

DESIGN AND DEVELOPMENT OF OBSTACLE DETECTION AND WARNING DEVICE FOR ABOVE ABDOMEN LEVEL

Kassim A.M., Jamri, M.S., Aras, M.S.M, Rashid, M.Z.A Yaacob M.R
Faculty of Electrical Engineering,
Universiti Teknikal Malaysia Melaka (UTeM),
Hang Tuah Jaya,
76109, Durian Tunggal,
Melaka, Malaysia
anuar@utem.edu.my

Abstract: This paper discussed on design and development of obstacle detection and warning device which is used for above abdomen level of human in order to support and guide the visually impaired person. This electronic device is an innovation product to support and help those visually impaired person such to have their own confident to travel independently. In the developed obstacle detection and warning device, the distance measurement sensor is used to detect the obstacles and headphone is used as the warning device to give the obstacle information to the user. The distance measurement sensor's input is processed via main controller and gives the warning signal to the headphone. The power supply is came from battery and also acquire from alternative energy such as solar energy in order to charge the battery. The proposed warning system is to combine the vibration method with audio method. The vibration method is the best solution to warn the visually impaired person because it uses touch sense of human when the system is run. In this paper, the effectiveness of the system gives command the direction of obstacle existence is very important and have been confirmed through simulation and experiment.

Keywords: Obstacle detection, warning system, visually impairment person, above abdomen level

1. INTRODUCTION

In early 2010, the Organization of the United Nations (UN) has been released the statistic that people with disabilities (PWDs) in the world are ten percent of the total population. Therefore, 80 percent of the disabled are located in developing countries from the calculated number. In addition, instead of Malaysia has a population of about 28 million people, the number of disabled persons in Malaysia is estimated at 2.8 million people. However, the numbers of people with disabilities which are registered with the Social Welfare Department (JKM) are only about 280 thousand people which are 12 percent of the estimated population of the disabled in our country [1]. This total number does not reflect to the real situation of disabled people in this country. Most of the disabled are ignored by the government, which they need not be considered.

The disabled should be given priority, but in the context of Malaysia, disabled people are not advanced, but often ignored. Malaysia has signed the Convention on the Rights of Disabled Association of the United Nations, but the rights of disabled persons are not granted equally. The convention guarantees that the disabled enjoy equal opportunities with those efforts as well as full and effective participation in society in all aspects of life - accessibility, mobility, health, education, employment, rehabilitation and participation in the political, economic and socio-cultural.

On the other hand, the disable person can be categorized in some classes such as deaf, visually impaired, physically disability and etc. However, almost of disabilities who always involved in great danger is visually impaired person. Recent years, almost of the

visually impaired person normally use white cane to travel from one place to another place. However, the one of the major problem by using white cane is the difficult to determine where the locations of obstacle are existed. Additionally, the disadvantage of the white cane is the obstacles can be detected only by contact. This problem will expose the users to danger situation when the visually impaired man is very close to obstacles [3]. Hence, there are a lot of researches that have been actively researched is a supporting device for visually impaired people. The machines that have been researched are electronic travel aids (ETAs), mobile robots, wearable travel aids, e.g. NavBelt, and guide canes and Robotic-cane [3-11]. Portability of guide cane type is the main advantage.

However, the decision maker of the system is a controller which controls the motor at the wheel to turn or go straight for researched machines. Consequently, it will give hidden damage to the user's brain where their brain cannot actively use as decision maker. The main requirements of the assistive device for visually impaired person are safety, practicality, portability and convenience. Safety is the basic requirement to judge whether an assistive device is reliable or not. The most important task for the visually impaired persons is to gain information on the circumstances of the road and the location of obstacle. By using the collected information, the visually impaired person needs to arrive at their destinations avoiding unexpected obstacles.

In this paper, the spectacle type of obstacle detection and warning system in order to guide and support the visually impaired person for above abdomen level is described. This intelligent travel aid device is

s called SMART EYE which replaces the eye of visually impaired person and not their brain. In addition, the warning system will assist them to detect the location of obstacles by using distance measurement sensor. Then, when the obstacles are detected (by distance sensor), the warning signal will be given immediately to the visually impaired person through vibrator and sound directly to the user's skin with the suitable strength via microcontroller. Therefore, it will help the visually impaired person to change the path or direction without collide with obstacles thus saving time and reduce the risk of accidents.

2. DEVELOPED SMART EYE

2.1 Device Construction

Figure 1 show the developed intelligent travel aid device which is consisted with spectacle including the distance measurement sensor, vibrator, controller box and earphone. The conceptual design of the product is to develop an effective warning system with low cost budget by applying the universal design in order to make the user comfortable to use. On the other hand, this product is designed light, compact and adjustable as the user-friendly aspects to fit to everyone who needs it. Hence, all visually impaired people in this world may travel independently.

On the other hand, the application of green technology, this product is designed with rechargeable power supply by using solar panel which is mounted on the top of device in order to supply electrical power to the main controller and sensor. Additionally, the earphone is applied as one of the warning device by using sound to guide the visually impaired person about the location of obstacle around.

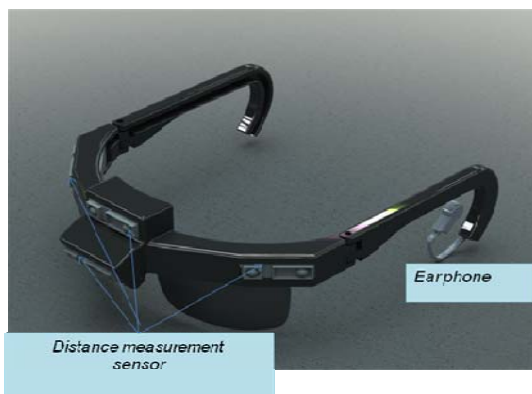


Figure 1. Developed "SMART EYE"

2.2 Experimental Setup

Figure 2 shows the configuration of the system in order to generate the vibration and sound warning system from the vibrator and the earphone. In SMART EYE system, the vibrator and earphone was chosen to give warn to the user once the obstacles was detected. From Fig. 2, the system of SMART EYE consists of obstacles detection by using distance measurement as an

input from four pieces of ultrasonic sensor which are used and located at the developed spectacle in order to measure the distance of obstacles front, right, left and down. The measured data from ultrasonic sensor will be transferred to PIC microcontroller. If the distance for front sensor from the obstacles is more than 150 cm, the vibrator and earphone will not be activated. Else, if the measured distance data is less or same 150 cm, the vibrator and earphone will be activated through PIC microcontroller and generate by using H-bridge motor driver by applying Pulse Width Modulation (PWM). At the same time, the power supply for SMART EYE is rechargeable battery that can be charging using DC adapter while at home and PV panel when the system run at outdoor.

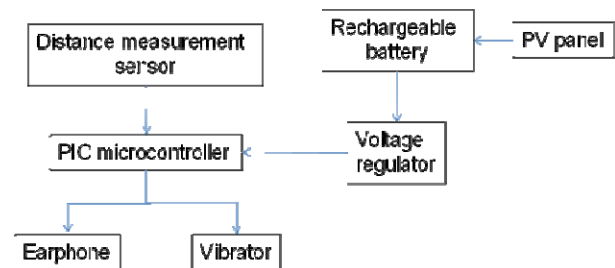


Figure 2. Experimental Setup

On the other hand, the directional angle which has been designed for locating the ultrasonic sensor can be illustrated as Fig. 3. This developed SMART EYE is used like a normal spectacle where mounted at human's forehead. In order to keep the safety of user, the limitation of front sensor is determined to 150 cm. Therefore, user can stop and easily from the obstacle because the distance of user from the obstacle still have about 150 cm. In addition, the sensor for down sensor also has special functions which can be used to detect wall or hanging object. If the measured distance for down's sensor is over than 160 cm which are 10 cm longer than set length, it means there is hanging object in front. Else, if the measured distance for down's sensor is less than 140 cm which are 10 cm longer that set length, it means there is wall in front.

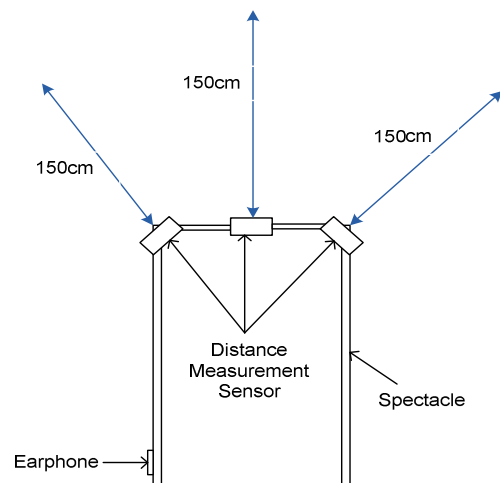


Figure 3. Directional angle for obstacle detection

3. PROPOSED WARNING SYSTEM

3.1 Vibration and sound system

For the proposed warning system, the vibration type and sound type system is the best solution as a warning system for the visually impaired person because it applied the touch sense of human and hear sense as medium of communication between device and human when the system is run. The human's sense of touch and hear is the very suitable sense for visually impaired person to know the circumstances around because it gives direct connection to the user. Technically, four pieces of vibrator are mounted to the gloves at different location. Each location have its own function that show distance inputs (sensor) from different direction such as front, left, right and down which can be illustrated in Fig. 4. The obstacle's distance is inputted to the controller and gives some command to vibrator while obstacle is detected.

In addition, the sound system for warning device is use only a earphone to generate the DO, RE, MI and FA beep signal to differentiate the location of obstacle for front, down, left and right. The different sound can be generated by using the setting of frequency in the program. The beep signal also will be generated parallel with vibration method in order to ease the user to differentiate the sound. The strength of the beep also can be adjusted by adjusting the resistor. The type of vibrator which is used in the proposed warning system is flat coreless vibrator that can be illustrated in Fig. 4.

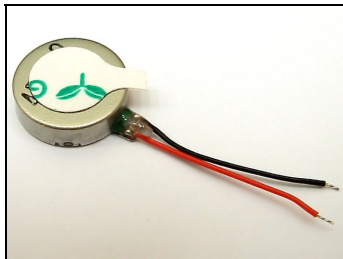


Figure 4. Flat Coreless Vibrator

Table 2. Specification Of Vibrator

Specification	Unit	Value
Voltage supply	V	2.7 – 3.3
Rated speed	rpm	12000
Rated current	mA	100
Vibration amplitude	G	0.4
Weight	g	0.7
Dimension	mm	8.0 x 3.4 (D xL)

From the table, the value of standard voltage is 3V and the operating voltage range is 2.7V-3.3V. The speed of vibrator is controlled by Pulse Width Modulation (PWM) on PIC16F84A at controller. The vibrator is one type of DC Motor and need a motor driver to control the motor. In this system, the IC type H-bridge motor driver is used in order to drive the vibrator successfully.

3.2 Simulation

The proposed warning system uses the PIC microcontroller made by Microchip as a main controller to control the system. The integrated chip(IC) that use is PIC16F84A and all the programming made is compiling to PIC16F84A by using PIC burner. The program is simulating at microcontroller software (MikroC) and the Proteus 7 software is chosen to simulate the program. First at all, the program is made to give a pulse “on” and “off” of the motor without receive data from input. Then the program will test based on the simulation at Proteus 7 software.

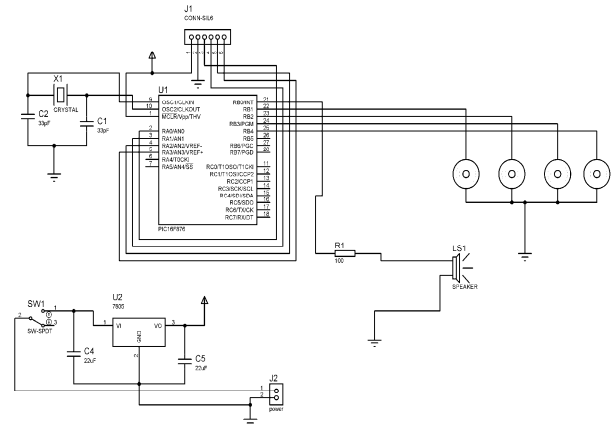


Figure 5. Schematic diagram by using Proteus

After the simulation phase, the second step is proceeding by using real time distance measurement signal as input.. The vibrator is set at different value of Pulse Width Modulation (PWM) to give a different speed at different distance. The strength of the beep also set to be low or high depend to the distance. Next, the real programming that receives an input from distance measurement is build after the design of prototype is done. The programming is needed to merge with the distance measurement from the other parts to get the input data. Figure 5 shows the schematic diagram which are designed to evaluate the validity of the proposed experimental setup.

4. EXPERIMENTAL RESULT

In order to evaluate the effectiveness the proposed warning system which has been developed in SMART EYE device, the simulation program by using Proteus is designed. From the figure, the PIC16F84A as a PIC controller and four pieces of DC motor as vibrator are used in the designed spectacle. Before start the simulation, the programming is compiled to the MikroC at first. Then, the simulation is run. As the consequences, the result shows the warning signals are generated by vibrator and earphone synchronously after detecting the obstacle. The vibrator is activated while detecting the obstacle at front, right, and left and down.

The warning system by using vibrator and earphone is very effective to realize on this travel assistive device for visually impaired person. The vibrator is a good

device to give fast responses; long time performance and safe to use without have a high risk of health problem. The different strength of the vibration and sound can be produced when detecting different distance to the obstacles.

The flat coreless vibrator is used in the developed SMART EYE because it has a small diameter and the operating voltage is suitable for human being. Microcontroller is use to make a complete programming and then is simulate at the Proteus. The best strength of using the vibration and sound is determined by survey and get the feedback from the user. The project is low cost project with using the cheap but effective component like vibrator and earphone because most visually impaired men belong to lower income group.

5. CONCLUSIONS

In this paper, the travel assistive device for visually impaired person is designed and developed. In addition, the simulation program has been conducted by using Proteus and the experiments on proposed warning system for the developed SMART EYE. Firstly, the designed simulation program is effectively activated when each vibrator and earphone run with synchronously. Besides, the effectiveness of this developed SMART EYE also confirmed when the vibrator at developed device are vibrated if the obstacles are detected. The vibrator is vibrated according to the direction of obstacle which has been detected.

In the future, the more advanced assistive device for visually impaired person which is using audio visual system and navigation system. In addition, more experiments and specimen will be conducted when the visually impaired person is at crowded people such as supermarket and obstacle avoidance for high speed movement such as car or ant transport.

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