Abstract

The paper presents a theoretical model and a system concept to provide a smart electronic aid for blind people. The system is intended to provide the visually challenged a better walking experience. The design is incorporated with Ultrasonic sensors for Obstacle detection, supported water detection. Ultrasonic sensors are used to calculate distance of the obstacles around the blind person to guide the user towards the available path. This research work explains about the setup we used for the implementation, design details.

CONTENT

Chapter 1

INTRODUCTION

1.1 Research Background

The Malaysian Association for the Blind (MAB) estimates that there are 63,0 00 people in the Malaysia, who are blind, and 53,000 people are having a bad blurry of eye. Therefore, both the size of the market and the size of the need for the technology proposing are large. The virtual cane coupled with an ordinary cane will allow unprecedented navigational power to those who need it. Products developed for the visually impaired have typically focused on communication devices such as reading machines and embossing printers for Braille.

Navigational aids beyond the cane have yet to be developed in a manner leading to their acceptance by the visually impaired community. The primary impediment to produce a marketable version of the proposed technology is the form factor. The product must be easy to use and lightweight. The potentially small size makes it a very attractive option for this product. As more markets are developed for this technology, the sensor will be able to be manufactured in high volume at very low cost. This is an added benefit for those in need of affordable assistive navigational tools.

As both technologies mature, the virtual cane will be able to be mass produced and refined. The device proposes is simple and should be no more difficult to use than an ordinary cane. The rich amount of information available to the user is a tremendous benefit and the novel way in which it is presented to the user make the virtual cane technology an important milestone in assistive devices.

1.2 Problem statement

For aided orientation and mobility, majority of the blind people use a long cane, which provide an extended spatial sensing within and are about 0.5 meters ahead of the user. However, the long cane does not provide protection to their body. The long cane has several limitations such as a range limited to the length of the cane, typically one pace ahead of the user, difficulties detecting overhanging obstacles, and safe storage in public places. Due to its inherent limitations, the long cane does not provide protection for the body above the waist elevation. Consequently, there is no guarantee that the presence of obstacles such as low slung signposts, utility boxes, tree branches, overhanging wires, can be detected by the blind person in time to avoid a collision.

An Electronic Travel Aid (ETA) is a form of assistive technology having the purpose of enhancing mobility for the blind pedestrian. The blind people find traveling difficult and hazardous because they cannot easily determine where things are, a process otherwise known as spatial sensing. Thus the problem of mobility can be reframed as a problem in spatial sensing. The techniques for spatial sensing are well known, radar, sonar, and optical triangulation methods being the most common, and the latter two have been incorporated into a wide variety of past ETA designs.

However, there are many problems with currently available devices. First, the rangefinder technology is unreliable in its detection of step-downs or step-ups, such as curbs. Secondly, blind users find the sounds of various pitches or tactile vibrations being used to code the spatial information to be esoteric and difficult to understand.

Thirdly, most blind users do not find the slight improvement in mobility performance to be worth the extra cost which can be many thousands of dollars, and the additional worry of maintaining a complex, expensive battery operated system that must be carried around and kept track of.

1.3 Objective

In expanding the idea of helping the blind, two main objectives are the target to be achieved upon completion of this project.

The first objective is to develop a model of cane for the blind. The most widely used primary mobility aid today is the long cane. The goal of this design is to improve upon the limitations of the long cane and to replace it.

The second objective is to design ETA prototype that consumes less power, portable size and has an acceptable accurate performance in object distance detection (using sensor) in order to provide fully automatic obstacle avoidance with audible notification.

The design of a small portable cane will be useful for the blind people. It is easier for them to find ways on daily activities without having to use the standard mobility aid available for individuals with this disability. Since the mobility aids are small and light, portable and can be taken anywhere.

1.4 Scope of project

The motivation for this project was to design an electronic mobility aid for the blind. The goal of this project is to design Electronic Travel Aid (ETA) for the blind and to improve upon the limitations of the long cane and to replace it. It will involve ultrasound technology to be more useful and reliable than classical cane. The ultrasonic cane is use to allow the blind people for aided orientation and easy mobility. The prototype is fitted in a 'flashlight-like' enclosure made of a PVC tube with an external battery pack as power supply, an earphone for the audible output and a range of 0 up to 1 meter.

The open ultrasonic sensor manufactured gold foil stretched over a grooved plate. The grooved, metallic back plate in contact with the insulated side of the foil forms a capacitor which, when charged, exerts an electrostatic force to the foil thus transforming electrical energy into acoustical waves. Similarly the energy flow can be reversed to transform the returning echo into electrical energy.

In this design, ultrasound is radiated out and the returning ultrasonic echoes are translated back down into the audible domain and presented binaurally to the blind user. The time based cues responsible for spatial hearing are encoded upon the sound, thereby creating the illusion of an externalized auditory image located out in space at the detected object's position. In this approach, one of the significant drawbacks is that the user must wear earphones, which can interfere with the listening of normal environmental sounds.

There are 2 parts involved in this project, namely hardware and software. The hardware part involved the construction of the walking stick, a microcontroller, ultrasonic sensors, a buzzer and a vibrator. The software used to program the microcontroller is Arduino UNO. The software part includes the programming of the sensors.

Chapter 2

LITERATURE REVIEW

2.1 Background of cane

This research intends to bring "intelligence" into the long cane by providing overhanging obstacle detection capabilities to the cane users. For this purpose, a self-contained, miniaturized ultrasonic ranging module with microelectronics will be designed, prototyped, and integrated into the shaft of a long cane. Upon obstacle detection, a human voice signal, describing in key words the distance and height of the obstacle, will be displayed to provide orientation assistance.

Compared to electronic travel aids (ETAs) developed in the past, the "smart" long cane will be ergonomic in design, easy to use, easy to maintain, less expensive, and much more compatible with daily travel situations. It will provide a useful tool to the blind community in terms of increased mobility, which is a prerequisite for employment and an independent, substantial social life.

10% of people considered legally blind also have mobility impairment, leading to reliance on others for mobility. Although there are limited specialty options available for blind people with mobility impairments, people have been successful using the current obstacle detection options like ultrasonic or infrared sensors.

2.2 Application of Ultrasonic Sensor on Arduino Mobility Cane

Jayant, Pratik and Mita have proposed the application of ultrasonic sensor in the walking stick to detect the obstacles. The overall project is discussed as below.

2.2.1 Working principle

The basic concept of ultrasonic sensor is to determine distance of an object. In this project, an ultrasonic sensor is used to measure the distance between the obstacles and the blind. The sensor enables to warn the blind when facing any dangerous circumstances.

The ultrasonic sensor works by generating high frequency sound waves and evaluates the echo which is received back by the sensor. The sensor calculates the time interval between sending the signal and receiving the echo to determine the distance of the obstacle. That signal is sent to the microcontroller and it decide which output must be triggered

2.2.2 Characteristic of Ultrasonic Sensor

The ultrasonic model used in this project is SRF-04. It was designed to be just as easy to use as the Polaroid sonar. The sensor is able to compute the distance of obstacles in maximum range of 10.7*m*.

It consists of 5 terminals, namely the power terminal, the ground terminal, trigger pulse terminal, echo pulse terminal and do not connect terminal. An analog voltage signal is produced as output which is proportional to the distance. The current consumption for the sensor is about 2.5A during the sonic burst and the power desired to turn it on is 5*V*

The sensor needs to supply a short 10μS pulse to the trigger input to start the ranging. Then the module will send out an 8 cycle burst of ultrasound at 40 kHz and raises its echo line high. The module is quite large to fit into small systems. Figure 2.1 shows the SRF-04 ultrasonic sensor.

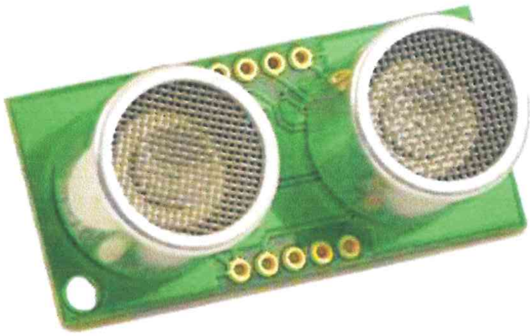

Figure 2.1 SRF-04 Sensor

2.2.3 Hardware Part

There are five main components in the system which are a charging circuit, a battery, a vibrator, an ultrasonic sensor and a control unit.

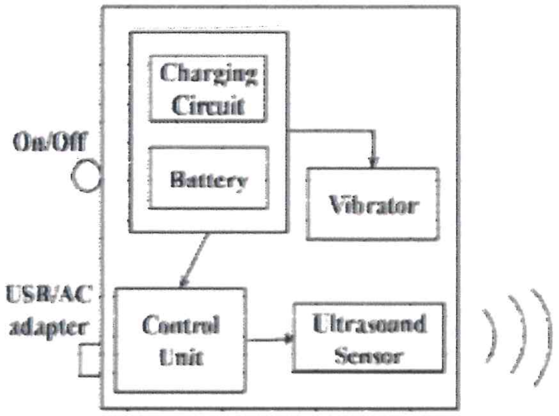

Figure 2.2 Block Diagram of the Components

Referring to Figure 2.2, ultrasonic module will emit ultrasonic waves which bounce back when hit an object or an obstruction in the path of the user. The received signal will be sent to the control unit which consists of an Arduino Board. Arduino will do the calculation and then it triggers the vibrator as the indicator to warn the user of the obstacles.

2.3 Microcontroller

Microcontroller is a compact microcomputer designed to regulate the operation of embedded system in motor vehicles, robots, office machines and numerous other devices. An embedded system is a very sophisticated system that required minimal memory and program length, no operating system and less software complexity.

2.3.1 Arduino Uno Microcontroller

The Arduino Uno is a microcontroller board based on the ATMEGA328. It is an open source single board microcontroller, heir of the open source wiring platform, thus helping in designing electronic project easily. Arduino need to be programmed in order to drive the designed function. The software that can be used for Arduino Uno programming is Arduino software.

It has 14 digital input/output pins of which can be used as PWM outputs, 6 analog inputs, a 16MHz crystal oscillator, a USB connection, a power jack, and ICSP header, and a reset button. It comprises everything needed to support the microcontroller.

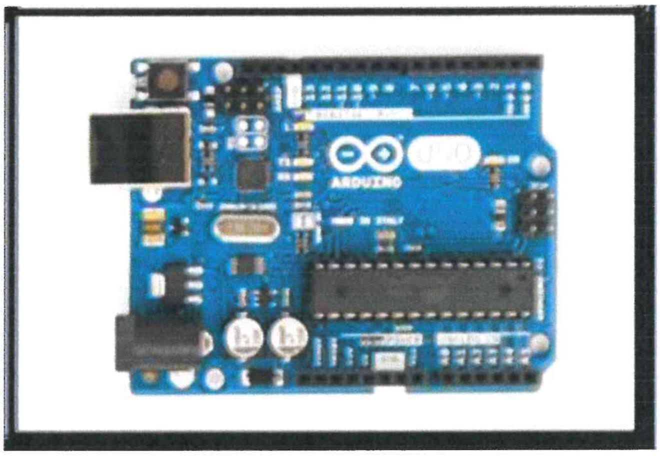

Figure 2.3 Arduino Uno R3

The brain of the entire system is the microcontroller where most part of the data management is done here. The microcontroller used in this project is Arduino Uno R3, as illustrated in Figure 2.3. Arduino board has an ATMEGA328P microcontroller merged in it. It has 32 KB of flash memory of storing code. It also has 2 KB of SRAM and 1 KB of EEPROM. The detail features of the microcontroller are as in Appendix E.

2.4 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit.

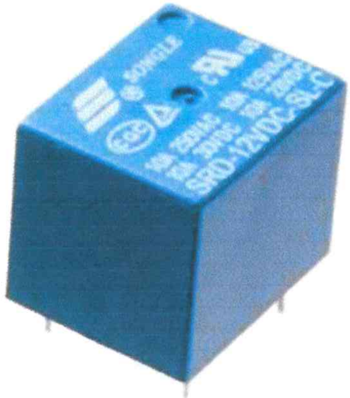

Figure 2.4 Relay

Chapter 3

METHODOLOGY

This chapter elaborated the approach to develop the proposed Blind Sensor. The design approach has been divided into four phases; system specification requirement, design implementation and verification.

The blind sensor will consist of ultrasonic sensor, buzzer, vibrator and Arduino UNO. Ultrasonic sensor will emit ultrasonic waves which bounces back when hit an object or an obstruction in the path of the user. The received signal will be sent to the control unit which consists of an Arduino board. Arduino will do the calculation and then it triggers the buzzer and motor DC to warn the user.

3.1 Fabrication & Measurement Process

PCB wizard is a highly innovative package for designing single-sided and double-sided printed circuit boards (PCB). It provides a comprehensive range of tools covering all steps in PCB production, including schematic diagram, schematic capture, component placement, and automatic routing.

3.2 Step of Project Implementation

To make a perfect and quality project, there are some steps that needed to implement the project and through the making of the project. Some of the steps are making a schematic circuit, exposed the PCB Board under UV light, etching the PCB Board, punch some hole and soldering components on the PCB Board.

3.3 Schematic Diagram for the Circuit

The important step before making a circuit are to make a circuit. The circuit first need to besketch to know where all the components need to put and to know all the connection of the circuit. When the circuit is ready, convert the circuit to printed circuit and examine the circuit wether it need jumper or not then print it on a tracing paper.

3.4 Expose the PCB Board under UV light

Put the tracing paper on a PCB Board then put it in the Ultra Violet Machine. Set the time to 100 seconds and wait for it to be ready then develop the board until the circuit is shown. Ultraviolet curing is a photochemical process in which high-intensity ultraviolet light is used to instantly cure or “dry” inks, coatings or adhesives.

Figure 3.1 PCB board under UV light

3.5 Etching Process

Put the board in the Etching machine and set the time to 5 minutes and wait for the machine to be ready. Check the board wether there is any unnecessary copper on the board. Put the board again in the machine and set the time for 1 minute. Repeat this until the unnecessary copper is gone. Then, clean the board with water. A machine is a tool containing one or more parts that uses energy to perform an intended action. Etching is traditionally the process of using strong acid or mordant to cut into the unprotected parts of a metal surface to create a design in incised in the metal.

Figure 3.2 Etching PCB board

3.6 Drilling the board

This process is for making a hole on a board according to component's feet. Use a suitable size for drilling. Example for resistor feet, use 0.5mm drill. It is because for easy to solder the components. Drill the hole carefully to avoid damaging the board.

3.7 Installing Components

Put the component's feet according to the hole according to the circuit. Then, bend the feet so the components will not fall from the board. Make sure all the components are put according to the polarity to so the circuit will function normally.

3.8 Soldering the Components

This process is to make the components stay on the PCB board and will make the circuit looks nice and not miserable. The first thing is heat the soldering iron so the lead solder will easily melt. When the soldering iron is hot enough, put the soldering iron to the feet on the component then slowly melt the lead solder. The lead solder must be put sufficiently so the it will cover the hole. After finish soldering all the components, cut the remaining component's feet using a cutter.

3.9 Types of Component

3.9.1 PCB Board

A printed circuit board (PCB) mechanically supports and electrically connects electronic components using conductive tracks, pads and other features etched from copper sheets laminated onto a non-conductive substrate. PCBs can be single sided (one copper layer), double sided (two copper layers) or multi-layer (outer and inner layers). Conductors on different layers are connected with vias. Multi-layer PCBs allow for much higher component density.

Figure 3.3 PCB board

3.9.2 Resistor

It a device having a designed resistance to the passage of an electric current. Resistors act to reduce current flow, and, at the same time, act to lower voltage levels within circuits. In electronic circuits, resistors are used to limit current flow, to adjust signal levels, bias active elements, and terminate transmission lines among other uses.

Figure 3.4 Resistor

3.9.3 Zener diode

A Zener diode allows current to flow from its anode to its cathode like a normal semiconductor diode, but it also permits current to flow in the reverse direction when its "Zener voltage" is reached. Zener diodes have a highly doped p-n junction. Normal diodes will also break down with a reverse voltage but the voltage and sharpness of the knee are not as well defined as for a Zener diode. Also normal diodes are not designed to operate in the breakdown region, but Zener diodes can reliably operate in this region.

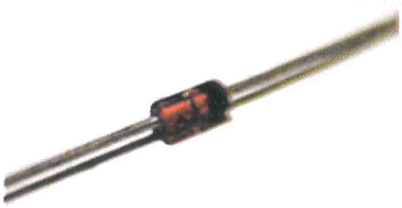

Figure 3.5 Zener Diode