" I hereby declare that I have read through this report entitle "Design and Develop The

Spectacle Type Supporting Device For Visually Impaired Person" and

found that it has comply the partial fulfilment for awarding the degree of Bachelor of

Mechatronics Engineering".

Signature   :   ....

Supervisor's Name   : EN ANUAR BIN MOHAMED KASSIM

Date   :   ....

DESIGN AND DEVELOP THE SPECTACLE TYPE SUPPORTING DEVICE FOR

VISUALLY IMPAIRED PERSON

YONG KUEN WEI

A report submitted in partial fulfilment of the requirements for the degree
of Bachelor of Mechatronics Engineering

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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I declare that this report entitle "Design and Develop the Spectacle Type Supporting Device for Visually Impaired Person" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature   :   ....

Name   :   YONG KUEN WEI

Date   :   ....

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ABSTRACT

Recent years, there are many devices have been developed in order to assist the visually impaired person. In the previous "My 2nd Eye" project, there was a stick integrated with sensors which help the visually impaired person to detect the obstacle below their abdomen. However, it is hard to detect obstacle above their abdomen. To solve the problem, a spectacle with sensor is proposed to detect the obstacles above abdomen. The sensor is integrated to the spectacle in certain angle to sense obstacles above abdomen. Sound system will integrate in the spectacle to alert the user when obstacles are detected. At first, simulation will be done to test the circuit of the board. After that, an experiment to test whether there are blind spot horizontal and vertical for the device within 50 cm in front of user will be done. Another experiment will be done to test the smart eye device durability and the relationship between voltage supply and accuracy. As a result, the device can sense the obstacle at head-level and assist user from head accident. Lastly a survey will be done to user for feedback and recommendation.

ABSTRAK

Pada zaman kini, terdapat banyak alat dicipta untuk membantu mereka yang kurang upaya dari segi penglihatan. Dalam projek "My 2nd Eye"sebelum ini, tongkat disepadukan dengan pengesan untuk membantu mereka mengesan penghalang pada kedudukan bawah pusat mereka. Namun, jika penghalang yang berada di kedudukan atas pusat mereka, pengesan pada tongkat susah untuk mengesan penghalang itu. Cermin mata disepadukan dengan pengesan yang dapat mengesan penghalang pada kedudukan atas pusat dikemukakan untuk mengatasi masalah ini. Sistem suara juga disepadukan dengan cermin mata untuk memberi amaran kepada penguna semasa penghalang dikesan. Simulasi akan digunakan untuk menyemak penyambungan litar untuk sistem ini. Seterusnya, satu ekperimen akan dijalankan untuk memastikan terdapat blind spot melintang dan melutur sekeliling 50 cm depan pengguna. Satu lagi ekperimen akan dijalankan untuk menyemak ketahanan alat dan perhubungan antara kejituan dan bekalan elektrik . Keputusan yang didapati adalah alat ini dapat mengesan penghalang pada kedudukan atas pusat dan akan membantu pengguna mengelak daripada terlanggar dengannya. Kaji selidik kepada pengguna akan dijalankan pada akhirnya untuk mendapat maklum balas dan cadangan.

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LIST OF ABBREVIATION

WHO   World Health Organization

PIC   A family of microcontroller

USB   Universal Serial Bus

ICSP   In-Circuit Serial Programming

CHAPTER 1

1   INTRODUCTION

1.1   Project Background

From the data estimated from WHO, the number of people for all ages visually impaired is 285 million for year 2010 [1]. Visually impaired person is facing a lot of problem compare to others disabilities. Many of them using long cane assist them to get around. Some of them use dog guides while walking. Unfortunately, both of these aids just can help the user to detect the obstacle at lower level of their body. These aids cannot protect the user from collision with the obstacle at head-level, such as propped-open window, tree branch, and the opened door of a truck. There was a survey about 300 blind people expert in using long cane have experience collision with head-level obstacle [2]. In the survey shows that there are 39% of respondent have the experience of head-level accident once a year and 14 % of respondent more often than once a month. So, this project is to designed a device that can use for detect the obstacle and prevent form head-level accident.

1.2   Problem Statement

This project is initiates after there are some problems which have been detected from the previous My 2nd Eye project. The problem of the project is there are only sensors that sense obstacle at ground level which cannot detect obstacles above abdomen level.

Survey shows that there are cases that the obstacle may hit the head. So therefore this project proposed a spectacle type supporting device for visually impaired person.

The technical problem for this project is to develop a prototype that can give alert signal 150 cm from the obstacle to user when obstacle is detected. The second technical problem is to develop a sound alert system as a warning system to user when an obstacle is detected.

1.3 Objective

The objectives of this project are:

1. To design and develop obstacle detection function on head to detect the obstacle located at upper abdomen.
2. To design a suitable angle for sensor to detect obstacle above human abdomen level.
3. To design a PIC control sound system for warning user when obstacles detected.

1.4 Scope

- Literature review on obstacle avoidance aids for blind people and distance sensors.
- The final result will be prototype product.
- The aid tool will be built on spectacle.
- The cost of the project will less than RM200
- The spectacle will have sound system to be alert when obstacles are sensed.
- The obstacle will be at the position 100 cm to 170 cm from ground.

CHAPTER 2

2   LITERATURE REVIEW

2.1   Introduction

There are many device have been developed to assist the disabilities person especially vision impaired person. This is because vision impaired person faced a lot of problem. They need others help to move to a destination. Many of the impaired persons will use a device to assist them during walking. Commonly they use a white cane to sense the obstacle around them. Many electronic sensing devices are designed now to replace the role for the white cane.

2.2   Current Aid Devices for Vision Impaired Person

In this section, current aid devices for vision impaired person and its operating step will be list out. Features comparison for each device also will show in this section.

2.2.1 GuideCane

The GuideCane is a device that has same function like white cane. User need to hold on the GuideCane while walking. This device is heavier compare to white cane due to the integrated servo motor and ultrasonic sensors. Although this device is heavier, the user just need roll on wheels that support for the device during normal operation. The left and right wheel is controlled by servo motor and built-in computer will give signal to servo motor to steer the wheel left or right direction. 10 ultrasonic sensors were used for obstacle detection (Figure 2.1). The user can control the joystick located at handle to move to desire direction. The built-in computer will decide the path free of obstacle based on the user's input and data from ultrasonic sensors. [3]
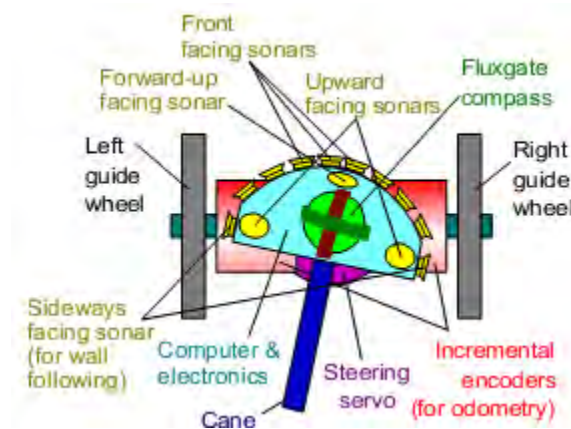
Figure 2.1 The GuideCane sensor-head [3]

While operation, when user pressed the forward button, the GuideCane will consider the direction as desire direction and both wheels will rotate forward. If the user press left button, the GuideCane will start rotate 90 ^{0} to the left from the current position. The wheels will steer completely when the direction is free of obstacle. The ultrasonic sensors detect angle range is in 120 ^{0} wide. While travelling, if the sensor detect obstacle in its range (step 1 in Figure 2.2), the built-in computer will get the data from sensor. The obstacle-avoidance algorithm prescribes another direction to turn avoid from the obstacle and resume in the desired direction (step 2 in Figure 2.2). The user will feels the resulting

horizontal rotation of the cane once the wheels begin to steer sideways to avoid the obstacle (step 3 in Figure 2.2).
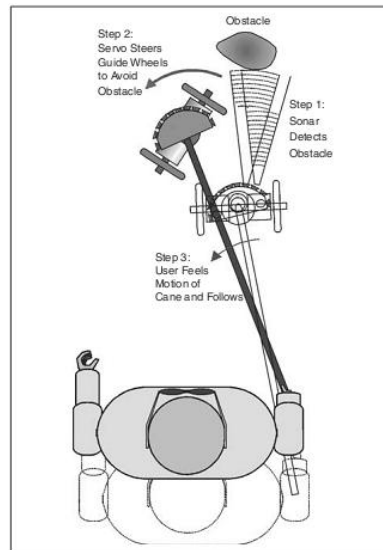
Figure 2.2 How the GuideCane avoids obstacles. [3]

2.2.2 NavBelt

NavBelt is a belt that consist a portable computer as a backpack, and 8 ultrasonic sensors mounted on front of the belt. Voice system also use in this device to give warning when there are obstacle detected. The ultrasonic sensor each covering a sector of 15 ^{o} and provide total scan range of 120 ^{o}. The concept for NavBelt is similar with the concept of mobile robot. In mobile robot, the computer processes the signal come from sensors and applies in robotic obstacle-avoidance algorithms. The different between mobile robot and NavBelt is the alert system. The electrical signals, which controlled the steering and drive motor of the robot (Figure 2.3 a), are replaced by acoustic signal that will send to user through headphone (Figure 2.3 b). [4]
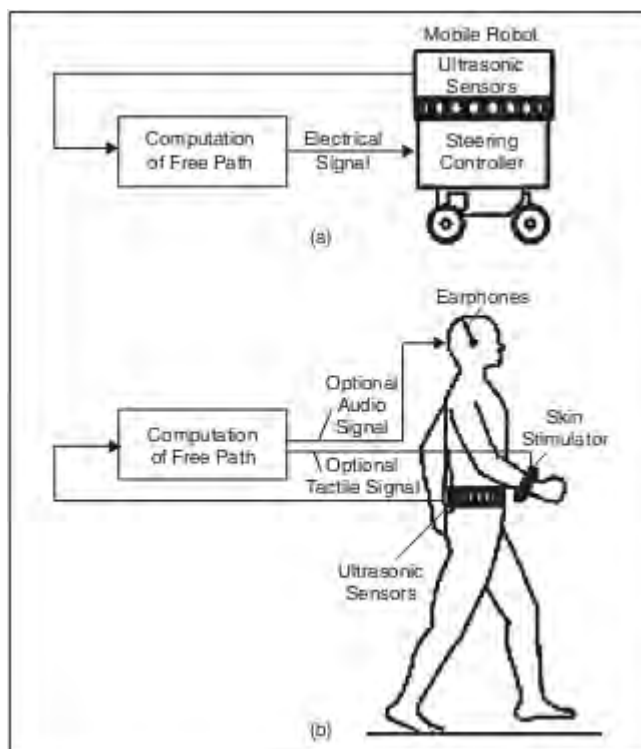
Figure 2.3 A mobile-robotics technology transfer to a portable navigation aid for the blind.[4]

In directional-guidance mode, a joystick or other suitable input device will be use by user to define a temporary target direction. For example, when the position of the joystick is neutral, the system will choose the current direction where the user face towards as default direction. If user wishes to turn left or right, user need to press the joystick in desired direction, and a temporary target is selected 5-m diagonally ahead of the user in that direction. NavBelt provides user with relevant information if an obstacle is detect to avoid it with minimal deviation from target direction.

2.2.3 Echolocation

This is a project that the mobility aid design out refer to bat's echolocation system. Two ultrasonic sensors are attached on the eyeglasses for detect the obstacle. This aid using microprocessor and A/D converter to down convert the data receive to a stereo

audible sound and sent it to user via headphones. The time different of the reflected ultrasound waves transmitted by the sensors show the different directions and sizes of obstacles, creating a form of localized sound images. [5]

2.2.4 vOICe

This project is using image to sound mapping concept. The prototype consists of a digital camera attached on the eyeglass, headphones and a portable computer with needed software (Figure 2.4). The digital camera will capture an image and the computer will use a direct, invertible one-to-one image-to sound mapping. The sound is sending to user through the headphones. This project will not filter the data to reduce the risk of filtering important information. Lately, the system will embedded the software into cellphone, thus user can use cellphone's camera and earphone. [6]

Figure 2.4 vOICe prototype. [7]

Table 2.1 Aid Devices Comparison

	GuideCane	NavBelt	Echolocation	vOICe	Smart Eye
Detection Device	Ultrasonic sensor	Ultrasonic sensor	Ultrasonic sensor	Digital camera	Ultrasonic sensor
Embedded system	Build-in Computer	Build-in Computer	Microprocessor	Portable Computer	Microprocessor
Feedback System	Servo motor	Acoustic signal	Audible Sound	Sound	Different Frequency Sound
Detection Range	Lower abdomen level	At abdomen level	Head level	Head level	Head level and above abdomen level

Table 2.2 Pair wise comparison table for aid devices features

Specification		A	B	C	D	Total	Weight
Detection Device	A		B	A	D	1	0.167
Embedded System	B			C	D	1	0.167
Feedback System	C				D	1	0.167
Detection Range	D					3	0.5
					Total	6	1.001

Table 2.3 Weighted Objective Table for aid devices

Specification	Weight	GuideCane	NavBelt	Echolocation	vOICe	Smart Eye
Detection Device	0.167	2	2	2	3	2
Embedded System	0.167	2	2	3	1	3
Feedback System	0.167	1	2	2	2	2
Detection Range	0.5	1	1	2	2	4
Total	1.001	1.335	1.502	2.169	2.002	3.169

2.2.5   Summary of Literature Review

All the literature reviews studied are related to products which will assist vision impaired person for daily use. Most of the project is using sensor as input for detecting the obstacle and use vibrator or sound as alert system to the user. For the GuideCane and NavBelt project, the position of the sensor placement can only detect the obstacle at abdomen or lower abdomen level. Both systems cannot ensure that the user can avoid from head level collision. The high quantity of sensor usage for both systems makes the product costly. For the echolocation project, the system is use for detect the obstacle at head level. It uses audible sound for feedback to user. This audible sound system is not comfort to user because when the product is longer use, the audible sound will become annoying to the

user. Two sonar sensors used in this system will not enough. This is because 2 quantities of sensors can only detect the obstacle in front of the user and cannot detect the obstacle beside of the user. The vOICe project is using image to sound concept. This project is using digital camera that attached to eye glass, a headphone for feedback and portable computer for software communicate. This project is not good enough because it need to bring along a portable computer during using it. It is heavy and not comfort when a user need brings a portable computer to walk around. So, this project is design out with 4 sonar sensor place on a spectacle for head-level obstacle detection control by microcontroller and sound system for alert system. In the weighted objective table, the Smart Eye gets 3.169 point, the highest point among the entire devices. This means that Smart Eye is better than other devices.

2.7   Sensor Comparison

In this section, the features of 3 different distance sensors will be list out and features comparison between these 3 sensors will be done.

2.7.1   PING)))™ Ultrasonic Distance Sensor (#28015) [10]

Ultrasonic distance sensor (Figure 2.5) provides a measurement range from about 2 cm to 3 meters. The ping))) sensor function by transmit an ultrasonic (well above human hearing range) burst and at the same time it providing an output pulse that corresponds to the time required for the burst echo to return to the sensor. The distance to target can be calculated by measuring the echo pulse width. The features for Ultrasonic Distance Sensor are show in table form (Table 2.4).

Figure 2.5 Ultrasonic Distance Sensor

Table 2.4 Features for Ultrasonic Distance Sensor

No.	Features	Quantity	Unit
1	Supply Voltage	5	VDC
2	Supply Current	30 – 35	mA
3	Range	2 – 300	cm
4	Burst Frequency for 200μs	40	kHz
5	Delay before next measurement	200	μs
6	Size	22 X 46 X 16	Mm^3
7	Weight	20	g
8	Price	80 – 180	RM

Theory of Operation

The PING))) sensor emitting a short ultrasonic burst and then "listening" for the echo that reflect from the object. The sensor emits a 40 kHz (ultrasonic) burst under the control of a host microcontroller. This burst will travels through the air at about 1130 feet per second, hits an object and then bounces back to the sensor. The PING))) sensor provides an output pulse when the ultrasonic burst is emitting and the pulse will terminate when the echo is detected. Hence, the width of this pulse is corresponding to the distance from sensor to the target.

2.7.2 Infrared Distance Sensor (GP2Y0A21YK0F) [9]

GP2Y0A21YK0F is an infrared distance measuring sensor unit (Figure 2.6) which integrated with combination of PSD (position sensitive detector), IRED (infrared emitting diode) and signal processing circuit. The variety of the reflectivity of the object, the environmental temperature and the operating duration are not influenced to the distance detection because of adopting the triangulation method. This device output the voltage corresponding to the detection distance. So this sensor can be used as a proximity sensor. The features of Infrared Distance Sensor are show in table form (Table 2.5).

Figure 2.6 Distance Sensor (GP2Y0A21YK0F)

Table 2.5 Features for Infrared Distance Sensor

No.	Features	Quantity	Unit
1	Supply Voltage	4.5 – 5.5	V
2	Consumption Current	30	mA
3	Range	10 – 80	cm
4	Response Time	38 ± 10	ms
5	Size	29.5 X 13 X 13.5	mm^3
6	Weight	3.5	g
7	Price	50 – 100	RM

Theory of Operation

A pulse of IR light is emitted by infrared emitting diode. This light will travels out in the field of view and either hits an object or just keep on going. In case there is no object, the light will never reflect. If the light reflects off an object, it returns to the position sensitive detector and creates a triangle between the point of reflection, the emitter, and the detector. The conductivity of position sensitive detector is depending on the position where the beam falls. The conductivity is converted to voltage and the distance can be calculated.

2.7.3   Laser Distance Sensor (MX1C)

MX1C is a type of laser distance sensor (Figure 2.7). Its detection range is 6cm to 160cm. The sensor is easy to align with its red laser.

Figure 2.7 Laser Sensor (URG-04LX-UG01)

Table 2.6 Feature for Laser Sensor

No.	Features	Quantity	Unit
1	Power Source	24	VDC
2	Current Consumption	200	mA
3	Range	6-16	cm
4	Operating Temperature	0 - 45	^{o}C
5	Size	50 x 21 x 78	mm^3
6	Weight	400	g
7	Price	3500-4000	RM