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Performance Study of Developed SMART EYE for Visually Impaired Person.

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ABSTRACT

Background: Direction is arguably the most pressing concern for visually impaired person. Nevertheless, we lack a convenient navigation system to guide a visually impaired person using point to point direction to reach desired destination independently while walking on tactile paving. Accessibility of this navigation system must be convenient and simple for visually impaired people. In order to provide an efficient and user friendly assistive tool, it is proposed to design and develop a navigation system using Radio Frequency Identification (RFID) to guide the visually impaired walking on tactile paving. Path planning algorithm will be implemented in this project to give the shortest path and direction as a navigation guide for visually impaired people. This project will directly contribute to society by making available a convenient navigation system for visually impaired people for a better lifestyle.

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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 (Country Report, 2009). 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(Katherine *et al*., 2007).

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 (Shoval *et al*., 2003). 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. (Borenstein and Ulrich, 1997), NavBelt (Shoval *et al*., 2003), Echolocation (Ifukube *et al*., 1991), My 2nd Eye (Kassim *et al*., 2011) and others. 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

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person are safety, practicability, 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 (Munetatsu, 2008), (Kassim *et al*., 2012, 2013), (Yaacob, 2012).

In this paper, the development and performances study 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 which is called SMART EYE. This developed SMART EYE 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. In this paper, the performances and effectiveness of distance measurement sensor in order to identify the blind spot and detect the obstacles is confirmed through experiments.

MATERIAL AND METHOD

***Electronic Spectacle 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.

Fig. 1: Illustration of developed SMART EYE.

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.

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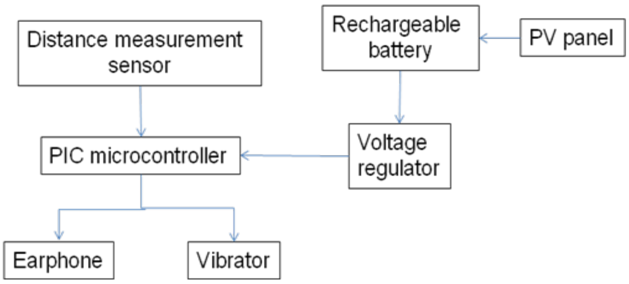
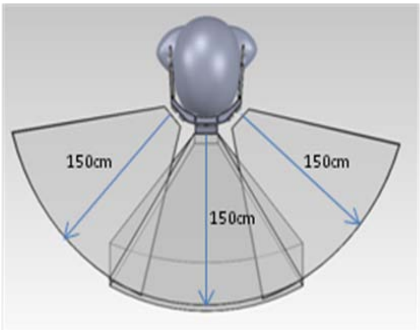
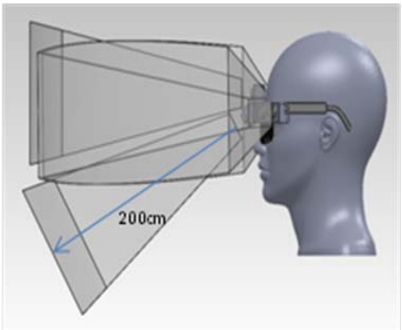


Fig. 2: Experimental Setup.

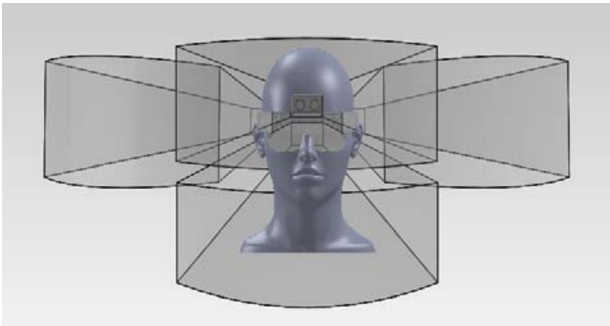
On the other hand, the directional angle which has been designed for locating the ultrasonic sensor can be illustrated as Fig. 3. This developed SMART EYE is used like a normal spectacle where mounted at human's forehead. In order to keep the safety of user, the limitation of front sensor is determined 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 210 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 190 cm which are 10 cm shorter that set length, it means there is wall in front.



(a)Top view



(b) Side view



(c) Front view

Fig. 3: Directional angle for obstacle detection.

Experimental Setup:

In order to evaluate the effectiveness of developed SMART EYE, the experimental setup is set. Figure 4 shows the experimental setup for evaluation the blind spot of the develop SMART EYE. The apparatus used such as tripod, developed SMART EYE, measuring tape and protractor. The developed SMART EYE device was installed on a tripod. A cardboard with angle was placed below the SMART EYE device with the centre of the angle is same with centre of the SMART EYE device. The developed SMART EYE device will be activated and obstacle will be moved in front of the device horizontally from 0º until 180º slowly form left to right. Same method also applied for the experiment for front and down sensor. The obstacle will be moved from up to down vertically from 0º until 180º.

(a) For front, right and left sensor (b) For front and down sensor

Fig. 4: Blind spot experimental setup.

Fig. 5: Performance test while walking motion.

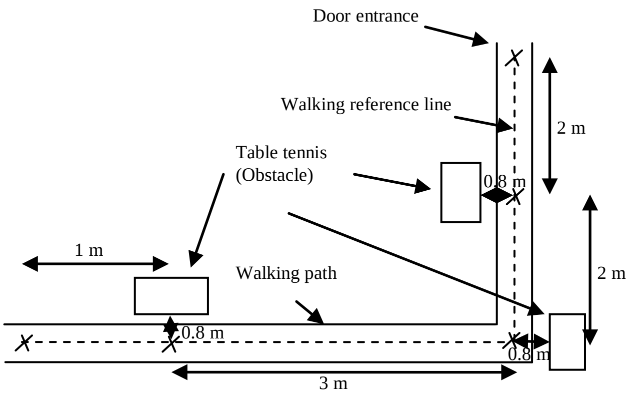
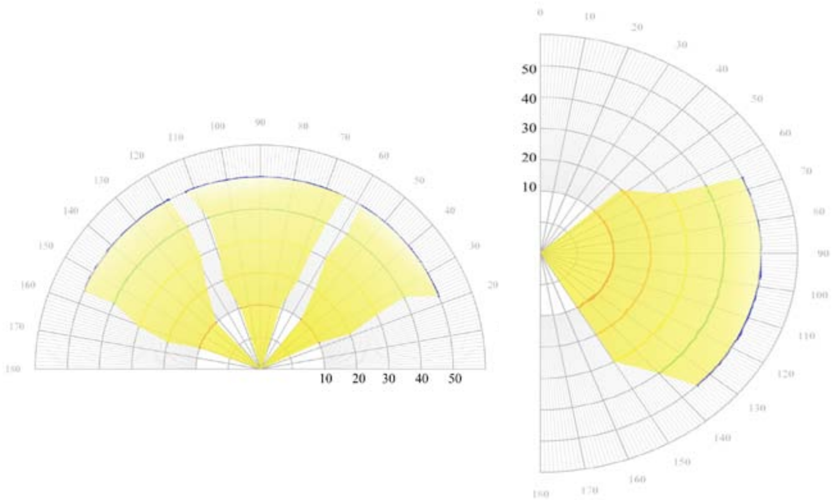


Fig. 6: Floor layout of obstacles displacement.

In addition, the experiment to evaluate the performance of the device while walking is conducted. Figure 5 shows the performances test for the developed SMART EYE while walking motion. The apparatus which are used are measuring tape, SMART EYE, MMC card circuit, obstacle(table ping pong), tripod with 2 wheels installed at stand. The developed SMART EYE is installed on the tripod. Four obstacles were placed along a track. The distance from the obstacle to the track was set to 80 cm and the point was marking down as refer point for each obstacle as shown Figure 6. The distance between start point to obstacle, obstacle to next obstacle and obstacle to end point will be recorded.

RESULT AND DISCUSSION

From the experiments which have been done, the blind spot of the device is evaluated. Figure 7(a) is a graph that shows as a result for the experiment for front, left and right sensor. The graph show that the angle detection ranges for the device is increase directly proportional to distance from the device. The graph shows that there are two blind spots for the device. For the left sensor, the line of beam is not smooth and there is distortion occur on the distance 10 cm and 20 cm. The distortion also occurs for right sensor at distance 40 cm far from SMART EYE. Figure 7(b) shows the degree graph for experiment for front and down sensors. This graph shows the sensor detection range for vertical means is the range of detection in front of user. The graph show that the detection range is decreasing means it is inversely proportional to distance. From the graph, it show that there are two distortion occurs which is in distance of 20 cm and 30 cm. The sensors detection range is more to downward for this device.

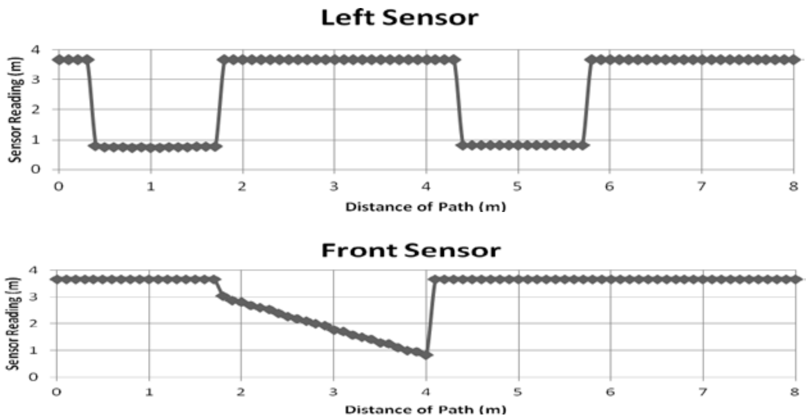


(a) For front, right and left sensor (b) For front and down sensor

Fig. 7: Blind spot experimental result.

The blind spot occur because of the strength of the sonar signals is concentrated in centre of the beam and with some lobes beside. The lobe beside has week signal. For the distortion case, the obstacle is on the lobe position for the ultrasonic sensor. So some errors occur like the obstacle cannot be detected although the obstacle is within the sensor detection range. In addition, the performances test for walking motion is conducted. Figure 8 shows the experimental result for walking motion. From the Figure 8, the graph for 0.4 m until 1.7 m and 4.4 m until 5.7 m show approximate 0.8 m. This is because there are obstacles place beside the way for that path.

For front and down sensor, the graph are similar because of the obstacle which have been set for the path is same for front and down sensor. The reading start drop from 1.8 m until 4 m. This happen because of in the experiment the device is pushing closer to an obstacle. For right sensor, there is approximate 0.8 m show on ultrasonic sensor data for the path from 4 m until 4.6 m. This is because the obstacle is place for that path to test the right sensor. For walking experiment, the average accuracy for four of the sensor in the experiment is 97.95 %. It is because of the angle of reflect. The obstacle which have been used is table of table tennis. The table is placed beside the path and perpendicular to it. During the experiment, the side sensors sense the table with the angle that are not perpendicular to it, and this cause the accuracy cannot get 100%.



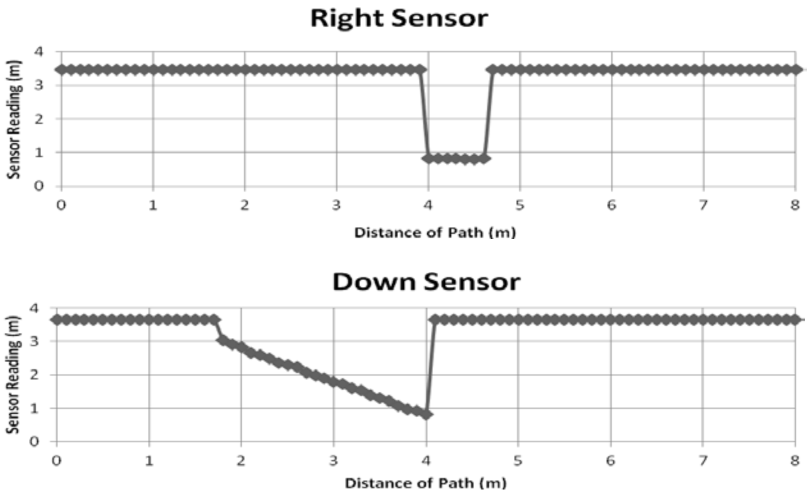


Fig. 8: Relation of reading range with reading position.

Conclusion:

In this paper, the prototype is developed and evaluated it's function. The SMART EYE device can detect the obstacle on head level and above abdomen level. The feedback is using sound system to alert user when the sonar sensor is detected. There are some angle designs for the sonar sensor to let the device detect the obstacle in the range above abdomen level. Some experiment has been done to test the blind spot of the SMART EYE device. The average accuracy for the sensor in experiment to compare the measurement value with the ideal value during walking is 97.95 %. There are also some error occur during experiment. Most of the errors occur due to the specification of ultrasonic sensor.

As recommendation, the sound alert system can be substitute with human voice and this will make the instruction more clearly. The project is just a prototype, for future work, other specification should be considered like battery duration and material for spectacle.

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