Design of Intelligent System for Visually Impaired to Access the Required Location

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***Abstract*—The percentage of blinds according to the world health organization is 0.4% of the population in industrialized countries and it rises to 1% in the developing countries.This paper aimed to help these categories of people to overcome their problems to move towards any location independently. The design in this paper specified three paths in the University of Gezira to help the visually impaired students to reach different places in the university campus easily. These paths were monitored and controlled using GPS and raspberry pi technology. Three switches were used to help the blind to select his path. An important feature was provided by this system, in which when the blind gets out of the selected path, the system automatically determined how far he is away from the path and a voice massage alerted him and guided him through headphone to return in the path. Ultrasonic sensors are used to alert for any detected obstacle along the path. Moreover, the system automatically calculated the distance between the blind and obstacle, which allows the blind to avoid it easily. This system informs the blind the distance that remains to reach to the required destination. The design has been experimentally tested and the results showed that the guiding system works correctly, which proved the ability to generalize this system in other places.**

***Index Terms*—GPS; Monitoring System; Ultrasonic Sensor; Raspberry Pi.**

I. INTRODUCTION

Realizing the difficulties faced by the visually impaired people to move freely without assistant, scientists around the world are trying to find solutions to address this issue [1]. Most of the works tend to find ways to improve the ability of detecting obstacles, while ignoring the inability of the visually impaired people to guide themselves freely without assistant. Besides cost, it is important for any assistive system for blind people, to consider the degree of assistance it can provide to the visually impaired people to enable them to move freely [2]. In this case, this paper presents an assistive system for the blind that combines the detecting and the guiding system in a single device. This guiding system adjusts the movement of the visually impired person within a specific path.

This system used Raspberry Pi3 technology to design an intelligent device for the blind. The design does not only offer obstacles detection but also guides them in specific paths to find their location easily on their own. The system is also optimized due to its low cost as the overall cost of the system is approximately $20. It is based on Raspberry pi technology, and represents a mini computer, which sized in single board.

II. RELATED WORKS

Many efforts all over the world are competing to propose designs that help visually impaired people to detect obstacles using different electronics technology. Table 1 shows a survey of related works, in which some of these works are based on microcontroller and some of them used GSM and GPS technology; but, most of them use ultrasonic sensor to detect obstacles. All these works are restricted to helping the blinds to detect obstacles and ignored the assistance to find their way on their own.

Table 1
Summary of Related Works

Author	Year	Description
Dan et al [3]	2007	This paper shows a design of obstacles detection. The design did not include a guding system and ignored measuring the distance between the blind and location.
Shruti et al [4]	2011	This paper presented a theoretical model based on microcontroller. The model is used to detect obstacles using ultrasonic sensor. It also used stereo camera to get information about the surrounding environment. It did not contain sound and text message, and did not include a guiding system to assist the impired to reach his destination correctly.
Abdellah [5]	2013	This paper is based on microcontroller. It offered to detect obstacles and indicate the location of the blind via GSM massage. Unlike our proposed syste, which is not limited on indicating the location of the blind, it helps him to reach to his desired place.
Sangami, et al [6]	2015	This paper presented obsacales detecting device. The design is based on microcontroller and used GPS to find the location of the blind people. The paper used ultrasonic sensor to detect obstacles.
Ayush, et al [7]	2016	As most of the existed published papers, this paper presented an obstacle detecting system through ultrasonic sensor. It used the raspberry pi 2 as a control device,instead of the microcontroller technology. The paper did not include a design of guiding system.
Hninn,et al [8]	2016	This paper also used ultrasonic sensors for detecting obstacles. It explained an automatic control design of stick movement to avoid the obstacles based on microcontroller and servo motor.
Hemanth et al [9]	2016	This paper offered obstacles detection, which helps the blinds to recognize where they are located using headphone. It is not provided with a guiding system to behave as electronic eye.
Jismi et al [10]	2017	This design is based on raspberry pi device, connected to a camera used to detect obstacles without illustration, the distance between the blind and the location.
Premi [11]	2018	This system is only used to detect obstacles. The design is based on Arduino, which is connected to a camera used to detect obstacles. The design used GSM technology to alert the blind about the obstacles.

Author	Year	Description
Uruba et al [12]	2018	This design is limited on the obstacles detection based on arduino and used three ultrasonic sensors. Unlike our proposed system, this system used electronic eye to detect obstacles, to calculate the distance between blind and obstacle, distance between blind and his desired place and guided him to reach this place. Our design also has the advantage of using raspberry pi technology which has modern features.

III. METHODOLOGY

The presented system in this paper consists of two parts, hardware and software implementation. The design block diagram is shown in Figure 1. It consists of Raspberry Pi 3, GPS, headphone and switches.

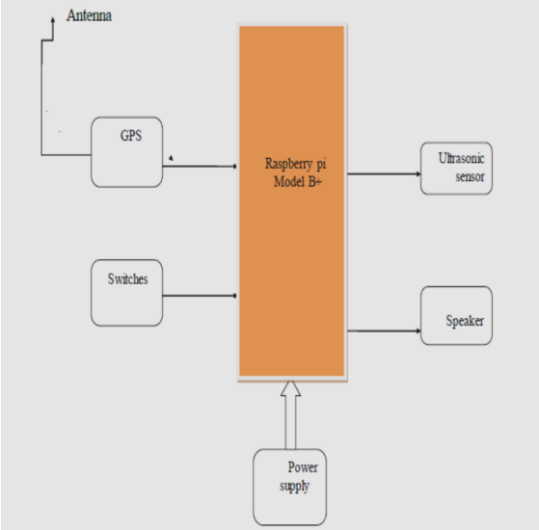

Figure 1: Block diagram

As shown in Figure 2, the circuit design contains three switches, which is used to specify the required path to the required location. This system requires a 5V power supply. It can be provided by using a battery, portable charger, micro USB or a rectifier circuit as the input power source.

Generally, the summarized operation method demonstrate how the blind can access to the three tracks, which can be done by specifying the path in the map located in the Internet. The path is saved in the form of points in a file through the controller GPS device. Data is received from satellites in the form of Nemea protocol.

By calculating the distance and specifying the direction, in which the blind is located, the system is guding the blind to reach the path. The final design fixed on a stick, as shown in Figure 3.

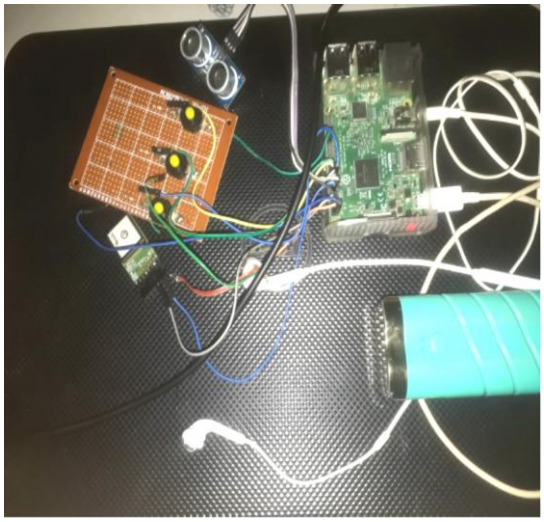

Figure 2: Schematic circuit

Figure 3: Final design

Figure 4 shows how ultrasonic sensor can be used to detect the obstacles, the ultrasonic sensor consists of transmitter and receiver. When an obstacle exists in the range of the sensor, the transmitted pulse hits the obstacles and returns back to receiver; thus the distance can be calculated. The distance between the obstacle and the blind can be given by:

$$Distance = speed * time \quad (1)$$

$$D = [(Speed\ of\ Sound * Time\ Taken) / 2] \quad (2)$$

where: D = Distance between an obstacle and the blind (meter)
Speed of Sound = 343 (meter/sec)
Time Taken = Time interval between the pulse emitted and the pulse received.

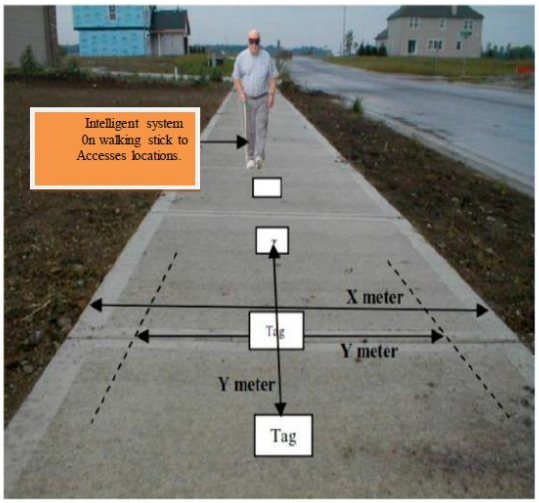

Figure 4: Obsticales detection using ultrasonic

Python language was used to implement the software of Raspberry Pi. Figure 5 shows the operation algorithm of detecting the obstacles mechanism in the paths. Figure 6 illustrates the mechanism of selecting the desired path and the steps used in accessing the required location. If the blind is out of the path, the system will continuously measure the distance he is deviating and alert him to get in the path again.

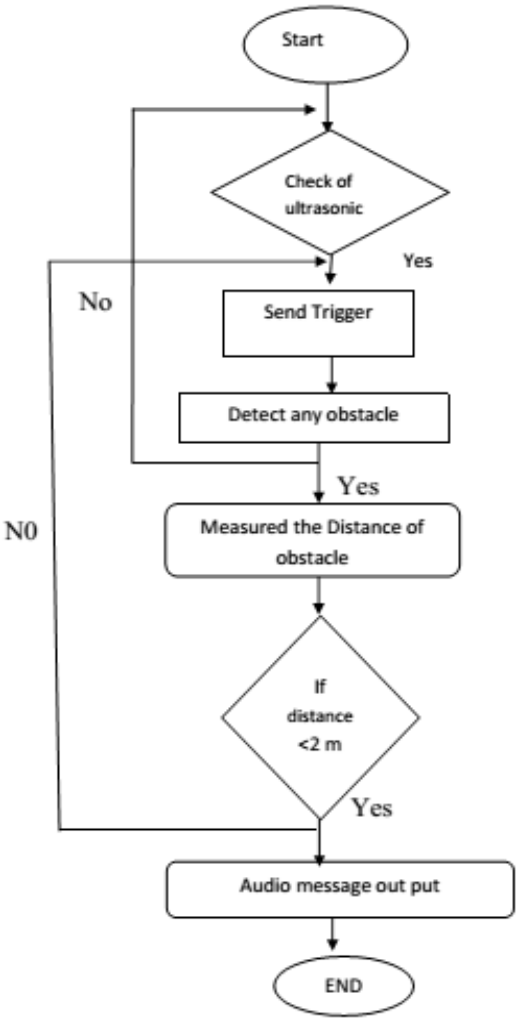

Figure 5: Flowchart of detecting obstacle

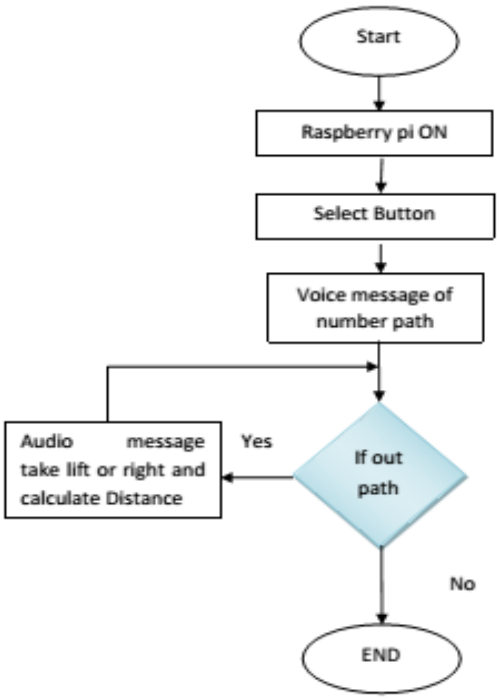

Figure 6: Selecting the path

IV. Results And Discussion

The design was examined experimentally. The following results shown in this section explained how the the desired path can be selected using the switches and how the obstacles detecting system works, and finally the results showed and experiment of how the guiding system operate.

A. Obstacles Detection System

In the case of the existance of obstacle in the path, the device can detect it by using ultrasonic sensors.. Figure 7 illustrates the result when an obstacle is set in the paths, the distance between blind and obstacle can be detected and calculated using ultrasonic sensors. A voice message will alert the blind that there is an obstacle in front of him.

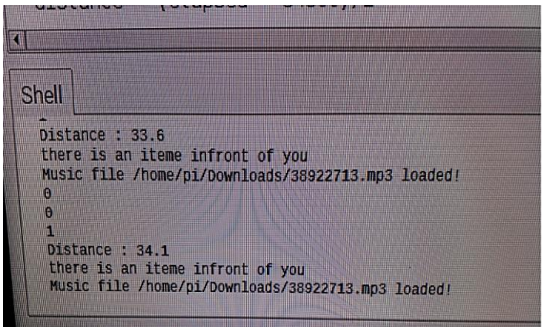

Figure 7: Detected of obstacle

As shown in the previous result, the system informs the blind that there is obstacle infront of him about 33 cm. In the case that the blind exit from the pathway, the system alerts the blind and guide him to get into the path again. It gives voice alert saying “take right” or “take left “ to reach the pathway, with an audio message to explain the distance from the pathway. The system also informs the blind for the remaining distance needed to reach the required place, as shown in Figure 8.

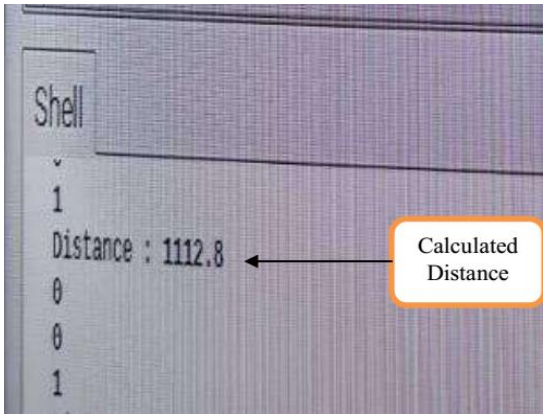

Figure 8: Distance from the path

B. Guiding System

When a pathway is chosen by pressing one of the switches, the active switch will take the value one to access the desired location, as shown in Figure 9.

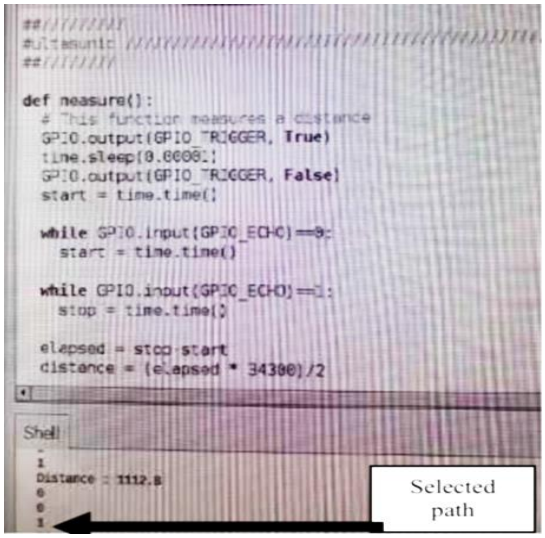

Figure 9: Select of switches

In this system, there are three switches used to help the blind to reach three locations. (0) means switch path OFF, (1)means ON. By pressing one of the switches only, the status of selected one will appear as true Position "1", the other switches will have false status "0", which refers to not worked status. Easy access to reach the location is the most important part of this paper. The tracking experiment was done in University of the Gezira as an example, but it can be generalized for all sites. This experiment was done using a specific map, as shown in Figure 10. The path appeared as points in the Google map. The results of the experiment showed how the blind moved successfully from the university bus station to the university campus.

Similarly, the system was tested, as shown in Figure 11. In this test, the blind student used the device to find the college block coming from student campus in university.

The third path shown in Figure 12 joined the student campus and the main classroom.

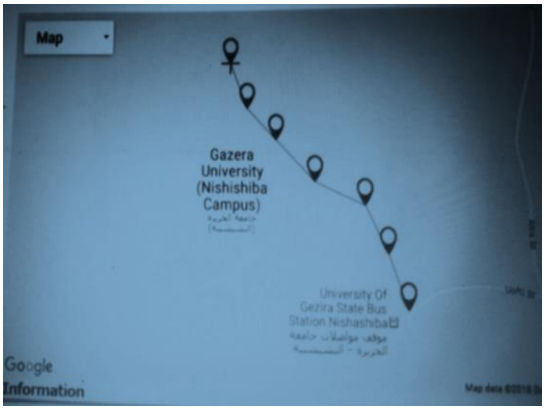

Figure 10: Location map of the first path

Figure 11: Path two

Figure 12: Path three

V. CONCLUSION

The intelligent system in this paper was exclusively designed for visually impaired people. It allows the visually impaired person to walk in an unfamiliar environment without fear. The blind is able to arrive any location. It can be said that the design provides electronic eye for visually impaired people. The results examined in three paths, but it is not restricted, and any number of paths can be added easily.

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