Intelligent Stick For Visually Impaired People

Umber Waraich, Dr. Muhammad Shafique,Qurat-ul-ain, Arsalan Habib
Biomedical Engineering Department, Riphah International University, Islamabad, Pakistan
*University of Electronic Science and Technology, China

Abstract

The significant developments has been made in field of rehabilitation in last few decades. Noticeable improvements can be seen in the commercially available devices for the help of visually impaired people. In spite of the current advance technology, this area still needs highly efficient and smart tools that can help such people in moving smoothly and with freedom. This study proposes the use of an open-source single-board computer Raspberry Pi to assemble a device for visually impaired people. The ultrasonic sensor was successfully interfaced with the Raspberry Pi board and measured the distance from the target or obstacle. The obstacle was detected online on Raspberry Pi board and the presence of obstacle was identified by the sound beep of different intensities.

Key words—embedded board; obstacle; algorithm; interfacing.

I. INTRODUCTION

The project presented in this document is established on the use of novel technology for visually compromised persons to increase their mobility. Visually impaired people agonise from the toughest communication lack; they cannot sufficiently substitute vital communication passages (vision). Agreeing to WHO (World Health Organization) information sheet of 2012, here are 285 million blind persons and 90% of visually impaired people breathing in developing countries [1].Visually impaired people use cane for their directions, when they pace or travel away from their residences. Some people also have skilled dogs or cats but their live is simply 3 years [2]. This project helps to escape hurdles by using intelligent stick with Raspberry Pi board as well as Ultrasonic unit. Raspberry pi is used as a treating unit. It controls the transducer coupled with it.

The projected stick is low budget, manageable and at ease to use. The individual can use it after a slight teaching. The stick is a supplement of traditional walking stick.

Visually impaired people face difficulties to interact with environment. They are unable to easily distinguish between the things surrounding them and unable to know where they are and where they want to be. These people are relying on their family or pets for their mobility. There are several systems designed for them but these systems have certain limitations and some systems are only for indoor activities. Some systems are costly, some systems are very heavy and cause fatigue to user and some systems are quite complex required proper training to use them.

The intelligent stick (by Sung Jae Kang, Young ho and Kim) uses ultrasonic sensor with two DC motors and microcontroller .This stick detects front-back and left-right distance, C++ software is used for simulation. This stick is quite heavy; its weight is 4kg [3].

Assistive cane for visually impaired (by International Journal of Computer Science issues), it uses servo motors which is controlled by built in computer. It uses ten ultrasonic sensors for distance detection. It has a joystick on its handle which allows user to determine direction of motion and it has microcontroller to control its system. This smart cane is quite heavy and costly [4].

S. Innet and N. Ritnoom designed a stick for distance measurement using infrared sensors. The stick has different vibration modes for different ranges. It has complex system and different vibration modes are not easily recognized by user [5].

II. METHODOLOGY

The headphone is connected to Raspberry Pi board to give audio output (when the sonar waves strike with the obstacle in its path and received by the receiver, the audio output can be heard by headphone.). The block diagram of the system is shown in figure 1.

A. Hardware

The ultrasonic sensor is connected with embedded board and feeds the distance data to Raspberry Pi.The Raspberry Pi is small credit card sized workstation having ARM 1176JFZ-S processor. It is a cheap and small computer and has a hardware GPIO pin that allows it to connect with different boards and sensors. It has a Broadcom system BCM2835 on chip [6].

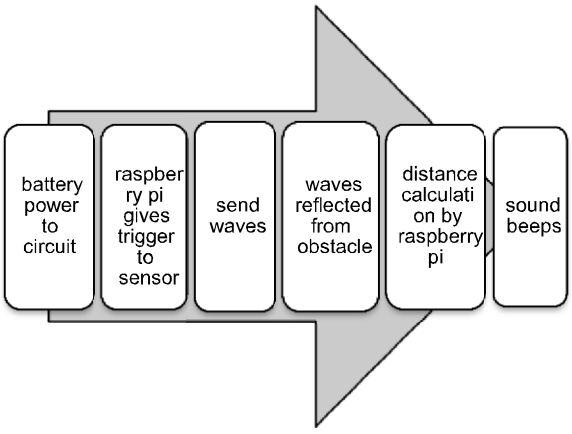

Figure 1. Block diagram explaining the working of Respberry Pi and ultrasonic sensor.

The board is used in project to use this technology for the welfare of visually impaired people and enable them to move without any injury or hesitation. MODEL-B having 512MB RAM is used. It does not have built in hard disk and have SD card for booting and memory storing.

The objective of this device is to measure distance accurately and on identifying obstacle it reflects back to the receiver, in this manner the concept of ultrasonic

waves are used for practical application. The ultrasonic transducer is used to detect the obstacle in its path and then the distance is calculated. It provides non-contact distance measurement from 2cm to 400cm, the ranging accuracy can reach up to 3mm and it uses sonar for detection. It has transmitter and receiver. Its action is not exaggerated by sunshine or dark material. It works on 5V power supply.

B. Sensor

Ultrasonic sensor is also called transceivers. These devicesproduce high frequency sound waves and calculate the echo which is acknowledged back by the measuring device.

Ultrasound Receiver is device that detects the ultrasonic waves and converts the ultrasonic energy into voltage so that it can be processed further.

Ultrasound Transmitter converts the electrical signal into ultrasonic waves; this ultrasonic beam of wave is transmitted and reflected back after hitting the target. The obstacles detection of sensor is explained in figure 2.

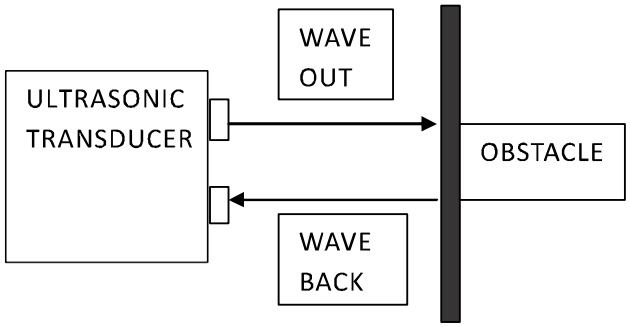

Figure 2 Obstacle detection by sensor

The sensor works on the principle of sonar which detects the object by reflected echoes. The module is triggered by giving 10us pulse at trig pin, and then it sends 8-10 pulses of 40 kHz and detects the echo bouncing back after striking from obstacle. If there is the signal or echo back then the echo line is pulled up for high for the duration which is taken by the echo to travel to the object and then return back [7].

The sensor is interfaced with Raspberry Pi board by the GPIO pins. The ultrasonic sensor is connected with GPIO pins, these pins are activated by installing the *BCM2835* library which enables us to access the GPIO pins. It provides access to GPIO pins and other IO functions of the BROADCOM chip. It has single non-shared header file [8].

The sensor has four pins which are attached with GPIO pins of Raspberry Pi.

* Echo would be low (0V) until the sensor is triggered when it receives the echo pulse.
* When the pulse reflects back, echo is set to high 5V for the duration of that pulse.

Pulse duration is the full time between the sensor outputting the ultrasonic pulse and reflected pulse detected by the receiver.

* The pin labelled Vcc is connected with GPIO Pin 2 (+5v).
* The trigger pin is coupledby GPIO Pin 23
* The echo pin is joined with GPIO Pin 24 and by two resistors 330 ohm and 470 ohm in series respectively.
* The ground pin is linked with the GPIO Ground pin as well as resistor of 470 ohm.

The GPIO pins on the Raspberry Pi is unprotected and is only rated for 3.3v whereas ultrasonic sensor required 5v so the resistors are connected with each pin to avoid any damage to GPIO pins.

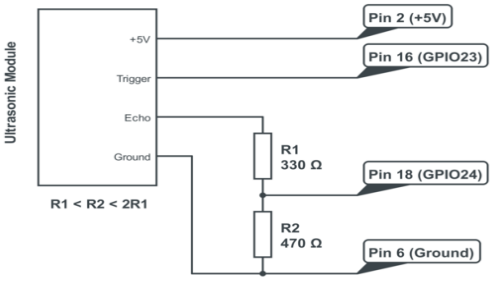

Figure 3 Sensor connections with gpio pins

Connections of sensor with GPIO pins are explained in figure 3.

* The code is in python language and is typed in Geany Python template. The program is compiled and executed successfully.
* The code is recalled in LX Terminal of Raspberry Pi.
* The signals are sent to GPIO pins according to the coding.
* The sensor is attached with GPIO PINS as mentioned above.
* Sensor receives the electrical signal and converts this electrical trigger to ultrasonic wave which is transmitted by the transmitter.
* These transmitted waves after striking with the target are reflected back to receiver.
* Receiver receives this data to raspberry pi where the distance is calculated according to given formula

Speed= distance/time
Where speed of sound is 340m/s
34000cm/s = distance/ time/2

The connections in actual circuit are explained in figure 4.

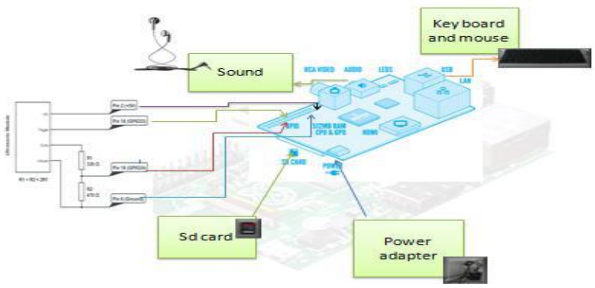

Figure 4 Connections in actual circuit

C. Software

Python is a programming language; it is used to integrate systems more effectively and is also used in Raspberry Pi. It is a power flexible programming language. Python is published under an open source licence [9].

The PYTHON library is already installed with the operating system RASPBIAN.

The algorithm is implemented in PYTHON. The time taken by the sound wave to transmit and reflected back to receiver is measured to conclude the distance of the thing.

III. RESULTS

The device successfully measures the distance and measured distance is displayed on monitor screen. The ultrasonic sensor and board is attached with stick enclosed in the box and is provided with switch for easy control access and gives audio feedback. Standard deviations of actual and measured results are shown in table 1.

Table 1. Standard Deviation of Actual and Meausred Distance

Sr . No	Actual Distance	Measured Distance	Standard Deviation
1.	12cm	12.6cm	0.057735
		12.6cm	
		12.6cm	
2.	33cm	33.3cm	0.251661
		33.5cm	
		33.8cm	
3.	59cm	59.4cm	0
		59.4cm	
		59.4cm	
4.	112cm	112.7cm	0.23094
		112.3cm	
		112.3cm	
5.	203cm	202.7cm	0.34641
		202.1cm	
		202.7cm	

Maximum Error = 0.8 cm

Minimum Error = 0.1 cm

The errors are noticed in reading after 300cm. the sensor gives errors different results after 300cm which can be observed in experimental results. Figure 5 shows the graphical representation of results. The sensor gives precise results up to 203 cm. Different readings has been taken to know the precision of sensor.

As described in experimental results

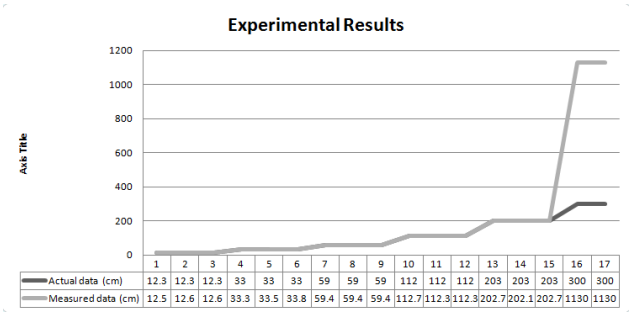

Figure 5 Graphical representations of experimental result

* Data 1-At 12cm, the sensor shows precise results up to 12.6cm.
* Data 2-At 33cm, the measured results are 33.8 cm
* Data 3-At 203cm, the results are 202.7cm

The accuracy of distance measurement depends on timing. When the timing of the reflected distance differs the accuracy will differ. The transducer has a wide angle of sensitivity. In a clustered environment we get shorter reading due to objects to the side of module.

The stick is light weight and it can help these people to move easily. It can detect the obstacle up to 400cm. Final form of stick is shown in figure 6.

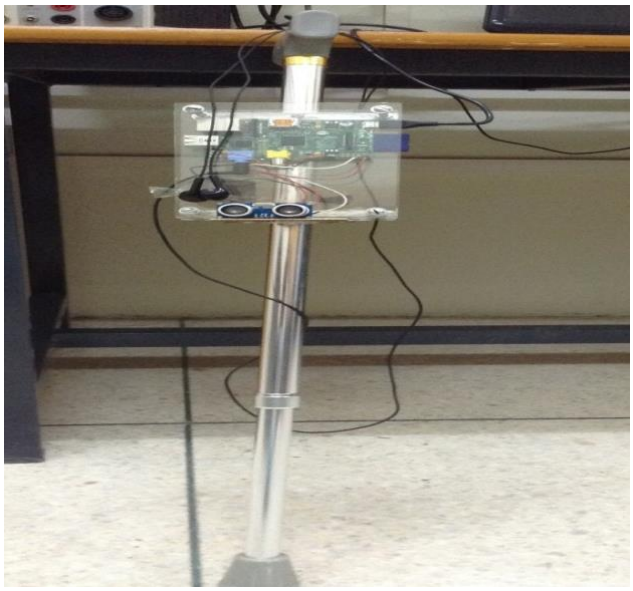

Figure 6 Final from of stick

IV. CONCLUSION

The intelligent stick is designed for visually impaired people using raspberry pi and ultrasonic distance sensor, which gives an audio output after striking with an obstacle in its path. It has following advantages

* It is light weight.
* Accurate detection of obstacle within range.
* The algorithm takes less training time.

In future such implementations can be done by improving certain parameters, which are

* Doppler radar motion sensor can be added for fast moving objects.
* More than one ultrasonic sensor can be added to improve its function.
* It can be used for object size and shape detection.
* The system can also be used for uneven surfaces.

ACKNOWLEDGEMENT

We take this opportunity to express our profound gratitude to Arsalan Habib, without his help it would have been difficult for us to complete this project and our Head of Department Dr. Muhammad Shafique who gave us opportunity to work on this project which also helped us in doing a lot of research and we also learned about new things.

REFERENCES

[1]. Anke Brock. "Interactive maps for visually impaired people: design, usability and spatial cognition. Human-Computer Interaction. Universit´e Toulouse 3 Paul Sabatier, 2013.

[2]. Vinoth, Chakaraverthy, N. "Talking assistance about locomotion finding both indoor and outdoor for both people". International Journal of Innovative Research in Science, Engineering and Techonology, Vol.3

[3]. Kang, S.-J.; Ho, Y. & Moon, I. H. (2001) "Development of intelligent guide-stick for the blind",Robotics and Automation 2001, Proceedings 2001 ICRA. IEEE International Conference on ,2001,4, 3208-3213

[4]. Wahab M. H. A.; Talib, A. A; Kadir, H.A; Johari, A; Noraziah, A.; Sidek, R. M. &Mutalib, A. A. "Smart Cane: Assistive Cane for Visually Impaired People" , Volume 8(Issue 4), arXiv preprint arXiv : 1110.5156 ; 2011

[5]. Innet, S. andRitnoom, N ."An Application of Infrared Sensors for Electronic White Stick" Intelligent Signal Processing and Communication Systems,2008. ISPACS 2008 . International Symposium on, 2009, 1-4

[6]. Dr.Eben Upton (n.d.) "Programming the Raspberry Pi" , Raspberry Pi Foundation , Element 14.

[7]. Easy ultrasonic 4-pin sensor monitoring (hc-sr04).2014,[ONLINE] Avaliable at:http://www.instructables.com/id/Easy-ultrasonic-4-pin-sensor-monitoring-hc-sr04

BIOGRAPHIES

Umber Waraich has received her Biomedical Engineering degree in 2014 from Riphah International University. Freshly she is a student of MS Biomedical Engineering from Riphah International University. She has worked in KRL Hospital and CDA Hospital as an internee during her studies.
am_waraich@hotmail.com

Engr. Dr. Muhammad Shafique, Head of Biomedical Engineering was awarded PhD Biomedical Engineering degree in 2011 by City University London. He received his MSc degree in Medical Electronics and Physics from Queen Mary University London in 2006 and B.E degree (receiving Gold Medal) in Biomedical Engineering from Sir Syed University of Engineering and Technology Karachi in 2003. He worked as a post-doctorate fellow at City University London in 2012 and served as a lecturer at the Electrical Engineering Dept. of Riphah International University, Islamabad from 2003 to 2005. During his PhD at City University London, he worked on novel techniques of photoplethysmography and pulse oximetry. He developed a multimode optical sensor that enhanced the conventional technique of pulse oximetry to work more efficiently for patients suffering from low peripheral blood perfusion. His areas of interests are tissueoptics, bio-instrumentation, and bio-signal processing
Muhammad.shafique@riphah.edu.pk

Quart-ul-Ain is studying Biomedical Engineering from Riphah International University.
qurat.ch@outlook.com

Arsalan Habib received his BS degree in Electrical Engineering in 2011 from Riphah International University, Pakistan M.S. degree in Embedded Intelligent Systems from University of Hertfordshire,

United Kingdom in 2012. He served for one year as a Lecturer at Riphah International University. Currently, he is a PhD Scholar under Cultural Exchange Scholarship Program 2014 in Sichuan State Provincial Lab of Power System Wide-Area Measurement and Control at University of Electronic Science and Technology, China. His current research interests are Magnetic Field Sensing and Real time Embedded Systems.
arsalanhabib@hotmail.com

****

.