Sudan University of Science and Technology

College of Engineering
Electrical Engineering

Blind Walking Stick

A project submitted in partial Fulfillment for the Requirement of the Degree of B.Sc (Honor) in Electrical Engineering

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October - 2017

الآية

بسم الله الرحمن الرحيم

(فتعالى الله الملك الحق ولا تعجل بالقرآن من قبل أن يقضى إليك وحيُه وقل رب زدني علما)

سورة طه الآية 144

DEDICATION

We dedicate this project to our families, our friends and all people who encourage us.

Thank you

ACKNOWLEDGEMENT

On the submission of our Project report of Blind Walking Stick, we would like to express our sincere gratitude to our supervisor DR. Galal Abdelrahman for his guidance. we would like to thank him for his encouragement. It was an invaluable learning experience for us to be a group of his students. As my supervisor, his insight, observations, and suggestions helped us to establish the overall direction of the research and contributed immensely to the success of this work. His immense knowledge, technical skills, and human values have been a source of inspiration to us. Our thanks are extended to Dr. Galal Abdelrahman who helped us with the roadblocks in our project. We would also like to thank him for providing us with all the necessary equipment required to complete this project.

ABSTRACT

Blind people consists of a large group of people in our society. Losing their eyesight has caused them inconvenience in performing daily tasks. Hence, smart cane had been developed in order to increase the life quality of a blind person. The purpose of this project is to design a smart cane with an ultrasonic sensor and global positioning system for the blind. This embedded system mainly has two parts, mobility, and navigation system. For mobility system, it is equipped with ultrasonic sensor HCSR04, soil moisture sensor, LDR, buzzer and vibrating motor. Ultrasonic sensor will send the trigger pulse to detect obstacles. When an obstacle is detected, signals will be sent to vibrating motor and buzzer to activate them. For navigation system, the SKM53 global positioning system is used to get real-time coordinates. The prototype of the smart cane was built to increase the mobility of the blind people and with the navigation system

المستخلص

المكفوفين يشكلون مجموعة كبيرة من الناس في مجتمعنا. فقدان البصر قد تسبب لهم بإزعاج في أداء المهام اليومية. وبالتالي، تم تطوير العصاة الذكية من أجل تسهيل الحياة للمكفوفين. والغرض من هذا المشروع هو تصميم عصاة ذكية مع جهاز استشعار بالموجات فوق الصوتية ونظام تحديد المواقع العالمي للمكفوفين. هذا النظام يتكون من جزأين ،التنقل ونظام الملاحة. لنظام التنقل، العصاة مجهزة بحساس الموجات فوق الصوتية HCSR04، حساس الرطوبة ، مقاومة ضوئية، جرس وهزاز. حساس الموجات فوق الصوتية سوف يرسل نبضات للكشف عن العقبات. عندما يتم الكشف عن عقبة، سيتم إرسال إشارة إلى هزاز المحرك والجرس لتنشيطهما. لنظام الملاحة، يستخدم نظام تحديد المواقع العالمي SKM53 للحصول على الإحداثيات. تم بناء النموذج الأولي من العصاة الذكية لتسهيل حركة المكفوفين ونظام الملاحة.

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LIST OF ABBREVIATIONS

PV	Process variable
SP	Set-point
PID	Proportional-integral-derivative controller
PLC	Programmable logic controller
SFC	Sequential function charts
MCU	Microcontroller unit
OTP ROM	One-time programmable read-only memory
PSoC	Programmable system on-chip
LED	Light-emitting diode
NAVIG	Navigation assisted by embedded vision and GNSS
GNSS	Global Navigation Satellite System
GPS	Global positioning system
GSM	Global system for mobile communication
RF	Radio frequency
LDR	Light dependent resistor
PWM	Pulse-width modulation
UART	Universal asynchronous receiver
USB	Universal serial bus
GPRS	General packet radio service
SIM	Subscriber identity module
ISDN	Integrated telephone network
PSTN	Public switched telephone network
SRAM	Static random access memory
EEPROM	Erasable programmable random memory
FTDI	Future technology devices international
TTL	Through the lens metering

CHAPTER ONE
INTRODUCTION

1.1 Overview

we are living in an era of advanced technology, where every part of our daily lives is related to the science of craft in one way or another. There's no doubt that over the years technology has been responsible for creating amazingly useful resources which put all the information we need at our fingertips. The definition of technology is science or knowledge put into practical use to solve problems or invent useful tools. The development of technology has led to so many mind-blowing discoveries, better facilities, and most importantly in healthcare who need it the most.

As students of electrical engineering, the technology nowadays provided in control systems and feedback methods are taken to design a smart and high-efficiency blind stick to aids and help the blind people that suffer from this disability in their life. An Electronic Travel Aid (ETA) is a form of assistive technology having the purpose of enhancing mobility for the blind pedestrian.

1.2 Problem Statement

For aided orientation and mobility, the majority of the blind people using a Long cane, but it has several limitations and difficulties detecting the presence of obstacles such as low-slung signposts, utility boxes, tree branches, overhanging wires, in time to avoid a collision.

1.3 Objectives

There are two main objectives of this study. The first is to make a smart cane that can Significantly help the blind in his daily life. The second is to ease the communication between the blind person and his family when he is in danger or in need.

1.4 Methodology

- Conducting literature review elucidate the extent of helpful the control systems in the development generally, and particularly in specialized technologies on the blind side.
- Identifying problems faced by the blind peoples.
- Developing a blind stick to solving the problems in previous blind sticks which will be defined.
- Surveying Design requirements in details.
- Illustrate the software side of design.
- The operating system.

All the methodology can be summarized as shown in Figure 1.1.

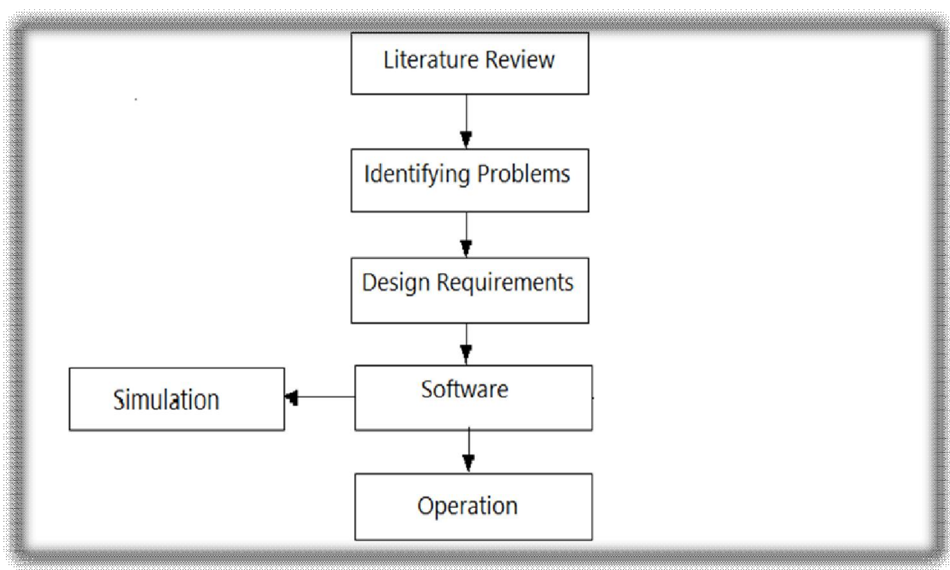

Figure 1.1: Flow chart of research methodology

1.5 Project Layout

Each chapter’s goal is described and arranged as below:

Chapter one gives an overview of the study, problem statement, objective and methodology.

Chapter two discussed all the data that has been collected such as theories and possible solutions are written in this chapter. This chapter is necessary to enable or verify that this invention is achievable, based on many methods from various sources of reference. In other words, chapter two is more on comparisons of researchers, fundamental working principles of the components involved and formulas.

Chapter three explains the components of the project are discussed in a detailed manner by defining the components and describe it and give a review for their operation as well as where they connect in the project and what they do as each one helped to build the project and provide a block diagram for it.

Chapter four shows the circuit and Arduino program are analyzed simulated and explained in this chapter. It involves the program for grove mini vibration motor and ultrasonic sensor. The prototype body was decided after all the functionality met the objectives requirement.

Chapter five conclude the significant achievement of the project and consists of some suggestion for future work to improvise it in the feature.

CHAPTER TWO

GENERAL OVERVIEW

2.1 Overview

The term blindness is used for complete or nearly complete vision loss [1]. Visual impairment may cause people difficulties with normal daily activities such as driving, reading, socializing, and walking. People with complete blindness or low vision often have a difficult time self-navigating outside well-known environments. In fact, physical movement is one of the biggest challenges for blind people, explains World Access for the Blind.

Traveling or simply walking down a crowded street may pose great difficulty. Because of this, many people with low vision will bring a sighted friend or family member to help navigate unknown environments. As well, blind people must learn every detail about the home environment. Large obstacles such as tables and chairs must remain in one location to prevent injury. If a blind person lives with others, each member of the household must diligently keep walkways clear and all items in designated locations.

Blindness causes considerable social challenges, usually in relation to the activities in which a blind person cannot participate. All too frequently, blindness affects a person's ability to perform many job duties, which severely limits the blind employment opportunities. Blindness may also cause difficulties with participating in activities outside of a workplace, such as sports and academics. Many of these social challenges limit a blind person's ability to meet people, and this only adds to low self-esteem.

There are an estimated 285 million visually impaired people, 39 million of which are blind ("Visual Impairment," 2014). Visual impairment indicates that a person has vision 20/40 or worse in his or her better eye when the eye is corrected (“Blindness and Vision Impairment,” 2011). A person with 20/40 vision can read a line of letters at 20 feet that a normal person can read at 40 feet.

A person is legally blind if his or her corrected vision in his or her best eye is 20/200. A visual field less than or equal to 20 degrees in diameter in a person’s best, corrected eye also constitutes legal blindness. (“Blindness and Vision Impairment,” 2011). The most common causes of visual impairment globally are uncorrected refractive errors (43%), cataracts (33%), and glaucoma (2%). Refractive errors include near sighted, far sighted, presbyopia, and astigmatism. Cataracts are the most common cause of blindness.

Other disorders that may cause visual problems include age-related macular degeneration, diabetic retinopathy, corneal clouding, childhood blindness, and a number of infections. Visual impairment can also be caused by problems in the brain due to stroke, premature birth, or trauma among others[2]. These cases are known as cortical visual impairment[2]. Screening for vision problems in children may improve future vision and educational achievement[3]. Screening adults without symptoms are of uncertain benefit[4]. Diagnosis is by an eye exam.

Visual impairments may take many forms and be of varying degrees. Visual impairments may take many forms and be of varying degrees. Visual acuity alone is not always a good predictor of the degree of problems a person may have. Someone with relatively good acuity (e.g., 20/40) can have difficulty with daily functioning, while someone with worse acuity (e.g., 20/200) may function reasonably well if their visual demands are not great. The American Medical Association has estimated that the loss of one eye equals 25% impairment of the visual system and 24% impairment of the whole person.

Total loss of vision in both eyes is considered to be 100% visual impairment and 85% impairment of the whole person. Some people who fall into this category can use their considerable residual vision – their remaining sight – to complete daily tasks without relying on alternative methods. The role of a low vision specialist (optometrist or ophthalmologist) is to maximize the functional level of a patient's vision by optical or non-optical means. Primarily, this is by use of magnification in the form of telescopic systems for distance vision and optical or electronic magnification for near tasks.

People with significantly reduced acuity may benefit from training conducted by individuals trained in the provision of technical aids. Low vision rehabilitation professionals, some of whom are connected to an agency for the blind, can provide advice on lighting and contrast to maximize remaining vision. These professionals also have access to non-visual aids, and can instruct patients in their uses.

2.2 Advantages and Disadvantages of Previous Types of White Cane

There are many advantages and disadvantages in previous types of white cans that can be mentioned as follow;

2.2.1 Straight Cane

Straight cane is fiberglass or carbon graphite cane. it has several advantages and disadvantages can be mentioned as follows. The advantages of the straight cane that it is the best type of cane for visually impaired individuals (first time users) learning to travel for both children and adults and provides the most information/feedback of upcoming surface to a visually impaired traveler also it is the best cane for traveling long distances because cane is Durable yet lightweight and considered a cheap product because they use metal tip – the cheapest form of cane tip.

The disadvantages of the straight cane can be mentioned as it is difficult to use when traveling – examples; using the straight cane in a crowded restaurant, placing cane into a car. Taxicab or airplane – unable to fold and put away and inflexible making the cane susceptible to snapping or cracking also uses metal tip that can be difficult for some individuals to replace – Note: A straight cane has a screw inserted into the end of the cane that requires a person to slip a stiff rubber material encased by metal over the head of the screw requiring considerable strength for a proper fit.

2.2.2 Folding Cane

Folding cane is fiberglass, carbon graphite and aluminum canes it has several advantages and disadvantages can be mentioned as follows. The advantages of the folding cane that it is the best cane for active person – easier to use when entering or exiting buildings such as a restaurant, cabs or airplanes – easy to put away by folding and works great for short travel distances plus it is considered durable sturdy and long lasting cane – elastic cord running through cane not easy to break and the cane tip available in different shapes made from hard plastic that lasts longer than metal tips.

The disadvantages of the straight cane can be mentioned as the construction of cane uses more material resulting in a heavier cane that can cause problems for people with wrist, arm, shoulder or back issues. Cane tip is also heavier. Folding process of cane takes practice and wrapping the elastic cord around the folded cane requires hand strength. Folded cane requires a large area for storing or large bag for carrying while folded. Cane tip although longer lasting is more expensive and requires effort to replace when connecting tip to an elastic cord running through the length of the cane.

Folding cane when unfolded becomes ridged and susceptible to snapping. I purchased an aluminum folding cane and went out to test my new cane when the tip caught in a crack in the sidewalk causing my bodyweight to push against and down onto the cane snapping the cane at one of the connection areas making it impossible to repair.

2.2.3 Telescoping Cane

it has several advantages and disadvantages can be mentioned as follows. The advantages of the straight cane that it is a perfect for active traveler – easy to collapse and folds up into short length and easily placed into a backpack or hooked to belt. Very easy to put away before entering a cab or sitting down to a meal. The lightweight carbon graphite material causes less stress or strain for a person with the wrist, arm, shoulder or back issues. It is easy to fold up – simply tap the cane while holding the top pushing down until the cane slides into one section and pop the rubber plug into place securing the cane and provides good feedback to a person concerning upcoming surface and uses the cheaper metal tip.

The disadvantages of the telescoping cane can be mentioned as the lightweight material with hollow sections makes the cane susceptible to cracking or breaking. Replacing the metal tip is more difficult because securing the tip requires tapping the cane, which is also the way the cane collapses. The tip fits over the head of a screw placed into the end of the cane with pressure applied to secure the tip. After continued use, the rubber plug on the cane becomes less effective at securing the cane in the folded up position.

2.3 Control System

A control system manages, commands direct or regulates the behavior of other devices or systems using control loops. It can range from a single home heating controller using a thermostat controlling a domestic boiler to large Industrial control systems which are used for controlling processes or machines.

For continuously modulated control the feedback control system is used to automatically control a processor operation. The control system compares the value or status of the process variable (PV) being controlled with the desired value or set-point (SP) and applies the difference as a control signal to bring the process variable output of the plant to the same value as the control signal.

For sequential and combinational logic, software logic, such as in a Programmable Logic Controller is used.

2.3.1 Open loop control system

There are two common classes of control action, open loop control systems, and closed-loop control systems. In an open loop control system, the control action from the controller is independent of the "process output". A good example of this is a central heating boiler controlled only by a timer, so that heat is applied for a constant time, regardless of the temperature of the building. (The control action is the switching on/off of the boiler. The process variable is the building temperature).

In a closed loop control system, the control action from the controller is dependent on the desired and actual process output values. In the case of the boiler analogy, this would utilize a thermostat to monitor the building temperature, and thereby feedback a signal to ensure the controller output maintains the building temperature to that set on the thermostat.

A closed loop controller, therefore, has a feedback loop which ensures the controller exerts a control action to control a process variable at the same value as the "Reference input" or "set point" (SP). For this reason, closed-loop controllers are also called feedback controllers[5]. And here are some practical examples of open-loop control systems:

- Electric Hand Drier - Hot air (output) comes out as long as you keep your hand under the machine, irrespective of how much your hand is dried.
- Automatic Washing Machine - This machine runs according to the pre-set time irrespective of washing is completed or not.
- Bread Toaster - This machine runs as per adjusted time irrespective of toasting is completed or not.
- Automatic Tea/Coffee Maker - These machines also function for pre-adjusted time only.
- Timer Based Clothes Drier - This machine dries wet clothes for pre-adjusted time, it does not matter how much the clothes are dried.
- Light Switch - Lamps glow whenever the light switch is on irrespective of light is required or not.
- Volume on Stereo System - Volume is adjusted manually irrespective of output volume level.

2.3.2 Feedback control system

The simplest form of the feedback control system is shown in Figure 2.1 In the case of linear feedback systems, a control loop, including sensors, control algorithms, and actuators, is arranged in such a fashion as to try to regulate a variable at a setpoint (SP) or reference value. An everyday example is the cruise control on a road vehicle; where external influences such as gradients would cause speed changes, and the driver has the ability to alter the desired set speed. The PID algorithm in the controller restores the actual speed to the desired speed in an optimum way, without delay or overshoot, by controlling the power output of the vehicle's engine.

Control systems that include some sensing of the results they are trying to achieve are making use of feedback and so can, to some extent, adapt to varying circumstances. Open-loop control systems do not make use of feedback and run only in pre-arranged ways[5].

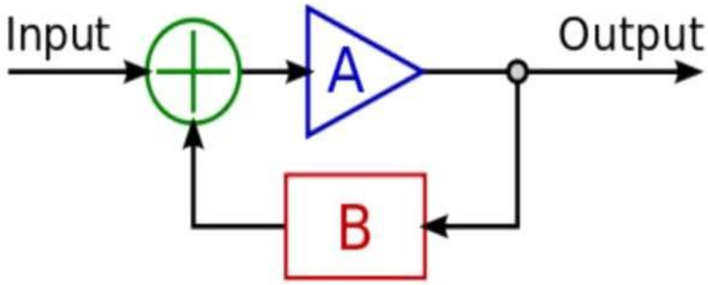

Figure 2.1: Basic feedback control system

And here are some practical examples of closed-loop control system:

- Automatic Electric Iron - Heating elements are controlled by output temperature of the iron.
- Servo Voltage Stabilizer - Voltage controller operates depending upon the output voltage of the system.
- Water Level Controller - Input water is controlled by water level of the reservoir.
- Missile Launched and Auto Tracked by Radar - The direction of the missile is controlled by comparing the target and position of the missile.
- An Air Conditioner - An air conditioner functions depending upon the temperature of the room.
- Cooling System in Car - It operates depending upon the temperature which it controls.

2.3.3 Logic control system

Logic control systems for industrial and commercial machinery were historically implemented by interconnected electrical relays and cam timers using ladder diagram logic. Today, most such systems are constructed with programmable logic controllers (PLCs) or microcontrollers. The notation of ladder logic is still in use as a programming method for PLCs[6].

Logic controllers may respond to switches, light sensors, pressure switches, etc., and can cause the machinery to start and stop various operations. Logic systems are used to sequence mechanical operations in many applications. PLC software can be written in many different ways – ladder diagrams, SFC – sequential function charts or in language terms known as statement lists[7].

Examples include elevators, washing machines and other systems with interrelated stop-go operations. An automatic sequential control system may trigger a series of mechanical actuators in the correct sequence to perform a task. For example, various electric and pneumatic transducers may fold and glue a cardboard box, fill it with the product and then seal it in an automatic packaging machine. Programmable logic controllers are used in many cases such as this, but several alternative technologies exist.

2.3.4 On-off control system

A thermostat is a bang-bang controller. When the temperature (the "process variable" or PV) goes below a set point (SP), the heater is switched on. Another example could be a pressure switch on an air compressor. When the pressure (PV) drops below the threshold (SP), the pump is powered. Refrigerators and vacuum pumps contain similar mechanisms. Simple on-off control systems like these are cheap and effective.

2.3.5 Linear control system

Linear control theory applies to systems made of linear devices; which means they obey the superposition principle; the output of the device is proportional to its input. Systems with this property are governed by linear differential equations. As shown in Figure 2.2.

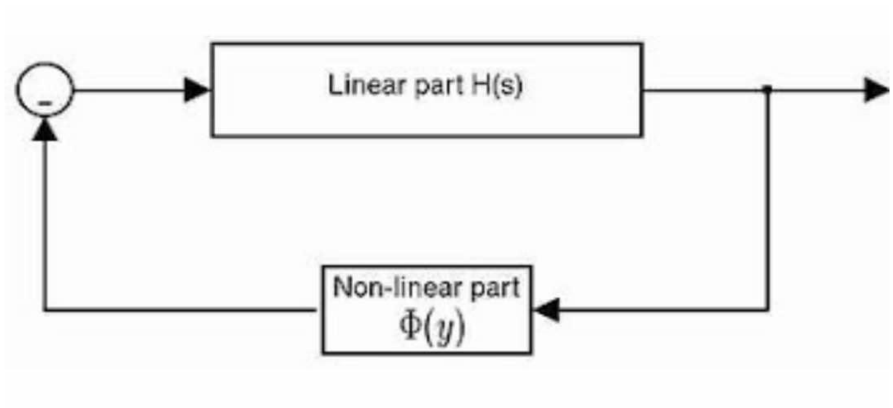

Figure 2.2: Basic Linear and nonlinear control system

2.3.6 Nonlinear control system

It is the area of control theory which deals with systems that are nonlinear, time-variant, or both. Linear control theory applies to systems made of linear devices; which means they obey the superposition principle; the output of the device is proportional to its input.

2.3.7 Fuzzy logic

Fuzzy logic is an attempt to apply the easy design of logic controllers to the control of complex continuously varying systems. Basically, a measurement in a fuzzy logic system can be partly true, that is if yes is 1 and no is 0, a fuzzy measurement can be between 0 and 1. The rules of the system are written in natural language and translated into fuzzy logic. For example, the design for a furnace would start with: "If the temperature is too high, reduce the fuel to the furnace. If the temperature is too low, increase the fuel to the furnace"[8].

2.4 Microcontroller

A microcontroller (or MCU for microcontroller unit) is a small computer on a single integrated circuit. In modern terminology, it is similar to but less sophisticated than, a system on a chip or SoC; a SoC may include a microcontroller as one of its components. A microcontroller contains one or more CPUs (processor cores) along with memory and programmable input/output peripherals. Program memory in the form of Ferroelectric RAM, NOR flash or OTP ROM is also often included on chip, as well as a small amount of RAM.

Figure 2.3 shows two ATmega microcontrollers. Microcontrollers are designed for embedded applications, in contrast to the microprocessors used in personal computers or other general-purpose applications consisting of various discrete chips. Microcontrollers are used in automatically controlled products and devices, such as automobile engine control systems, implantable medical devices, remote controls, office machines, appliances, power tools, toys and other embedded systems. By reducing the size and cost compared to a design that uses a separate microprocessor, memory, and input/output devices, microcontrollers make it economical to digitally control even more devices and processes.

Mixed-signal microcontrollers are common, integrating analog components needed to control non-digital electronic systems. Some microcontrollers may use four-bit words and operate at frequencies as low as 4 kHz, for low power consumption (single-digit milliwatts or microwatts). They will generally have the ability to retain functionality while waiting for an event such as a button press or other interrupt; power consumption while sleeping (CPU clock and most peripherals off) may be just nanowatts, making many of them well suited for long lasting battery applications.

Other microcontrollers may serve performance-critical roles, where they may need to act more like a digital signal processor (DSP), with higher clock speeds and power consumption. There are many examples of microcontroller, for example:

- Altera. Nios II 32-bit configurable soft microprocessor.
- Analog Devices. Blackfin.
- Cypress Semiconductor. Main article: PSoC.
- Maxim Integrated. 8051 Family.
- ELAN Microelectronics Corp.
- EPSON Semiconductor.
- Freescale Semiconductor.
- Atmel ATmega1280.

Figure 2.3: Two ATmega microcontrollers

2.5 Sensors

A sensor is a device that converts a physical phenomenon into an electrical signal. As such, sensors represent part of the interface between the physical world and the world of electrical devices, such as computers. The other part of this interface is represented by actuators, which convert electrical signals into physical phenomena. In recent years, enormous capability for information processing has been developed within the electronics industry.

The most significant example of this capability is the personal computer. In addition, the availability of inexpensive microprocessors is having a tremendous impact on the design of embedded computing products ranging from automobiles to microwave ovens to toys. In recent years, versions of these products that use microprocessors for control of functionality are becoming widely available. In automobiles, such capability is necessary to achieve compliance with pollution restrictions. In other cases, such capability simply offers an inexpensive performance advantage.

All of these microprocessors need electrical input voltages in order to receive instructions and information. So, along with the availability of inexpensive microprocessors has grown an opportunity for the use of sensors in a wide variety of products. In addition, since the output of the sensor is an electrical signal, sensors tend to be characterized in the same way as electronic devices. The data sheets for many sensors are formatted just like electronic product data sheets. However, there are many formats in existence, and there is nothing close to an international standard for sensor specifications.

The system designer will encounter a variety of interpretations of sensor performance parameters, and it can be confusing. It is important to realize that this confusion is not due to an inability to explain the meaning of the terms rather it is a result of the fact that different parts of the sensor community have grown comfortable using these terms differently[9].

2.6 Types of Smart Cane

In this section, several types of smart cane will be reviewed and discussed.

2.6.1 MobiFree

MobiFree cane is equipped with MobiFree sunglasses and MobiFree echo[12]. MobiFree is designed to detect obstacles, step-off, and holes. MobiFree sunglasses are used to detect obstacle above knee level, whereas MobiFree echo is designed to detect obstacles far away by using the directive speaker. Figure 2.4 shows MobiFree function and its usage.

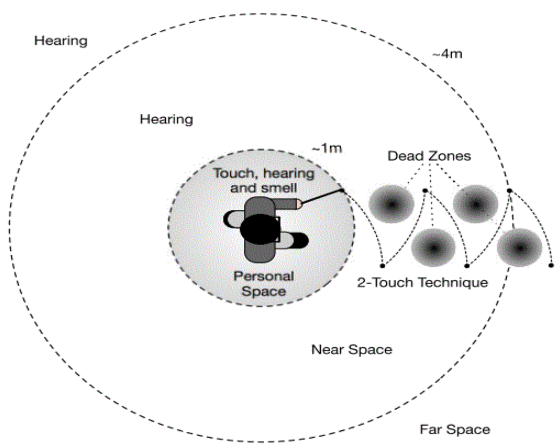

Figure 2.4: MobiFree function and usage [10]

The obstacles, step-off, and holes are detected by an ultrasonic sensor which will be used as input to a vibrator to alert the user. The body of the cane is installed with blinking LED where available light is detected, then the LED will be on. Moreover, Mobifree uses photovoltaic solar cells as the power source.

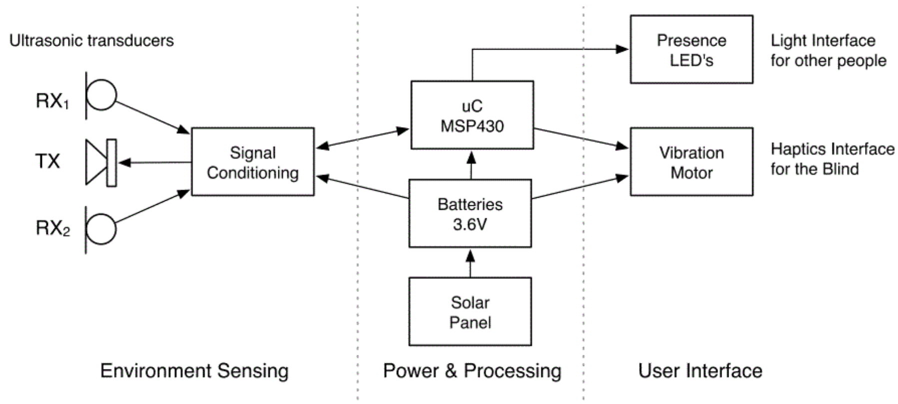

Figure 2.5: MobiFree cane overall architecture [10]

Figure 2.5 shows overall architecture of MobiFree cane. There are two ultrasonic sensors in the smart cane for better detection of obstacles. One of the ultrasonic sensors is located higher than the other. Different kinds of the wave are received and combined together, hence able to increase the diversity of the system. The microcontroller used is with low power ability and using a solar panel to store power. LED signals are used for safety issue to alert others especially car drivers. The vibration motor is used to pass information to the user on the existence of obstacles[10].

MobiFree has good ability in detecting obstacle as it used long cane, sunglasses and hearing device to detect obstacle surrounding and within a distance limit.

2.6.2 Electronic Long Cane

Electronic Long Cane’s main purpose is to detect the obstacle above the waist. The vibration strength is according to the distance between the obstacle and user. The obstacles are detected by using an ultrasonic sensor which connects with micromotor to give the vibration output. Figure 2.6 shows the function of the electronic long cane.

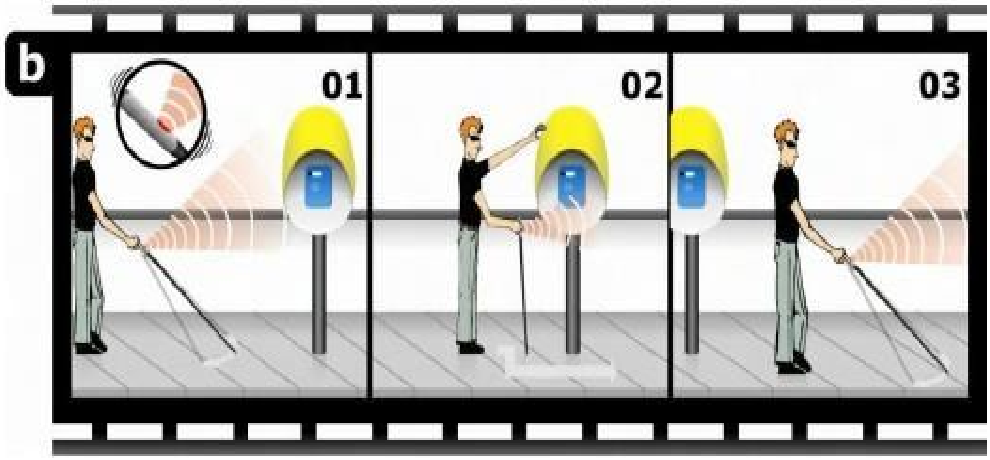

Figure 2.6: Function of electronic long cane [11]

Electronic long cane uses an ultrasonic sensor which is placed in the middle of the smart cane. Micromotor used is based on an Atmel AVR microcontroller and with 9V of batteries to supply power to the embedded system[11]. Electronic long cane mainly focuses on detecting any kind of physical barrier above the waistline. It is simply the improved version of traditional long white cane where it does not have an additional advanced function.

2.6.3 Virtual Cane

Virtual Cane's concept is using the inner force sense to be aware of the existence of obstacle around. The main component used is haptic force generator with a gyroscope. Development of this cane is based on the superficial moment of inertia theory. Moment of inertia of rod depends on the perceived length of the rod. Figure 2.7 shows the haptic force generator in virtual cane.

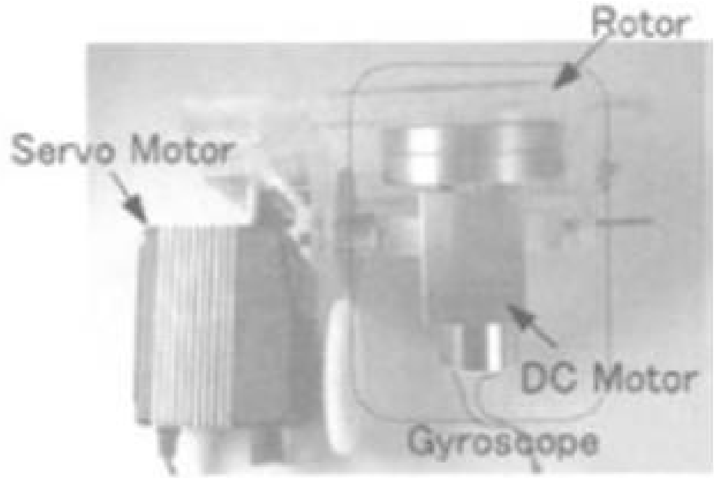

Figure 2.7: Haptic force generator [12]

Perceive length of the rod will be increased exponentially with a moment of inertia. The haptic force generator is used to generate torque that will lead to a moment of inertia. DC motor is used to rotate the rotor at high speed. The servo motor is managed through a pulse width modulation circuit. This type of smart cane is using haptic force generator with the gyroscope as non-installing and non-equipping device[12].

Virtual cane still needs a lot of investigation as its design is still based on concept and theory without practical experiment. Perceive length that relates to the superficial moment of inertia and haptic illusion still needs some research and development as the results obtained are affected by a lot of factors and noise.

2.6.4 Hybrid Infrared-Ultrasonic Electronic Travel Aids

This system uses a combination of the infrared-red and ultrasonic sensor. Two infrared-reds are used to sense smaller objects which are not detected by the ultrasonic sensor while the ultrasonic sensor is used to sense surfaces. The vibrating motor is installed to alert the user to the existence of obstacles and the microcontroller is used to control input and output of signals. Figure 2.8 shows the Hybrid Infrared-Ultrasonic Electronic Travel Aids.

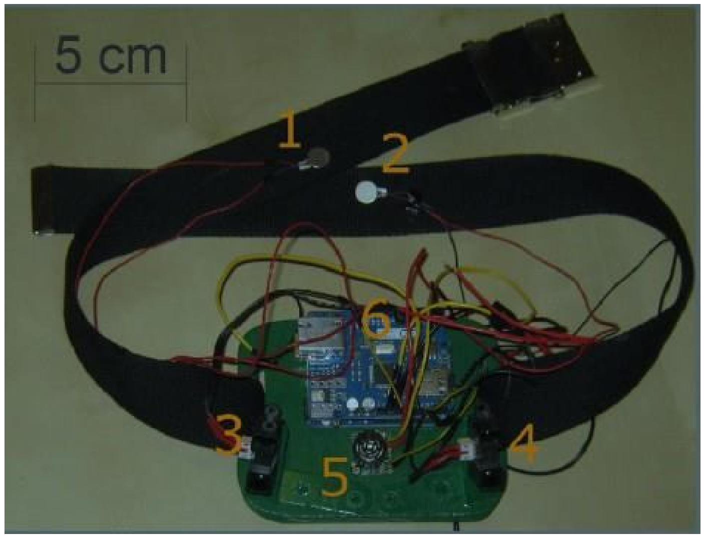

Figure 2.8: Hybrid Infrared-Ultrasonic Electronic Travel Aids

This travel aid is designed in a belt shape so it is wearable and easy to carry. Part 1 and 2 are vibrating motors, part 3 and 4 are infrared sensors, part 5 is an ultrasonic sensor and part 6 is the microcontroller. There are 4 vibrating motors which are located at the front and the back of the belt. Therefore, when an obstacle is detected, vibrating motor is able to alert the user of the obstacle located in the direction of front or back and right or left. A microcontroller that is used is an Arduino UNO board based on ATmega328 type[13].

Hybrid infrared-ultrasonic electronic travel aids is a simple design of travel aids for the blind. It uses infrared red and an ultrasonic sensor for an obstacle detection purpose which is low cost and efficient. However, it is designed with a belt instead of cane which may cause inconvenience for blind people as they may feel insecure without a white cane.

2.6.5 NAVIG – Navigation Assisted by Embedded Vision and GNSS (Global Navigation Satellite System)

NAVIG project mainly focuses on navigation purpose. Its main purpose is strengthening mobility and orientation parts. Mobility is the ability to be aware and avoid the obstacles in the surroundings. Orientation is able to determine the direction and location. NAVIG has three parts, embedded artificial vision, pedestrian positioning issue, and interaction. Embedded artificial vision uses a stereoscopic camera to extract images and match with SpikeNet Vision. SpikeNet Vision is used for structuring adaption to compare with object localization and user's position.

For object localization, the system reads according to the image taken and leads the user towards the object. For user position, this function will alert the user whether they are located at the right position, giving the correct path and inform the user the location they are situated. The pedestrian position issue faces are a most common problem that is lack of data for pedestrian navigation as most navigation design is for vehicles.

Therefore, Geographical Information System that is used for navigation for the pedestrian purpose is improved and included with the user's position. It improves the route path information for pedestrian selection. In order to improve the shortage of pedestrian navigation, inertial motion tracker is used. It is able to sense face facing and body direction and hence sense the direction headed. To increase the accuracy of pedestrian network, data fusion is used. The first stage is to read the data input like speed, direction and reduce the amount of noise.

Secondly, reduce the random and systematic error to get better information. Lastly, the image obtained is matched with a map of GPS location. Interaction is through audio navigation by presenting guidance on direction and also room available in the surroundings. NAVIG device uses 3D audio scene when giving guidance to users[14]. Figure 2.9 shows the results of using NAVIG for navigation purpose. It uses landmarks of a location in order to track the position of a blind person.

Figure 2.9: Geolocated visual landmarks used for user-positioning [14]

2.6.6 Real-time GPS Track Simplification Algorithm

This project mainly is to modify the GPS into more user-friendly for the pedestrian purpose instead of the vehicle. For track simplification, simplification algorithm that is able to filter GPS location is used in order to decrease the sensitivity. Kalman Filter is used to reducing the random error of the GPS due to the low number of visible satellites. The time error will be able to be reduced as it is able to track the exact route according to the velocity of the user[15]. Figure 2.10 shows the track simplification algorithm process flow diagram.

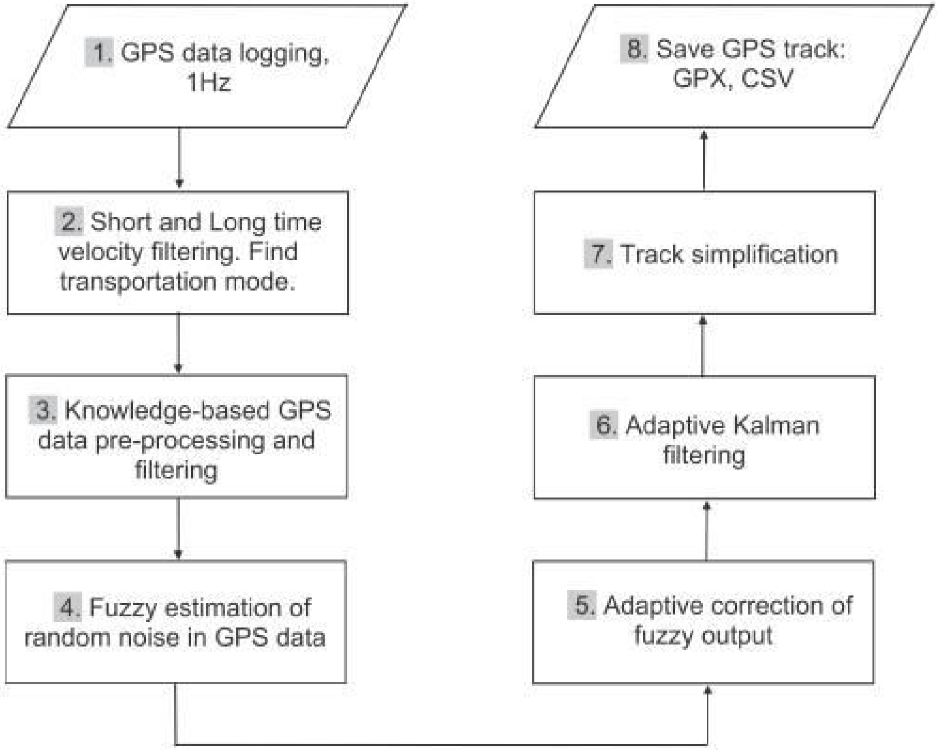

Figure 2.10: Track simplification algorithm process flow diagram [15]

CHAPTER THREE
PROJECT COMPONENTS

3.1 Introduction

This chapter will discuss the components used to complete the project. Each of the hardware devices that helped to design a smart white cane that can help the blind people in many various ways is discussed in a detailed manner to fully understand the Functionality of the components.

3.2 Components of The Project

The components that used in the project are:

- Arduino mega
- GPS
- GSM
- Ultrasonic
- Soil moisture sensor
- RF MODULE
- LDR
- LED
- Vibration motor
- Keypad
- Buzzer

3.2.1 Arduino mega

Arduino is an open-source computer hardware and software company, project, and user community that designs and manufactures single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world.

The Arduino Mega is a microcontroller board based on the ATmega1280 . 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 reset button.

It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila. The Arduino Mega can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

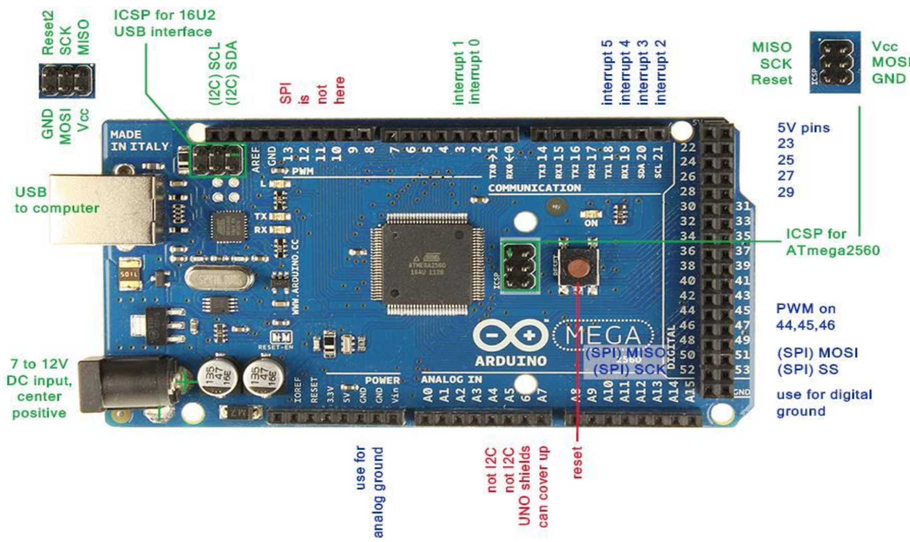

Figure 3.1: Arduino Mega

The power pins are as follows:

- VIN. The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or another regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V. The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via an on-board regulator, or be supplied by USB or another regulated 5V supply.
- 3V3. A 3.3 volt supply generated by the on-board FTDI chip. Maximum current draw is 50 mA.
- GND. Ground pins

The ATmega1280 has 128 KB of flash memory for storing code (of which 4 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM Each of the 54 digital pins on the Mega can be used as an input or output. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor of 20-50 kOhms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the FTDI USB-to-TTL Serial chip.
- External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- PWM: 2 to 13 and 44 to 46. Provide 8-bit PWM output.
- SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila.
- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- I^2C: 20 (SDA) and 21 (SCL). Support I^2C (TWI) communication using the Wire library

The Mega has 16 analog inputs, each of which provides 10 bits of resolution (i.e. 1024 different values). By default, they measure from ground to 5 volts, though is it possible to change the upper end of their range using the AREF pin.

There are a couple of other pins on the board:

- AREF. The reference voltage for the analog inputs.

- Reset. Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

The Arduino Mega has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega1280 provides four hardware UARTs for TTL (5V) serial communication. A FTDI FT232RL on the board channels one of these over USB and the FTDI drivers (included with the Arduino software) provide a virtual com port to software on the computer. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the FTDI chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

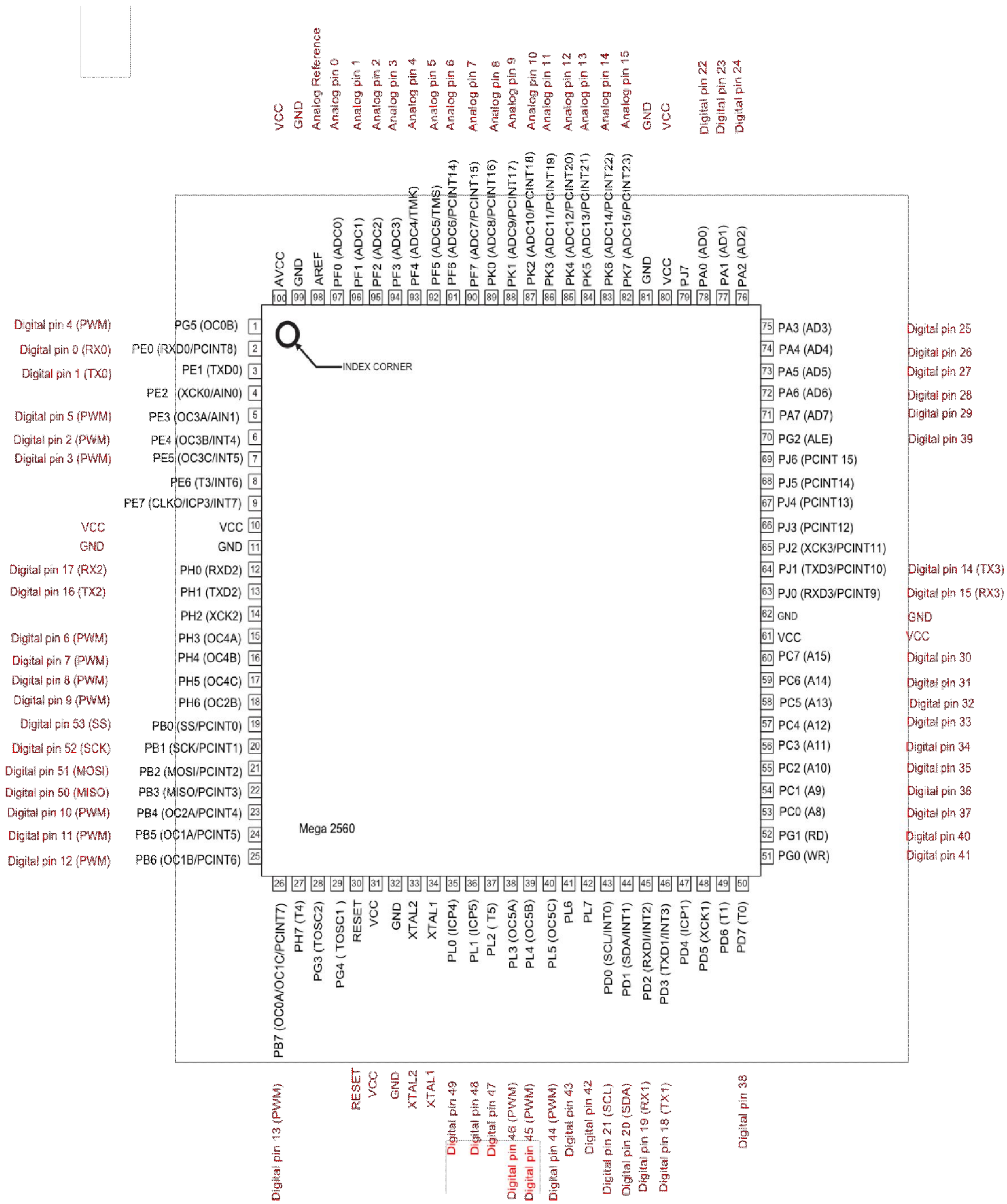

Figure 3.2: Arduino Mega 2560 PIN diagram

3.2.2 GPS

A GPS Receiver is an L-band radio processor capable of solving the navigation equations in order to determine the user position, velocity and precise time (PVT), by processing the signal broadcasted by GPS satellites.

Figure 3.3: GPS module

The GPS receiver module consists of a microstrip antenna that detects the electromagnetic wave signal transmitted by GPS satellites and converts the wave energy into electric current and amplifies the signal strength and sends them to receiver electronics. RF Section with Signal Identification and Processing convert The incoming GPS signals to a lower frequency and processed within one or more channels. The microprocessor controls the operation of a GPS receiver, and it is essential for acquiring the signals, processing the signal and decoding the broadcast message. Precision Oscillator generates a reference frequency in the receiver.

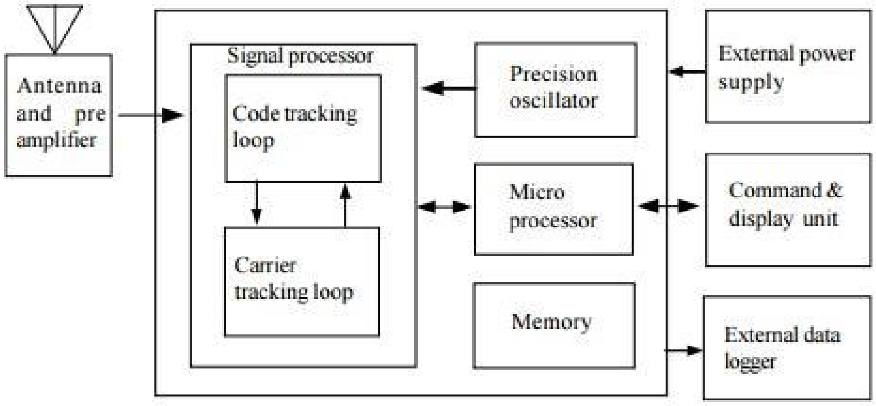

Figure 3.4: GPS module construction

When a receiver circuit detects a satellite's broadcast, the GPS device uses the ephemeris and almanac data to set its own clock and saves the data for use when it's called upon to calculate its position. When the unit's receivers have locked onto at least four satellites, the receiver can begin navigating through the process of trilateration. The receiver to determine how far away each satellite is. To do this, each of the receiver circuits, in effect, tries to sing along with its designated satellite.

The receiver generates the same pseudorandom code that the satellite is broadcasting, beginning at the same time as the satellite begins transmitting the next loop of the code. There are two types of positioning errors: correctable and non-correctable. Correctable errors are the errors that are essentially the same for two GPS receivers in the same area. Non-correctable errors cannot be correlated between two GPS receivers in the same area[16]. The TX pin is connected to Arduino in pin 10. The GPS module is used in the project to determine the coordination of the user of the blind stick.

3.2.3 GSM

A GSM module or a GPRS module is a chip or circuit that will be used to establish communication between a mobile device or a computing machine and a GSM or GPRS system. The modem (modulator-demodulator) is a critical part here.

Figure 3.5: GSM module

These modules consist of a GSM module or GPRS modem powered by a power supply circuit and communication interfaces for the computer. A GSM modem can be a dedicated modem device with a serial, USB or Bluetooth connection, or it can be a mobile phone that provides GSM modem capabilities. A mobile Station is a mobile phone which consists of the transceiver and the processor and is controlled by a SIM card operating over the network. A Base Station Subsystem acts as an interface between the mobile station and the network subsystem.

It consists of the Base Transceiver Station which contains the radio transceivers and handles the protocols for communication with mobiles. It also consists of the Base Station Controller which controls the Base Transceiver station and acts as an interface between the mobile station and mobile switching center. And a network Subsystem provides the basic network connection to the mobile stations. The basic part of the Network Subsystem is the Mobile Service Switching Centre which provides access to different networks like ISDN, PSTN etc.

It also consists of the Home Location Register and the Visitor Location Register which provides the call routing and roaming capabilities of GSM. It also contains the Equipment Identity Register which maintains an account of all the mobile equipment wherein each mobile is identified by its own IMEI number. IMEI stands for International Mobile Equipment Identity. Wireless modems generate, transmit or decode data from a cellular network, in order to establish communication.

A GSM/GPRS modem is a class of wireless modem, designed for communication over the GSM and GPRS network. It requires a SIM (Subscriber Identity Module) card to activate communication with the network. Also, they have IMEI (International Mobile Equipment Identity) number similar to mobile phones for their identification. The MODEM needs AT commands, for interacting with processor or controller, which is communicated through serial communication. These commands are sent by the controller/processor. The MODEM sends back a result after it receives a command.

Different AT commands supported by the MODEM can be sent by the processor/controller/computer to interact with the GSM and GPRS cellular network. The GSM TX pin is connected to Arduino in pin 8 and the RX is connected to pin 7. It is used in this project to send SMS with the location of the user to a specific number that stored in the Arduino when the user needs an urgent help.

3.2.4 Ultrasonic

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. The frequency of the sound waves used for detecting objects is around 20 kHz to 100 kHz. It is mostly applied in ambient noise level, leak detection, and material testing[17]. The ultrasonic sensor is highly used as it is cheap, simple design and efficient.

Figure 3.6: Ultrasonic sensor

The ultrasonic sensor consists of wave producer, transducer, counter mass, amplifier and radiation section. Ultrasonic waves attenuated more frequently, which makes it become a better for directivity than other kinds of waves. The transmitter of ultrasonic sensor can be designed using Gallego Juarez's stepped plate where it consists of wave generation, amplification, and radiation while the microphone is used as a receiver. Gallego Juarez's stepped plate is also used in producing intense wave for the parametric array purpose[18] .Figure 3.7 shows the schematic diagram of an ultrasonic sensor.

At the end of the transducer is where the counter mass is located in order to ensure transducer produces same node point. The transducer material used is Lead Zirconate Titanate with different polarization. Linear Horn is used as amplification and radiating plate will consist of amplified high-intensity of ultrasound.

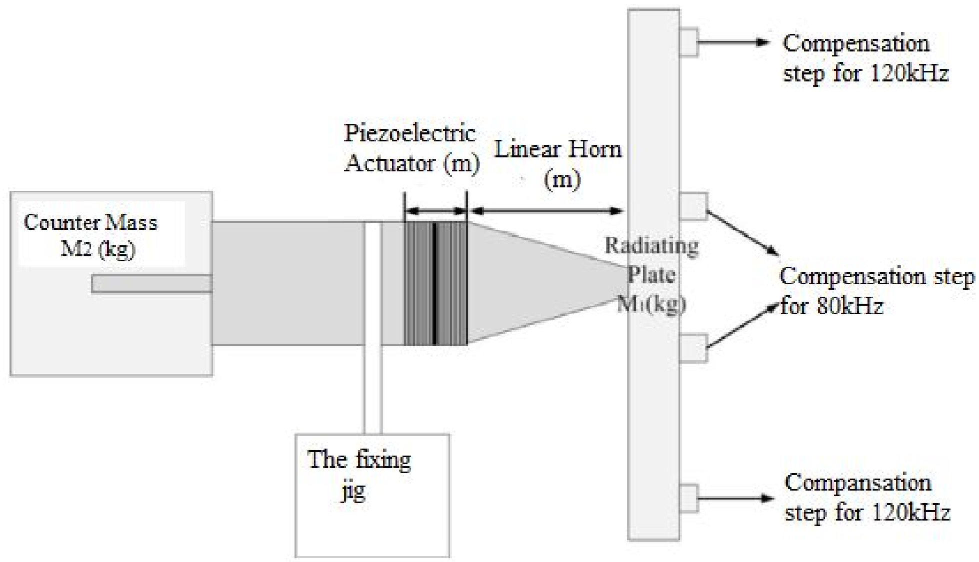

Figure 3.7: Schematic diagram of ultrasonic sensor [18]

The ultrasonic sensor measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. Figure 3.8 shows the operation of ultrasonic sensor to send and receive sonar to detect the object. 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 sonar sensor and the object. In this project, there are two ultrasonic sensors used. The first one the echo and trigger pins are connected with pins 2 and 3 in the Arduino respectively that used to detect the obstacles that in front of the blind user. The second one the echo and the trigger pins are connected with pins 4 and 5 in the Arduino respectively that used to detect any kind of physical barrier above the waistline.

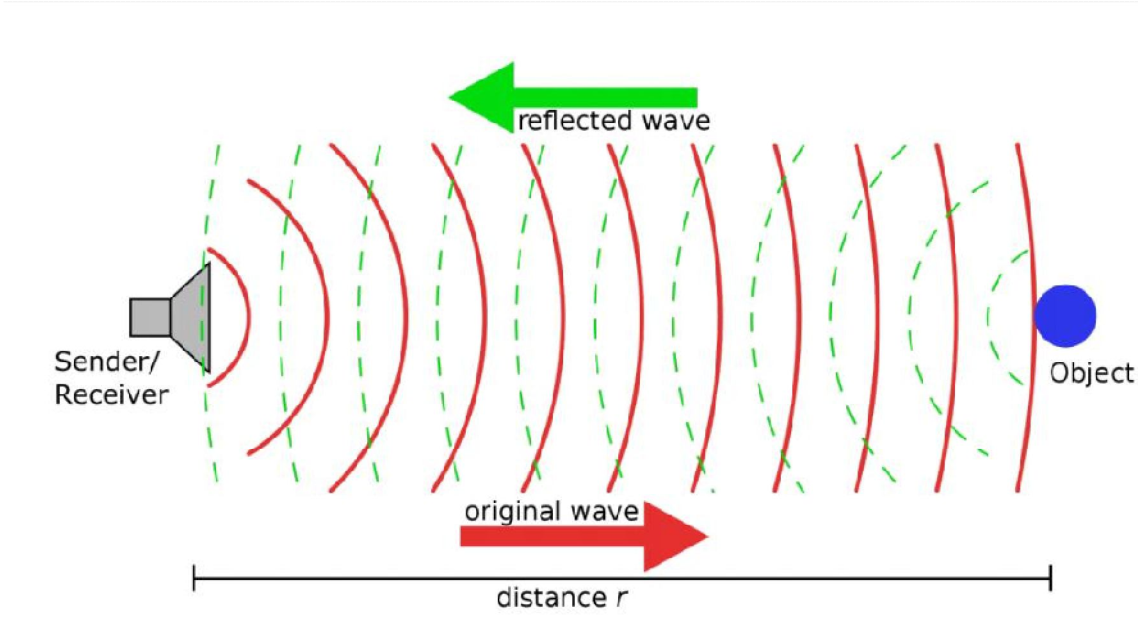

Figure 3.8: Sonar illustration

3.2.5 Soil moisture sensor

A soil moisture sensor measures the quantity of water contained in a material, such as soil on a volumetric or gravimetric basis. A typical Soil Moisture Sensor consists of two components. A two-legged Lead, that goes into the soil or anywhere else where water content has to be measured. This has two header pins which connect to an Amplifier/ A-D circuit which is in turn connected to the Arduino. The Amplifier has a Vin, Gnd, Analog and Digital Data Pins. This means that you can get the values in both Analog and Digital forms.

Figure 3.9: Soil moisture sensor

Most soil moisture sensors are designed to estimate soil volumetric water content based on the dielectric constant (soil bulk permittivity) of the soil. The dielectric constant can be thought of as the soil's ability to transmit electricity. The dielectric constant of soil increases as the water content of the soil increases. This response is due to the fact that the dielectric constant of water is much larger than the other soil components, including air. Thus, measurement of the dielectric constant gives a predictable estimation of water content. The Soil moisture sensor is connected to the analog pin A0. It is used in the project to detect the water spot and mud in the path of the user of the stick.

3.2.6 RF Module

An RF module (radio frequency module) is a usually small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system, it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through radio frequency (RF) communication. For many applications, the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and a receiver.

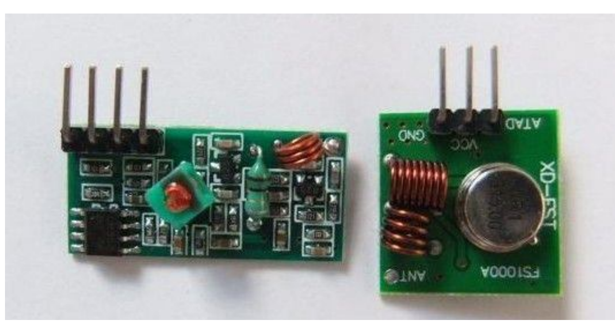

Figure 3.10: RF Module

An RF transmitter module is a small PCB sub-assembly capable of transmitting a radio wave and modulating that wave to carry data. Transmitter modules are usually implemented alongside a microcontroller which will provide data to the module which can be transmitted. RF transmitters are usually subject to regulatory requirements which dictate the maximum allowable transmitter power output, harmonics, and band edge requirements.

An RF receiver module receives the modulated RF signal and demodulates it. There are two types of RF receiver modules: superheterodyne receivers and super-regenerative receivers. Super-regenerative modules are usually low cost and low power designs using a series of amplifiers to extract modulated data from a carrier wave. Super-regenerative modules are generally imprecise as their frequency of operation varies considerably with temperature and power supply voltage. The RF receiver module is connected to pin 12 on the Arduino. And the RF transmitter is connected with push button. The RF module used in the project to help find the stick if it is far and the blind cannot find it.

3.2.7 LDR

A photoresistor (or light-dependent resistor, LDR, or photoconductive cell) is a light-controlled variable resistor. The resistance of a photoresistor decreases with increasing incident light intensity; in other words, it exhibits photoconductivity. A photoresistor can be applied in light-sensitive detector circuits, and light- and dark-activated switching circuits. A photoresistor is made of a high resistance semiconductor. In the dark, a photoresistor can have a resistance as high as several megohms (MΩ), while in the light, a photoresistor can have a resistance as low as a few hundred ohms.

If incident light on a photoresistor exceeds a certain frequency, photons absorbed by the semiconductor give bound electrons enough energy to jump into the conduction band. The resulting free electrons (and their hole partners) conduct electricity, thereby lowering resistance. The resistance range and sensitivity of a photoresistor can substantially differ among dissimilar devices. Moreover, unique photoresistors may react substantially differently to photons within certain wavelength bands. The LDR is connected to the Arduino in the analog pin A2. it is used in the project to sense the light intensity value and send this value to the Arduino.

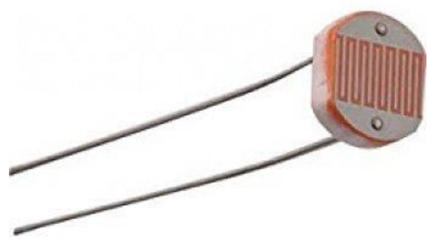

Figure 3.11: LDR

3.2.8 LED

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p–n junction diode, which emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor. The LED is connected to the Arduino in pin 13. It is used in the project to warn other people and drivers about the blind user that holding the stick in the dark.

Figure 3.12: LED

3.2.9 Vibration motor

A vibration motor is a mechanical device to generate vibrations. The primary function of the vibration motor is to alert the user to incoming calls. Vibration motors are normally classified into cylinder type and button type. A coreless motor is a DC motor with a rotor that does not have an iron core. Instead, it has a permanent magnet inside and a coil outside. An offset counterweight is fitted to the end of the motor shaft. When the shaft turns, the imbalance in the counterweight causes the handset to vibrate. There are two vibration motors connected in 52 and 53 pins of the Arduino. They are used to alert the blind and direct the user of the blind stick to the desired path.

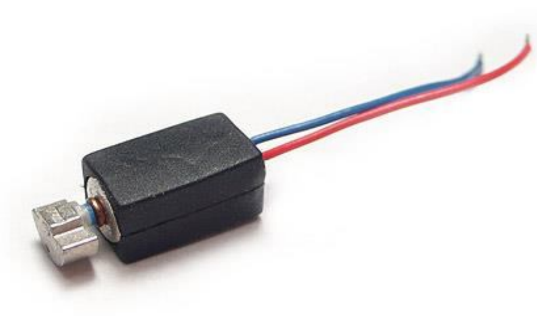

Figure 3.13: Vibration motor

3.2.10 Keypad

The 16-button keypad provides a useful human interface component for microcontroller projects. Convenient adhesive backing provides a simple way to mount the keypad in a variety of applications like Security systems, Menu selection and Data entry for embedded systems. Matrix keypads use a combination of four rows and four columns to provide button states to the host device, typically a microcontroller. Underneath each key is a pushbutton, with one end connected to one row, and the other end connected to one column.

In order for the microcontroller to determine which button is pressed, it first needs to pull each of the four columns (pins 1-4) either low or high one at a time, and then poll the states of the four rows (pins 5-8). Depending on the states of the columns, the microcontroller can tell which button is pressed. The four columns (pins 1-4) in the keypad are connected to the Arduino (pins 22, 24, 26 and 28) and the four rows (pins 5-8) in the keypad are connected to the Arduino (pins 30, 32, 34 and 36). The keypad is used to select the desired path and a method to request help.

Figure 3.14: keypad

3.2.11 Buzzer

Piezo buzzer is an electronic device commonly used to produce sound. Piezo buzzer is based on the inverse principle of piezo electricity. It is the phenomena of generating electricity when mechanical pressure is applied to certain materials and the vice versa is also true. Such materials are called piezo electric materials.

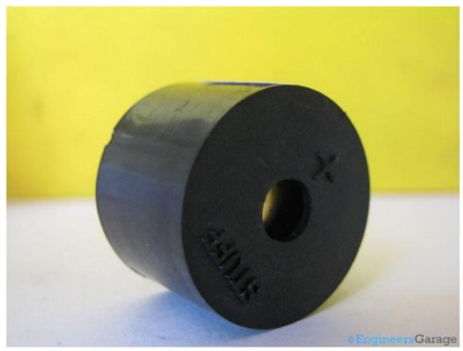

Figure 3.15: Buzzer

Piezo electric materials are either naturally available or manmade. Piezoceramic is the class of manmade material, which poses piezo electric effect and is widely used to make a disc, the heart of piezo buzzer. When subjected to an alternating electric field they stretch or compress, in accordance with the frequency of the signal thereby producing sound.

The electronic components are a resistor, a transistor, and an inductor. The input to the transducer is a low voltage DC signal, however in order to produce sound the piezoceramic disc needs oscillations of high voltage. The transistor and resistor combination works as an oscillator circuit to produce low amplitude oscillations from the DC voltage. The magnitude of these oscillations is amplified by the inductor. When a small DC voltage is applied to the input pins, it is first converted to an oscillating signal using the combination of resistor and transistor.

These oscillating signals are amplified using the inductor coil. When high voltage alternating signals are applied to the piezo ceramic disc, it causes mechanical expansion and contraction in the radial direction. This causes the metal plate to bend in opposite direction. When metal plate bends and shrinks in opposite direction continuously it produces sound waves in the air. The buzzer is connected to the Arduino in pin 40. It is used in the project to generate a buzzer sound to alert the user of the blind stick.

3.3 Block Diagram

Figure 3.16. shows the block diagram of the project.

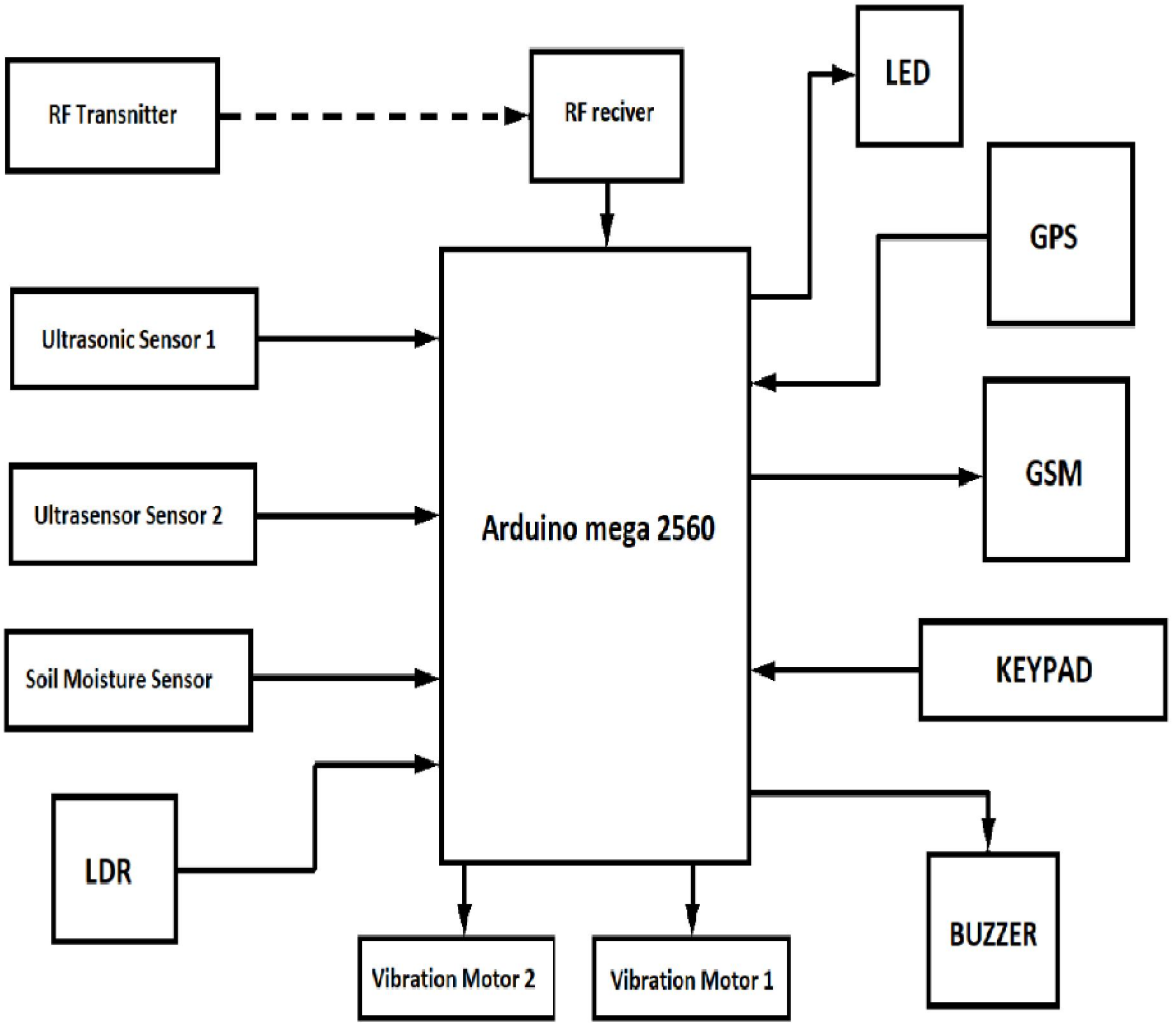

Figure 3.16: Block diagram of the project

CHAPTER FOUR

Simulation and Operation

4.1 Introduction

In this chapter, the software that has been used in the simulation is shown and the operation of the project.

4.2 Software

The Arduino mega is programmed in an Arduino software. This is an open source software. The open-source Arduino environment makes it easy to write code and upload it to the Arduino board. It is compatible with Windows, Mac OS X, and Linux. And we also use The Proteus Design Suite it is a proprietary software tool suite used primarily for electronic design automation.

The software is used mainly by electronic design engineers and electronic technicians to create electronic schematics and electronic prints for manufacturing printed circuit boards. It can be used in two rather distinct ways - either for Interactive Simulation or for Graph-Based Simulation and this is reflected in the structure of the manual.

Typically, you will use interactive simulation to see if a design works at all, and graph-based simulation to investigate why it doesn’t or to take very detailed measurements. However, there are no hard and fast rules. Some elements of the system, such as Generators are relevant to both modes of use and are given their own chapters for this reason.

4.3 Simulation

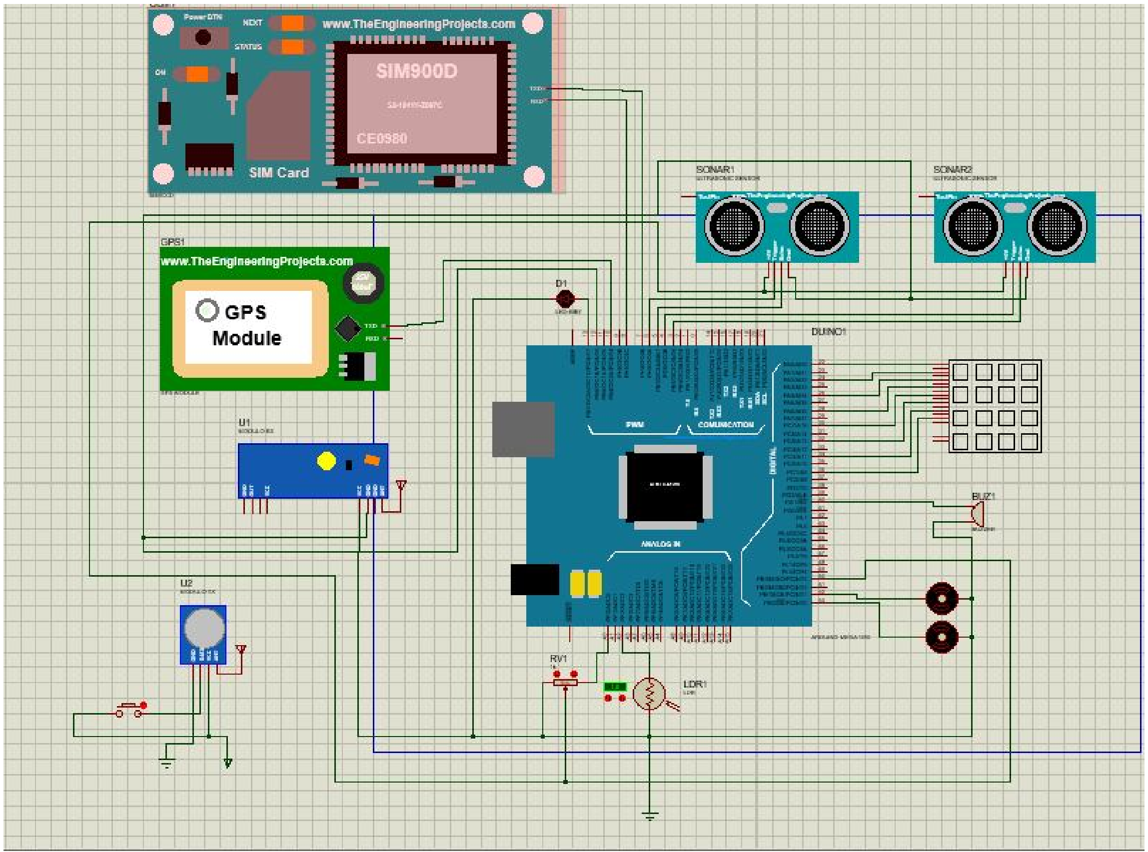

Figure 4.1: Simulation of the project

4.4 Operation

Once the system starts operating the controller (Arduino mega) starts the code, the external power source feeds the sensors and the actuators and start sending the signals. The Arduino mega runs the setup code and identify the pins, the first thing the Arduino will check if there any data received by the radio frequency receiver if it received '1' the buzzer will start buzzing to locate the stick for the blind person, if not the Arduino will continue the program.

After checking whether there are data sent to the stick the Arduino will read the LDR sensor attached to the Arduino analog pin (A2) and compare it with code and check if the value is lower the 5 (which means it's dark) the Arduino light up the LED, if it's more than 5 the LED keeps off.

Then the controller read the analog readings from (A0) -the humidity sensor-(YL-38) in the bottom of stick and check if the ground wet or not, if it's lesser than 900 that's mean it's wet then the arguing sends a signal to the buzzer to be on, and the buzzer will be on as long as the sensor is wet. While all that happening, The upper ultrasonic sensor (HC-04) calculates the distance using the calculation of the duration between sending the ultrasonic waves and receiving them then check the code if the distance is lesser than 1 meter then the vibration motor will vibrate and the buzzer will buzz every 200 milliseconds, For the lower ultrasonic if the distance is lesser than 50 cm the buzzer will buzz every half second (500 milliseconds).

After all sensors and actuators are finished the Arduino will read the condition of the keypad if it is pressed. if the case is "PRESSED" then read the pressed key and run its case. In case '1' the Arduino will run the function "SendMessage()", in this function the Arduino will read the location using the GPS module and get the latitude and the latitude and save them in a string and send them using the GSM module (SIM900A) in an SMS message the number in the code in a URL for to open it in the Google Maps.

If the case is one of the cases 'A','B' or 'C' the program will go to the functions "AA", BB" or "CC", in every function they are number of coordinates set as a path for the blind person to get to his/her distension, then it will navigate the blind person to the location using a small vibration motors attached to the stick on the right and the left to guide him/her, if the person needs to go ahead the two vibrations will run together, and to turn right the right vibration will run, and so on for the left until reaching the distention then the buzzer will start buzzing notifying the blind person that he/she reached there distention.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The main purpose of this project is to help the blind to detect objects or obstacles of the surrounding and in front of the blind user of the stick to increase safety by using ultrasonic sensors and soil moisture sensor and feeds warning back, in the forms of voices and vibration. This project makes the blind user of stick ask help if needed by sending messages of his location to a family member or a friend.

The smart blind cane is successfully designed consistent with all the objectives achieved. The first objective is achieved by making the blind more dependent on himself locating and go safely to his position. The second objective is achieved by the possibility of sending a message contains site coordinates of the blind, which help the receiver person find and salvage the blind.

5.2 Recommendations

Some future works are suggested and recommended in order to improve the smart cane is shown below:

- The navigation system can be improved by using speech recognition to control the function of the smart cane.
- The ultrasonic sensor can be adjusted to detect fast moving objects and detect objects properly while it is swept
- The vibrating strength and sound should be more obvious for a blind person to feel a large difference between near and far obstacles.
- Exploitation of contemporary development and ensure the adoption of the blind on himself using another processor more accurate and wide to be able to locate and track any site coordinates using the network, this option can be applied using a Raspberry Pi processor.

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APPENDIX

ARDUINO CODE

```
#include <Password.h>

#include <Keypad.h>

#include <TinyGPS.h>

#include <SoftwareSerial.h>

#include <VirtualWire.h>

SoftwareSerial gpsSerial(10, 11); //RX=11, TX=12

TinyGPS gps;  //Creates a new instance of the TinyGPS object

SoftwareSerial mySerial(7, 8);

#define echoPin 2 // Echo Pin

#define trigPin 3 // Trigger Pin

#define echoPin1 4 // Echo1 Pin

#define trigPin1 5 // Trigger1 Pin

int motor1 = 53;

int motor2 = 52;

int w = 6;

int buzzer = 40;

int water;

int led = 13;

int maximumRange = 400; // Maximum range needed
```

```
int minimumRange = 0; // Minimum range needed

long duration, distance; // Duration used to calculate distance

long duration1, distance1; // Duration used to calculate distance

char msg;

char call;

float flat, flon;

String latitude = "";

String logitude = "";

const byte ROWS = 4; // Four rows

const byte COLS = 4; //  columns

// Define the Keymap

char keys[ROWS][COLS] = {

  {'1', '2', '3', 'A'},

  {'4', '5', '6', 'B'},

  {'7', '8', '9', 'C'},

  {'*', '0', '#', 'D'}

};

byte rowPins[ROWS] = { 36, 34, 32, 30 }; // Connect keypad ROW0, ROW1, ROW2 and ROW3 to these Arduino pins.

byte colPins[COLS] = { 28, 26, 24, 22, }; // Connect keypad COL0, COL1 and COL2 to these Arduino pins.

Keypad keypad = Keypad( makeKeymap(keys), rowPins, colPins, ROWS, COLS );
```

```
void setup() { pinMode(trigPin,
 OUTPUT); pinMode(echoPin,
 INPUT); pinMode(trigPin1,
 OUTPUT);
 pinMode(echoPin1, INPUT);
 pinMode(motor1, OUTPUT);
 pinMode(motor2, OUTPUT);
 pinMode(led, OUTPUT);
 pinMode(buzzer, OUTPUT);
 pinMode(motor1, OUTPUT);
 pinMode(motor2, OUTPUT);
 vw_set_ptt_inverted(true); // Required for DR3100
 vw_set_rx_pin(12);
 vw_setup(4000); // Bits per sec
 vw_rx_start();
 mySerial.begin(9600);   // Setting the baud rate of GSM Module
 gpsSerial.begin(9600);
 Serial.begin(9600);
 keypad.addEventListener(keypadEvent); //add an event listener for this
keypad
}
void loop() {
 locate();
```

```
get_gps();
int ldr = analogRead(A2);
Serial.print("ldr=");
Serial.println(ldr);
locate();
if (ldr == 0 ) {
  digitalWrite(led, HIGH);
  locate();
}
else {
  digitalWrite(led, LOW);
  locate();
}
water = analogRead(A0);
Serial.print("hum = ");
Serial.println(water);
locate();
if (water < 900) {
  digitalWrite(buzzer, HIGH);
  locate();
  delay(3000);
}
```

```
else {
  digitalWrite(buzzer, LOW);
  locate();
} locate();
keypad.getKey();
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
duration = pulseIn(echoPin, HIGH);
distance = duration / 58.2;
locate();
if (distance >= maximumRange || distance <= minimumRange) {
  Serial.println("distance out of range");
}
else {
  Serial.print("distance= ");
  Serial.println(distance);
  locate();
}
```

```
delay(50);
if (distance < 100) {
  digitalWrite(buzzer, HIGH);
  digitalWrite(motor1, HIGH);
  digitalWrite(motor2, HIGH);
  delay(200);
  digitalWrite(buzzer, LOW);
  digitalWrite(motor1, LOW);
  digitalWrite(motor2, LOW);
  delay(200);
  digitalWrite(buzzer, HIGH);
  digitalWrite(motor1, HIGH);
  digitalWrite(motor2, HIGH);
  delay(200);
  digitalWrite(buzzer, LOW);
  digitalWrite(motor1, LOW);
  digitalWrite(motor2, LOW);
  locate();
}
else {
  digitalWrite(buzzer, LOW);
  digitalWrite(motor2, LOW);
```

```
  digitalWrite(13, LOW);
  locate();
}
digitalWrite(trigPin1, LOW);
delayMicroseconds(2);
digitalWrite(trigPin1, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin1, LOW);
duration1 = pulseIn(echoPin1, HIGH);
distance1 = duration1 / 58.2;
locate();
if (distance1 >= maximumRange || distance1 <= minimumRange) {
  Serial.println("distance1 out of range");
}
else {
  Serial.print("distance1= ");
  Serial.println(distance1);
  locate();
}
Serial.println();
delay(50);
if (distance1 < 50) {
```

```
    digitalWrite(buzzer, HIGH);
    locate();
  }
  else {
    digitalWrite(buzzer, LOW);
    locate();
  }
}
void keypadEvent(KeypadEvent eKey) {
  switch (keypad.getState()) {
    case PRESSED:
    Serial.print("Pressed: ");
    Serial.println(eKey);
      switch (eKey) {
        case '1': SendMessage(); break;
        case 'A': AA(); break;
        case 'B': BB(); break;
        case 'C': CC(); break;
      }}}
void SendMessage()
{
  float flat, flon;
```

```
  unsigned long ag;
  bool newData = false;
  unsigned long chars;
  unsigned short sentences, failed;
  for (unsigned long start = millis(); millis() - start < 1000;)
  {
    while (gpsSerial.available())
    {
      char c = gpsSerial.read();
      Serial.print(c);
      if (gps.encode(c))
        newData = true;
    }
  }
  if (newData)      //If newData is true
  {
    gps.f_get_position(&flat, &flon, &ag);
    Serial.print("lat: ");
    Serial.println(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
    Serial.print("lon: ");
    Serial.println(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
// print longitude
    Serial.println("Sending Message....");    //Sets the GSM Module in Text Mod
```

```
String StringTWO = latitude + "," + logitude;
String StringOne = "https://www.google.com/maps/@"; String StringTheree
= StringOne + StringTWO; mySerial.println("AT+CMGF=1");    //Sets the
GSM Module in Text Mode delay(1000);  // Delay of 1000 milli seconds or
1 second mySerial.println("AT+CMGS=\"+249902113193\"\r");  //
Replace  x  with
mobile number delay(1000);
mySerial.print("http://maps.google.com/?q=");
mySerial.print(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
mySerial.print(",");// print latitude
mySerial.print(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon,
6); // print longitude
mySerial.print(",16z");// print latitude
delay(100);
mySerial.println((char)26);// ASCII code of CTRL+Z
delay(1000);
Serial.println(" Message Send");    //Sets the GSM Module in Text Mode
  }
}
void get_gps()
{
  mySerial.begin(9600);
```

```
Serial.begin(9600);
float flat, flon;
unsigned long ag;
bool newData = false;
unsigned long chars;
unsigned short sentences, failed;
for (unsigned long start = millis(); millis() - start < 1000;)
{
  while (gpsSerial.available())
  {
    char c = gpsSerial.read();
    Serial.print(c);
    if (gps.encode(c))
      newData = true;
  }
}
if (newData)      //If newData is true
{
  Serial.begin(9600);
  gps.f_get_position(&flat, &flon, &ag);
  Serial.print("lat: ");
  Serial.println(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
```

```
    Serial.print("lon: ");
    Serial.println(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
// print longitude
  }
}
void AA()
{
  mySerial.begin(9600);   // Setting the baud rate of GSM Module
  gpsSerial.begin(9600);
  float flat, flon;
  unsigned long ag;
  bool newData = false;
  unsigned long chars;
  unsigned short sentences, failed;
  for (unsigned long start = millis(); millis() - start < 1000;)
  {
    while (gpsSerial.available())
    {
      char c = gpsSerial.read();
      Serial.print(c);
      if (gps.encode(c))
        newData = true;
    }
```

```
  }
  if (newData)      //If newData is true
  {
    gps.f_get_position(&flat, &flon, &ag);
    Serial.print("lat: ");
    Serial.println(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
    Serial.print("lon: ");
    Serial.println(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
// print longitude
  }
  latitude = (flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
  digitalWrite(motor1, HIGH);
  digitalWrite(motor2, HIGH);
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  if (latitude == "15.15562005" && logitude == "32.536876") {
    digitalWrite(buzzer, HIGH);
    digitalWrite(13, HIGH);
    delay(2000);
    digitalWrite(buzzer, LOW);
    digitalWrite(13, LOW);
  }
```

```
  else {
    digitalWrite(buzzer, LOW);
    digitalWrite(13, LOW);
  }
}
void BB() {
  mySerial.begin(9600);   // Setting the baud rate of GSM Module
  gpsSerial.begin(9600);
  float flat, flon;
  unsigned long ag;
  bool newData = false;
  unsigned long chars;
  unsigned short sentences, failed;
  for (unsigned long start = millis(); millis() - start < 1000;)
  {
    while (gpsSerial.available())
    {
      char c = gpsSerial.read();
      Serial.print(c);
      if (gps.encode(c))
        newData = true;
    }
```

```
  }
  if (newData)      //If newData is true
  {
    gps.f_get_position(&flat, &flon, &ag);
    Serial.print("lat: ");
    Serial.println(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
    Serial.print("lon: ");
    Serial.println(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
// print longitude
  }
  latitude = (flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
  digitalWrite(motor1, HIGH);
  digitalWrite(motor2, HIGH);
  digitalWrite(13, HIGH);
  delay(1000);
  digitalWrite(13, LOW);
  if (latitude == "15.562005" && logitude == "32.536876") {
    digitalWrite(motor1, HIGH);
    digitalWrite(13, HIGH);
    delay(2000);
    digitalWrite(motor1, LOW);
    digitalWrite(13, LOW);
  }
```

```
  else {
    digitalWrite(motor1, LOW);
    digitalWrite(13, LOW);
  }
  if (latitude == "15.562920" && logitude == "32.541709") {
    digitalWrite(buzzer, HIGH);
    digitalWrite(13, HIGH);
    delay(2000);
    digitalWrite(buzzer, LOW);
    digitalWrite(13, LOW);
  }
  else {
    digitalWrite(buzzer, LOW);
    digitalWrite(13, LOW);
  }
}
void CC() {
  mySerial.begin(9600);   // Setting the baud rate of GSM Module
  gpsSerial.begin(9600);
  float flat, flon;
  unsigned long ag;
  bool newData = false;
```

```
  unsigned long chars;
  unsigned short sentences, failed;
  for (unsigned long start = millis(); millis() - start < 1000;)
  {
    while (gpsSerial.available())
    {
      char c = gpsSerial.read();
      Serial.print(c);
      if (gps.encode(c))
        newData = true;
    }
  }
  if (newData)      //If newData is true
  {
    gps.f_get_position(&flat, &flon, &ag);
    Serial.print("lat: ");
    Serial.println(flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
    Serial.print("lon: ");
    Serial.println(flon == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flon, 6);
// print longitude
  }
  latitude = (flat == TinyGPS::GPS_INVALID_F_ANGLE ? 0.0 : flat, 6);
  digitalWrite(motor1, HIGH);
```

```
digitalWrite(motor2, HIGH);
digitalWrite(13, HIGH);
delay(1000);
digitalWrite(13, LOW);
if (latitude == "15.562005" && logitude == "32.536876") {
  digitalWrite(motor1, HIGH);
  digitalWrite(13, HIGH);
  delay(2000);
  digitalWrite(motor1, LOW);
  digitalWrite(13, LOW);
}
else {
  digitalWrite(motor1, LOW);
  digitalWrite(13, LOW);
}
if (latitude == "15.562920" && logitude == "32.541709") {
  digitalWrite(motor2, HIGH);
  digitalWrite(13, HIGH);
  delay(2000);
  digitalWrite(motor2, LOW);
  digitalWrite(13, LOW);
}
```

```
  else {
    digitalWrite(motor2, LOW);
    digitalWrite(13, LOW);
  }
  if (latitude == "15.568863" && logitude == "32.540699") {
    digitalWrite(buzzer, HIGH);
    digitalWrite(13, HIGH);
    delay(2000);
    digitalWrite(buzzer, LOW);
    digitalWrite(13, LOW);
  }
  else {
    digitalWrite(buzzer, LOW);
    digitalWrite(13, LOW);
  }
}
void locate() {
  uint8_t buf[VW_MAX_MESSAGE_LEN];
  uint8_t buflen = VW_MAX_MESSAGE_LEN;
  if (vw_get_message(buf, &buflen)) // Non-blocking
  {
    Serial.println(buf[0]);
```

```
    if (buf[0] == '1') {
      Serial.println("find the stick");
      int i;
      for (i = 0; i < 20; i++)
      {
        digitalWrite(40, 1);
        delay(100);
        digitalWrite(40, 0);
        delay(100);
      }
      i = 0;
    }
    if (buf[0] == '0') {
      digitalWrite(40, 0);
    }
  }
}
```

1.