION_GRANTED) {
                ActivityCompat.requestPermissions(MainActivity.this,
                        new String[]{Manifest.permission.CALL_PHONE}, REQUEST_CALL);
            } else {
                String dial = "tel:" + number;
                startActivity(new Intent(Intent.ACTION_CALL, Uri.parse(dial)));
            }

        } else {
            Toast.makeText(MainActivity.this, "Enter Phone Number", 
Toast.LENGTH_SHORT).show();
        }
    }

    @Override
    public void onRequestPermissionsResult(int requestCode, @NonNull String[] 
permissions, @NonNull int[] grantResults) {
        if (requestCode == REQUEST_CALL) {
            if (grantResults.length > 0 && grantResults[0] == 
PackageManager.PERMISSION_GRANTED) {
```

```
            makePhoneCall();
        } else {
            Toast.makeText(this, "Permission DENIED", Toast.LENGTH_SHORT).show();
        }
    }
}
}
```

AndroidManifest.xmL

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.codinginflow.phonecallexample">

    <application
        android:allowBackup="true"
        android:icon="@mipmap/ic_launcher"
        android:label="@string/app_name"
        android:roundIcon="@mipmap/ic_launcher_round"
        android:supportsRtl="true"
        android:theme="@style/AppTheme">
        <activity android:name=".MainActivity">
```

```
            <intent-filter>
                <action android:name="android.intent.action.MAIN" />

                <category android:name="android.intent.category.LAUNCHER" />
            </intent-filter>
        </activity>
    </application>

    <uses-permission android:name="android.permission.CALL_PHONE" />

</manifest>
```

activity_main.xml

```
<?xml version="1.0" encoding="utf-8"?>
<RelativeLayout xmlns:android="http://schemas.android.com/apk/res/android"
    xmlns:app="http://schemas.android.com/apk/res-auto"
    xmlns:tools="http://schemas.android.com/tools"
    android:layout_width="match_parent"
    android:layout_height="match_parent"
    tools:context="com.codinginflow.phonecallexample.MainActivity">

    <EditText
```

```
        android:id="@+id/edit_text_number"
        android:layout_width="match_parent"
        android:layout_height="wrap_content"
        android:layout_alignParentStart="true"
        android:layout_alignParentTop="true"
        android:layout_marginTop="147dp"
        android:inputType="phone" />


    <ImageView
        android:id="@+id/image_call"
        android:layout_width="80dp"
        android:layout_height="80dp"
        android:layout_centerHorizontal="true"
        android:layout_centerVertical="true"
        android:src="@drawable/ic_phone" />


</RelativeLayout>
```

/***********Notice and Troubleshooting***************

```
 This code is tested on Arduino Uno.

 ****************************************************/


#include "Arduino.h"

#include "SoftwareSerial.h"

#include "DFRobotDFPlayerMini.h"


SoftwareSerial mySoftwareSerial(10, 11); // RX, TX

DFRobotDFPlayerMini myDFPlayer;

void printDetail(uint8_t type, int value);


void setup()

{

  mySoftwareSerial.begin(9600);

  Serial.begin(115200);


  Serial.println();

  Serial.println(F("DFRobot DFPlayer Mini Demo"));

  Serial.println(F("Initializing DFPlayer ... (May take 3~5 seconds)"));
```

```
  if (!myDFPlayer.begin(mySoftwareSerial)) {  //Use softwareSerial to communicate with
mp3.
    Serial.println(F("Unable to begin:"));
    Serial.println(F("1.Please recheck the connection!"));
    Serial.println(F("2.Please insert the SD card!"));
    while(true);
  }
  Serial.println(F("DFPlayer Mini online."));

  myDFPlayer.setTimeOut(500); //Set serial communictaion time out 500ms

  //----Set volume----
  myDFPlayer.volume(10);  //Set volume value (0~30).
  myDFPlayer.volumeUp(); //Volume Up
  myDFPlayer.volumeDown(); //Volume Down

  //----Set different EQ----
  myDFPlayer.EQ(DFPLAYER_EQ_NORMAL);
//  myDFPlayer.EQ(DFPLAYER_EQ_POP);
//  myDFPlayer.EQ(DFPLAYER_EQ_ROCK);
//  myDFPlayer.EQ(DFPLAYER_EQ_JAZZ);
```

```
//  myDFPlayer.EQ(DFPLAYER_EQ_CLASSIC);

//  myDFPlayer.EQ(DFPLAYER_EQ_BASS);


  //----Set device we use SD as default----

//  myDFPlayer.outputDevice(DFPLAYER_DEVICE_U_DISK);

  myDFPlayer.outputDevice(DFPLAYER_DEVICE_SD);

//  myDFPlayer.outputDevice(DFPLAYER_DEVICE_AUX);

//  myDFPlayer.outputDevice(DFPLAYER_DEVICE_SLEEP);

//  myDFPlayer.outputDevice(DFPLAYER_DEVICE_FLASH);


  //----Mp3 control----

//  myDFPlayer.sleep();     //sleep

//  myDFPlayer.reset();     //Reset the module

//  myDFPlayer.enableDAC();  //Enable On-chip DAC

//  myDFPlayer.disableDAC();  //Disable On-chip DAC

//  myDFPlayer.outputSetting(true, 15); //output setting, enable the output and set the gain
to 15


  //----Mp3 play----

  myDFPlayer.next();  //Play next mp3

  delay(1000);
```

```
  myDFPlayer.previous();  //Play previous mp3

  delay(1000);

  myDFPlayer.play(1);  //Play the first mp3

  delay(1000);

  myDFPlayer.loop(1);  //Loop the first mp3

  delay(1000);

  myDFPlayer.pause();  //pause the mp3

  delay(1000);

  myDFPlayer.start();  //start the mp3 from the pause

  delay(1000);

  myDFPlayer.playFolder(15, 4);  //play specific mp3 in SD:/15/004.mp3; Folder
Name(1~99); File Name(1~255)

  delay(1000);

  myDFPlayer.enableLoopAll(); //loop all mp3 files.

  delay(1000);

  myDFPlayer.disableLoopAll(); //stop loop all mp3 files.

  delay(1000);

  myDFPlayer.playMp3Folder(4); //play specific mp3 in SD:/MP3/0004.mp3; File
Name(0~65535)

  delay(1000);

  myDFPlayer.advertise(3); //advertise specific mp3 in SD:/ADVERT/0003.mp3; File
Name(0~65535)
```

```
  delay(1000);

  myDFPlayer.stopAdvertise(); //stop advertise

  delay(1000);

  myDFPlayer.playLargeFolder(2, 999); //play specific mp3 in SD:/02/004.mp3; Folder
Name(1~10); File Name(1~1000)

  delay(1000);

  myDFPlayer.loopFolder(5); //loop all mp3 files in folder SD:/05.

  delay(1000);

  myDFPlayer.randomAll(); //Random play all the mp3.

  delay(1000);

  myDFPlayer.enableLoop(); //enable loop.

  delay(1000);

  myDFPlayer.disableLoop(); //disable loop.

  delay(1000);


  //----Read imformation----

  Serial.println(myDFPlayer.readState()); //read mp3 state

  Serial.println(myDFPlayer.readVolume()); //read current volume

  Serial.println(myDFPlayer.readEQ()); //read EQ setting

  Serial.println(myDFPlayer.readFileCounts()); //read all file counts in SD card

  Serial.println(myDFPlayer.readCurrentFileNumber()); //read current play file number
```

```
  Serial.println(myDFPlayer.readFileCountsInFolder(3)); //read fill counts in folder SD:/03
}

void loop()
{
  static unsigned long timer = millis();

  if (millis() - timer > 3000) {
    timer = millis();
    myDFPlayer.next();  //Play next mp3 every 3 second.
  }

  if (myDFPlayer.available()) {
    printDetail(myDFPlayer.readType(), myDFPlayer.read()); //Print the detail message
from DFPlayer to handle different errors and states.
  }
}

void printDetail(uint8_t type, int value){
  switch (type) {
    case TimeOut:
```

```
  Serial.println(F("Time Out!"));
  break;
case WrongStack:
  Serial.println(F("Stack Wrong!"));
  break;
case DFPlayerCardInserted:
  Serial.println(F("Card Inserted!"));
  break;
case DFPlayerCardRemoved:
  Serial.println(F("Card Removed!"));
  break;
case DFPlayerCardOnline:
  Serial.println(F("Card Online!"));
  break;
case DFPlayerPlayFinished:
  Serial.print(F("Number:"));
  Serial.print(value);
  Serial.println(F(" Play Finished!"));
  break;
case DFPlayerError:
  Serial.print(F("DFPlayerError:"));
```

```
switch (value) {
  case Busy:
    Serial.println(F("Card not found"));
    break;
  case Sleeping:
    Serial.println(F("Sleeping"));
    break;
  case SerialWrongStack:
    Serial.println(F("Get Wrong Stack"));
    break;
  case CheckSumNotMatch:
    Serial.println(F("Check Sum Not Match"));
    break;
  case FileIndexOut:
    Serial.println(F("File Index Out of Bound"));
    break;
  case FileMismatch:
    Serial.println(F("Cannot Find File"));
    break;
  case Advertise:
    Serial.println(F("In Advertise"));
```

```
            break;
          default:
            break;
        }
        break;
      default:
        break;
    }
}
```