UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ULTRASONIC SMART CANE FOR VISUALLY IMPAIRED PEOPLE

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Engineering Technology (Telecommunication) with Honours

by

LEE YI PEI
B071310519
930805-07-5634

FACULTY OF ENGINEERING TECHNOLOGY
2016

DECLARATION

I hereby, declared this report entitled "Ultrasonic Smart Cane for Visually Impaired People" is the results of my own research except as cited in references.

Signature : _____

Author's Name : Lee Yi Pei

Date : _____

APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfilment of the requirements for the degree of Bachelor of Electronic Engineering Technology (Telecommunication) with Honours. The member of the supervisory is as follow:

_____

(Puan Siti Asma binti Che Aziz)

_____

(Encik Fakhrullah bin Idris)

ABSTRAK

Projek ini bertujuan untuk membantu golongan yang cacat penglihatan dalam menjalani kehidupan mereka. Tongkat yang biasa digunakan hari ini adalah terhad dari segi fungsinya. Hal ini secara langsung mendatangkan banyak masalah seperti tongkat tersebut susah untuk mengenal pasti kedudukan sesuatu halangan dan juga kewujudan air di lantai. Oleh itu, projek ini bertujuan untuk membuat perubahan pada tongkat yang sedia ada dan menambahbaikan fungsi tongkat tradisional kepada tongkat moden yang mempunyai elektronik berteknologi (alat pengesan ultrabunyi dan alat pengesan air). Untuk memahami fungsi Arduino Uno dan juga alat-alat yang digunakan dalam projek ini, pelbagai penyelidikan telah dijalankan. Dalam projek ini, pelbagai perkakasan dan perisian yang digunakan. Perkakasan yang digunakan termasuklah alat pengesan ultrabunyi, alat pengesan air, buzzer dan motor gegaran manakala perisian yang digunakan ialah Arduino IDE. Setelah semua komponen dikumpulkan, projek ini dimulakan dengan menguji komponen dan juga tongkat yang dihasilkan. Beberapa ujian akan dijalankan untuk menguji prestasi tongkat yang dihasilkan, termasuklah mengenal pasti benda dan air di depan pengguna. Hasil daripada ujian akan ditafsirkan dalam bentuk graf dan jadual. Hasil ujian ini akan dibandingkan dan diubahsuaikan untuk mengenal pasti kelemahan tongkat yang dihasilkan dan juga kelemahan untuk keseluruhan projek. Setelah tongkat moden dihasilkan, cadangan untuk menambahbaikan fungsi tongkat moden akan diberikan.

ABSTRACT

This project is started with an objective to help the visually impaired people from continuing their daily lives. The normally used cane is found to have many limitations, which has caused many problems including the inability of detecting head-level obstacles and water on the floor. Hence, this project is aimed to improve and transform the traditional white cane into a modern smart cane which is fully equipped with useful devices (ultrasonic sensor and water sensor). Plenty of researches have been carried out to understand the application of the usage of Arduino Uno and different sensors installed on the smart cane. In this project, the various kinds of hardware and software are being utilized. Many components will be used in this project, including ultrasonic sensor, water sensor, buzzer, vibration motor, and Arduino Uno which form the hardware part of the project while Arduino IDE is used as the software part of the program. After all the required components have been collected, the project is started immediately with the testing of each component. Then, several actions are to be carried out to test the performance of each of the special function of the smart cane, including detecting obstacles and water in front of the users. The results of testing will be tabulated and shown in graphs and tables. Then, they are compared and improved to find out the limitation of the smart cane as well as the limitation of the project. After the smart cane is made, recommendations will be given to enhance more experiment made in future to improve the smart cane based on the limitation.

DEDICATION

To my beloved parents and friends.

ACKNOWLEDGEMENT

This project would not be done without the guidance and support from my supervisor, friends as well as family.

First of all, I would like to show my deepest gratitude to my supervisor, Puan Siti Asma binti Che Aziz, who gave me advice and updated information during the progression of this project. Her guidance and motivation have helped me a lot in completing the final year project.

Secondly, I would like to express my gratitude to my co-supervisors, Encik Fakhrullah bin Idris and Puan Wan Haszerila binti Wan Hassan, who gave me tons of guidance and ideas for my project. Encik Fakrullah has helped me a lot by providing his knowledge and opinions. Special thanks to Puan Wan Haszerilla, who gave me inspiration on the prototype for this project. Her comment and guidance have helped me a lot in producing the smart cane prototype.

Next, I would like to thank my friends who shared their opinions when I was doing this project. When I met problem with my project, they were always there to advice and help me even though they were busy with their project. Their opinions have helped me in solving the problems faced.

Lastly, I would like to show my gratitude to my beloved family. Their encouragement and support have motivated me during the tough times. Thank you for giving me the strength to complete my final year project.

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LIST OF ABBREVIATIONS

API	-	Application Program Interface
ATM	-	Automated Teller Machine
DC	-	Direct Current
GPS	-	Global Positioning System
GSM	-	Global System for Mobile Communication
IC	-	Integrated Circuit
ID	-	Identification
IDE	-	Integrated Development Environment
MCU	-	Microcontroller Unit
ODS	-	Obstacle Detection System
PC	-	Personal Computer
PIC	-	Peripheral Interface Controller
PWM	-	Pulse Width Modulation
RFID	-	Radio Frequency Identification
RPM	-	Revolutions Per Minute
SD	-	Secure Digital
SMS	-	Short Message Service
WDS	-	Water Detection System
WHO	-	World Health Organization

CHAPTER 1

INTRODUCTION

1.0 PROJECT BACKGROUND

White cane is a mobility tool used by the blind or visually impaired people. It is believed that the white cane was originated in Europe and invented by James Biggs in 1921. After James Biggs had lost his vision due to an accident, he started to paint his walking stick white in order to alert the motorists and pedestrians of his presence. The white cane also used to alert himself to the presence of obstacles that were located within his path.

Nowadays, the white cane is widely used. However, it is found that the white cane is not effective in detecting the obstacles especially at head or knee level. Due to the limitation of white cane in detecting the obstacles, the visually impaired person may hit the obstacles and get himself injured. Besides, it is observed that most of the white cane could not detect the presence of water on the floor. Due to the ineffectiveness of white cane, the visually impaired person may slip when he steps on the water.

The smart cane looks to overcome the limitations brought by the white cane. This can be done by upgrading the present white cane. An ultrasonic sensor will be inserted on the present white cane in order to locate the head-level obstacles that are 2.5m away. When an obstacle is detected by the ultrasonic sensor, the sensor will

alert the visually impaired person by activating buzzer and vibration motor. The buzzer and vibration motor will then send different sets of sounds and vibrations. This means that when the visually impaired person comes nearer to the obstacles, the frequency of vibrations and sounds produced by both vibration motor and buzzer will get higher. Furthermore, a water sensor will be inserted on the smart cane. The function of water sensor is to detect the water on the floor and alert the blind or visually impaired people by using the alarm and vibration motor in order to prevent them from stepping on the water and slipping.

1.1 PROBLEM STATEMENT

The number of blind is increasing rapidly and it increases up to 2 million worldwide every year. Shahful Shaffiq (2015) claims that according to the statistics produced by United Nations, there is 1 out of 10 people worldwide who suffered from the disabled issue. By applying this estimation, the Malaysian Association for the Blind claims that there are around 69000 blind people and 40000 individuals suffering from eye problems and vision loss in Malaysia. Hence, the issues that relevant to the population of the visually impaired people shall be taken into consideration while developing the country.

One of the difficulties faced by the visually impaired people is that the white cane is hard to detect the obstacles that are above the head of the blind. It can only detect obstacles which are located at a distance equal to the cane's length. Due to the short detection range of white cane, the visually impaired people may hit the obstacles and get themselves hurt. Thus, it is believed that the invention of smart cane will overcome this problem. The smart cane can detect the head-level obstacles which are placed at a distance of 2.5 metres from the user and hence, it can be said that the smart cane has longer detection range than a normal white cane.

In addition, white cane does not have any device that can be used to alert the user effectively. It does not have any audio device or vibrating device to alert the

user when they are approaching to an obstacle. In contrast with the white cane, smart cane consists of alerting devices such as buzzer and vibration motor that can be used to warn the user when he is approaching to an obstacle. Thus, it is believed that the alerting system of a smart cane is more effective than a normal white cane.

Besides, white cane does not have the ability to detect the presence of water on the floor. According to the data provided by National Vital Statistics System (2015) in United State, in 2012 to 2013, 55% of the unintentional injury cases among adults of aged 65 and over were due to fall. Most falls happen at home and one of the causes of fall is the person especially the visually impaired person is unaware of the existence of water on the floor. Due to the limitation on the functionality of white cane, the visually impaired person may step on the water and slip.

1.2 OBJECTIVES OF PROJECT

I. To study the function of ultrasonic sensor, water sensor and Arduino.
II. To design a low budget ultrasonic smart cane which is effective in detecting the head level obstacles within 2.5m and water on the floor.
III. To determine the performance of ultrasonic sensor and water sensor as well as ultrasonic smart cane.

1.3 SCOPE OF PROJECT

Two systems, namely obstacle detection system and water detection system will be implemented in this smart cane. For obstacle detection system, the ultrasonic sensor will detect the head-level obstacle which is located at a distance of 2.5m from the visually impaired user. For water detection system, water sensor will detect the presence of water. The water sensor will be activated as long as the sensor is in contact with water. It does not determine the depth of water. This project will be implemented through both software and hardware. For software part, C programming

language will be used for coding purpose and Multisim will be used to simulate the circuit before the circuit is being soldered on actual board. For hardware part, ultrasonic sensor, water sensor, buzzer, vibration motor as well as Arduino Uno will be used to perform the operation of the circuit designed.

1.4 PROJECT OVERVIEW

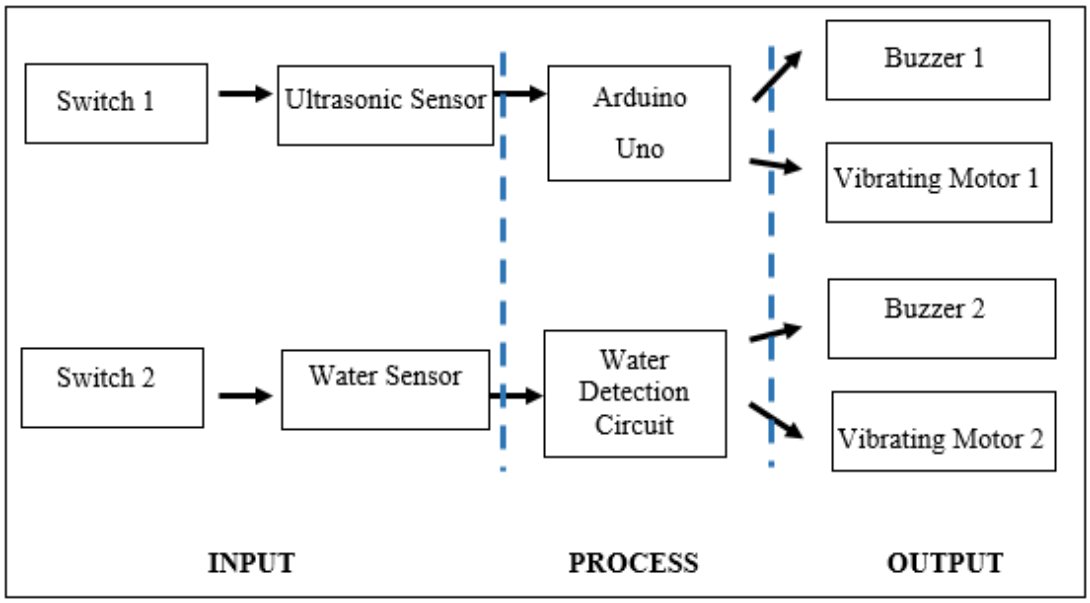

Figure 1.1: Block Diagram of the Project

1.5 THESIS OUTLINES

This report consists of five chapters, including introduction (chapter 1), literature review (chapter 2), methodology (chapter 3), result and discussion (chapter 4) as well as conclusion (chapter 5). The theory and implementation of the project with title Ultrasonic Smart Cane will be discussed in details in this report.

I. Chapter 1 consists of the overview of this project. In this chapter, background, problem statement, objectives, work scope, block diagram as well as thesis outlines of this project will be explained in details.

II. Chapter 2 consists of the projects which related to the smart cane that had been conducted by other researchers. A brief introduction of the relevant projects will be discussed in this chapter. Besides, the applications of ultrasonic sensor and water sensor as well as their relevant projects will be explained in details.

III. Chapter 3 consists of the methods used to implement this project. Flow charts for development of the project and operation of the circuit will be inserted in this chapter. Furthermore, function and information about the technologies and components used in this project will be discussed in details in this chapter.

IV. Chapter 4 consists of the results of this project. The performance of the ultrasonic sensor, water sensor as well as the smart cane will be explained in details in this chapter. Problems that occurred during the implementation of this project will be discussed in this chapter too.

V. Chapter 5 consists of the overall review of this project. Conclusion and recommendation will be made based on the performance of the smart cane.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

According to the information provided by the World Health Organization WHO (2014), 285 million people are estimated to be visually impaired worldwide and most of them are from the developing countries. Among these 285 million of people, 39 million are blind and 246 million are facing the problem of low vision. Due to the limitation of vision faced by the visually impaired people, they have to depend on others in performing their daily tasks. This has indirectly cause inconveniences to the others as well as the visually impaired person himself. Hence, the objective of this project is to design and produce a low budget smart cane which can bring conveniences to the daily life of visually impaired people. It is believed that with the invention of smart cane, it can increase the living standard of visually impaired people. In this chapter, projects that related to the smart cane will be discussed briefly. Besides, researches that relevant to the components used in this project, including ultrasonic sensor and water sensor, will be discussed in details in this section.

2.1 Accidents Experienced by Visually Impaired People

In this section, accidents that encountered by the visually impaired people will be reviewed in details. Visually impaired people are referred to those population who are partially blind or totally blind. According to Roberto Manduchi and Sri Kurniawan (2011), walking without sight bring forth the risk of falls and collisions. Due to the vision impairment faced by the visually impaired people, they are unable to see the object clearer and even unable to see the object which may lead to falls and collisions. Thus, the chances of visually impaired people fall or collide are twice as compared to those without visual impairments.

In order to study the relationship between visual impairment and the number of accidents, a research was carried out by Roberto Manduchi and Sri Kurniawan, from the University of Santa Cruz. There were more than 300 legally blind or blind individuals joined in this survey. The survey was focused on the frequency, nature and causes of head-level and fall accidents. The result that collected was being analyzed.

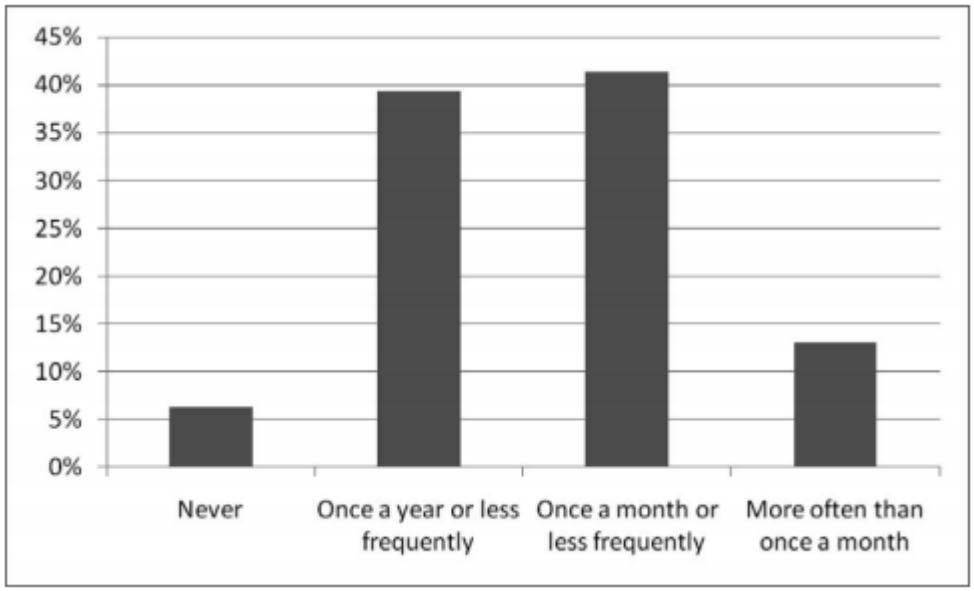

Figure 2.1: Distribution of Frequencies of Head-level Accidents (Roberto Manduchi *et al*., 2011)

By referring to Figure 2.1, it can be observed that among the 300 respondents who have visual impairments, only 6 percent of the respondents who never experienced head-level accidents. About 39 percent of respondents said that they had experienced head-level accidents once a year or less frequently and 41 percent of the respondents said that they had experienced head-level accidents once in a month or less frequently.

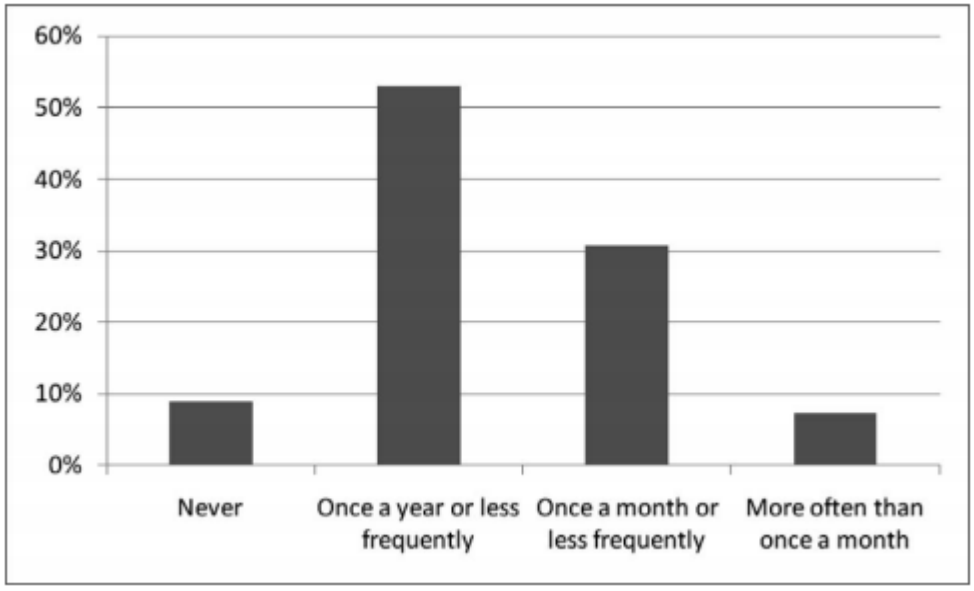

Figure 2.2: Distribution of Frequencies of Fall Incidents (Roberto Manduchi *et al.*, 2011)

There were a total of 289 participants joined in the survey on fall. By referring to Figure 2.2, it can be observed that among 289 visually impaired respondents, there are only 8 percent of respondents who did not experienced fall. Around 52 percent of respondents said that they had experienced fall once in a year or less frequently and 31 percent of respondents experienced fall once in a month or less frequently.

There are a lot of causes which can lead to collision and fall for visually impaired people. For collision, the visually impaired people might unaware with the presence of car, dustbin and staircase. For fall, they might unaware with the wet floors or obstacles.

2.2 White Cane

White cane is a tool used by visually impaired people to aid them in navigating purpose. It is introduced by James Biggs after World War I. White cane is a symbol of blindness and in United Kingdom, white cane with two red bands indicates that the user is deafblind. The function of the white cane is to alert the visually impaired people of the obstacles in their path such as a tree, dustbin as well as stairs. It is also used to alert the people around them that they are visually impaired people. All visually impaired people must go for training before they can use a white cane in performing their daily tasks.

There are three types of white cane which are normally used by the visually impaired people nowadays. These three types of white cane are long cane, support cane and identification cane. Long cane is also known as 'traditional' white cane. It is the most common type of cane which is used by the visually impaired people nowadays. The length of the cane depends on the height of the user and it is measured from the floor to the sternum (breastbone) of the user. Support cane is used to provide physical stability to the visually impaired people. It cannot detect obstacles and thus, it is not used for mobility purpose. Identification cane is also known as symbol cane. Alike with the support cane, the identification cane is not designed for mobility purpose. It is only used to alert the public that the visually impaired user has low vision.

Figure 2.3: Images of Long Cane, Support Cane and Folding ID Cane

(Source: <http://www.magnifyingaids.com/Canes> 23/03/16)

2.3 Smart Cane

Smart cane is an electronic device which uses technology to overcome the difficulties faced by the visually impaired people. It enhances the present white cane and overcomes the limitation of white cane by detecting the obstacles that are above the knee-height of the user. There are various kinds of smart cane which have developed by researches. In this section, seven types of smart cane and navigation system will be discussed and reviewed.

2.3.1 Embedded Navigation Assisting Cane for the Blind

This project was proposed by Nishant Banat James and Ashish Harsola (2015), from F.C.R.I.T which is an engineering college affiliated to the University of Mumbai in India. They found that the visually impaired people are unable to navigate independently and need to depend on others when they want to travel from one destination to another destination. With the intention to overcome the navigation problem faced by the visually impaired people, they have designed a smart walking stick to overcome the limitations of white cane. The smart walking sticks contains an Arduino mega 2560 microcontroller, ultrasonic sensors, a GPS receiver, a wet surface detection sensor, a headphone and a vibration motor. The function of the ultrasonic sensor is to detect the obstacles whereas a GPS receiver is used for navigation purpose. A navigation algorithm was developed by using GPS coordinates (latitude and longitude readings of the user's current location) which were provided by the GPS receiver. To effectively navigate the user to his desired destination, the cane also provided audio feedback which assisted the user for navigation. A vibration motor is installed at the handle of the stick in order to generate vibrations when the ultrasonic sensor detects the presence of obstacles. Furthermore, the wet surface detection sensor is used