Navigation Jacket for Visually Impaired People

Shreyas Joshi[1], Nikhil Kanawade[2], Manisha Gaikwad[3], Ramgopal Sahu[4], Kirti Adoni[5]

[1,2,3]*Student, Dept. of Electronics and Telecommunication Engineering, P.E.S's Modern College of Engineering, Pune, Maharashtra, India*
[4,5]*Asst. Professor, Dept. of Electronics and Telecommunication Engineering, P.E.S's Modern College of Engineering, Pune, Maharashtra, India*

---***---

Abstract – *Despite of many advancements in medical tools, technology for overcoming blindness is still limited. Blind people mostly rely on the symbolic white cane for the purpose of navigation, which is very primitive. It is necessary to provide them a better option. Sensing systems like LIDAR, echolocation and infrared proximity are used in some navigation tools developed recently. In the proposed system, the design and implementation of a navigation jacket for blind people is carried out using PIC microcontroller. Using the principle of echolocation, ultrasonic sensors are used to detect the presence of obstacles around the visually impaired user. This wearable accessory is designed such that the blind person can be alert about how far and in which direction the obstacle is present. The purpose of this system is to develop a cheap and efficient way to help the visually impaired to navigate with greater comfort, speed and confidence.*

Keywords: **navigation, echolocation, PIC microcontroller, ultrasonic sensor.**

1. INTRODUCTION

About 285 million people worldwide are visually impaired, of whom 39 million are completely blind, according to the World Health Organization. Since eyes are primary sense organ in perceiving the outside environment, blinds and visually impaired persons always depend on other people for their locomotion. Development of navigation devices capable of guiding the blinds through their localities has remained a challenge. Most of the blind people still navigate using the standard white cane, which was invented in 1921. This cane is a simple and purely mechanical device dedicated to detect the static or steady obstacles on the ground, uneven surfaces, holes and steps. This device is light and portable, but cannot be used for detection of dynamic obstacle. Another way is having a pet animal such as a dog, but it is really expensive. This problem can be solved by developing a wearable navigation jacket based on electronic sensors that could help visually impaired people find their way.

1.1 Literature Review

Generally, individuals rely primarily on vision to know own position and direction in the environment. Humans recognize things in the surroundings with their relative location and motion. Those tasks are often termed as 'wayfinding'. A lack of vision heavily hampers the performance of such tasks. Blinds require continuous efforts to integrate perceptions from remaining senses and predict an image of their surroundings in memory. The image so formed by virtue is termed as 'cognitive collage'. In this paper, a navigation system that identifies direction and distance of the obstacles around the blind is proposed. This will help the blinds to be better aware of their surroundings and have a better cognitive image of it. Over last few decades, some similar systems have been developed [1], namely *Eyeronman* (by Tactile Navigation Tools) and *The Third Eye* [2]. Nowadays there are many technologies, things and smart devices [3] for the visually impaired people for the navigation, but most of them have certain limitations and problems for the blind people. The major drawbacks are that those tools need a lot of training and efforts to use. They are not feasible for many from cost and ease of operation prospective also. From literature review, it is clear that the remote guidance system is very difficult to carry and thus the wearable jacket is more optimized version [4]. Emphasis of this paper is to provide a cost efficient and easy-to-use navigation tool.

2. DESIGN AND ARCHITECTURE

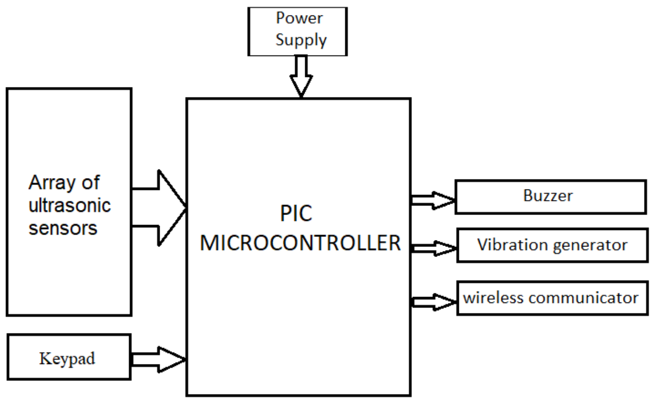

Figure 2.1 – Block diagram of system

The proposed system uses PIC 18F microcontroller as its brain. System consists of a wearable jacket equipped with ultrasonic sensors located on necessary spots in all possible directions. This helps in detecting obstacle in all four directions. Buzzer and vibration motors are used to give alert when obstacle is found in the proximity of user. The system is purposefully retrofitted in a jacket, to ensure maximum comfort and ease of operation. Once the jacket is worn by user, system essentially keeps user's hands unengaged, as hands are significant for a blind for touch-sensing, braille reading etc. [5]. Buzzer and vibration motors are connected to controller which is programmed to notify and alert the user when some obstacle is detected. If the obstacle is beyond distance 100cm, buzzer gives beeping alert. For objects within 100cm, vibration alert is given. For more optimized results, one vibration motor is fitted in each direction inside jacket i.e. on abdomen, on both arms and back. Controller is programmed such that when sensor in one direction detects obstacle, motor in respective direction will vibrate. Also, input voltage to motors is varied with respect to distance of object. This produces different vibration intensities for different distances. Based on where the vibrations are felt and intensity of vibrations, a user can figure out the direction of the obstacle and the distance at which it is situated.

2.1 System Components

2.1.1 PIC Microcontroller

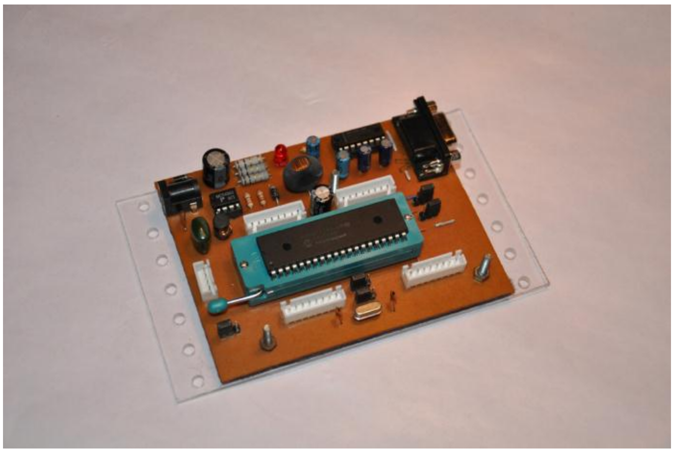

Figure 2.2 - PIC microcontroller

PIC microcontroller is famous for its easy programming and affordable price. PIC18f4520 can operate at various clock frequencies upto 40MHz. It has program memory of 32K bytes and 3 timers of 16 bits. The inbuilt 10 bit analog to digital converter of PIC has 13 channels. It operates at voltage range of 2.0V to 5.5 V. Though PIC18f4520 is discussed here, practically any member from PIC18F family can be used in this system.

2.1.2 Ultrasonic sensor

The HC SR04 ultrasonic module is used in this system. The principle of ultrasonic distance measurement uses the already-known air velocity of sound, measuring the time from launch to reflection when it encounteres obstacle and then calculates the distance between the transmitter and the obstacle according to the time and the velocity. This principle is same as the principle used in SONAR. Ultrasonic sensor is preferred over infrared sensor. Because there are chances that infrared sensor can give faulty readings in adversely illuminated conditions outdoors [6]. Equation 2.1 is used to calculate distance by ultrasonic sensor.

Figure 2.3 – Ultrasonic sensor

$$D = \frac{(T\times V)}{2} = \frac{T\times V\times \cos\theta}{2} \qquad \text{... Equation 2.1}$$

Where, D = Distance in metre.
T = Time for which
V = Sound velocity in m/s
θ = Angle of incident wave

2.1.3 Buzzer and vibration motor

5V DC buzzer is used to generate beep alert. To generate vibration alert, disc type shaftless vibration motors are used. 10mm*3mm sized motors are recommended, in order to keep the whole assembly compact.

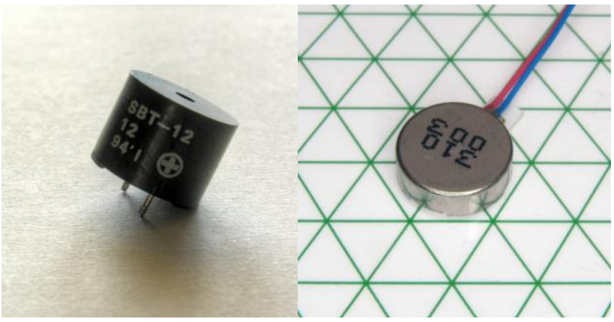

Figure 2.4 – Buzzer and vibration motor

2.1.4 Power supply

A 9V DC battery along with LM7805 voltage regulator acts as power supply. Reference voltage for ADC of PIC is set to 5V. Further, if a USB port is added to the circuit, then power bank can be used instead of battery.

2.1.5 Keypad and wireless communicator

To provide the control of system to the user, a 5-button keypad is used. Each button switches ON/OFF the sensors in one direction. Thus, user can snooze the sensors in all four directions whenever required. One button is provided to turn ON/OFF whole system. A Bluetooth module is used to establish wireless communication between the system and another Bluetooth device like mobile phone.

3. FLOWCHART

The system works according to the loop as given in fig. 3.1 below.

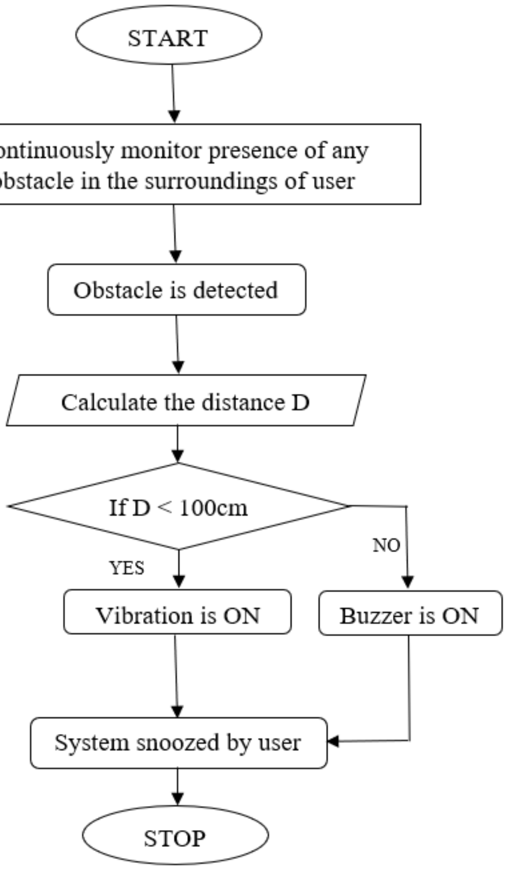

Figure 3.1 – Flowchart of the system

The vicinity of 100cm around the person wearing navigation jacket is divided into four stages. The voltage input to the vibration motors is applied in four levels as well. Till the obstacle is beyond 100cm distance, only buzzer alert is given. When the obstacle comes within 100cm but more than 75 cm far, motor is given with input 1V. This voltage creates minimum intensity of vibration. As the obstacle comes closer, input voltage to motor is increased step by step. If the obstacle comes as close as 25cm, motor gives highest intensity of vibration.
Inputs from controller to the vibration motors for objects at various distances are illustrated in the graph in fig. 3.2.

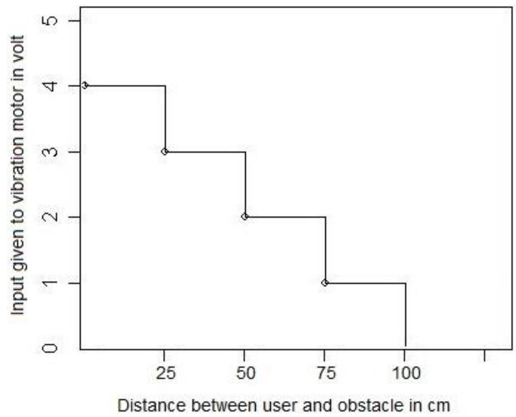

Figure 3.2 – Vibration response to obstacle

4. ENCLOSURE DESIGN

Entire system is fitted in a jacket. Controller and power supply circuit can be placed in pocket of the jacket. This makes system slick and user friendly. 3D view of sensor location on jacket is as shown in fig. 4.1. The ultrasonic sensors are oriented properly such that crosstalk due to interference of ultrasonic waves should be avoided.

Figure 4.1 (a)

Figure 4.1 (b)

Figure 4.1- 3D design of sensors embedded on jacket

5. RESULTS

The system detects presence of obstacle within a radius of 3m (10 feet) around the user. It detects both stationary and moving objects, as ultrasonic proximity works for both. Once the user is notified and aware about his surroundings, or as required in certain circumstances, user can snooze the system using keypad. This also avoids repetitive detection of the same obstacle.

6. FUTURE ENHANCEMENT

The system can further be improved by incorporating a camera and digital image processor in it. Thus, system can give customized alert for distinguishing object and human. Also, by considering angle of ultrasonic sensors, algorithm of system can be improved such that it should calculate and notify in prior the height / depth of uneven elevations like staircase, pothole, road divider etc. Electrosensitive polymers can be used as material for the jacket.

7. CONCLUSION

This paper proposes the design and architecture of an innovative navigation tool using PIC microcontroller and ultrasonic sensor. A simple, affordable, easy to use, customizable electronic guidance system is proposed to help blinds and visually impaired people. With the mentioned features, this navigation jacket can help visually impaired person in finding their way independently.

8. REFERENCES

[1] Rüştü Güntürkün et al. "The Design and Implementation of a Vest Made for Visually Handicapped Which Recognizes the Obstacles and Determines the Direction" Int. Journal of Engineering Research and Applications, ISSN: 2248-9622, Vol. 6, Issue 2, (Part - 4) February 2016, pp.59- 62.

[2] M Narendran, Sarmistha Padhi, Aashita Tiwari, "Third Eye For The Blind Using Arduino And Ultrasonic Sensors", National Journal of Multidisciplinary Research and Development, ISSN: 2455-9040, Volume 3; Issue 1; January 2018; Page No. 752-756

[3] Tejal Chandekar, Ranavikrant Chouhan, "Implementation Of Obstacle Detection And Navigation System For Visually Impaired Using Smart Shoes", ITJET, Volume 4, Issue 4, Apr 2017, ISSN (online): 2395-0056.

[4] Riya Mishra, Sampurna Mondal, Aditi Kuchnure, Risha Shah, "Directions Aids for the Visually Challenged Using Image Processing Using Image Recognition", IJCSN International Journal of Computer Science and Network, Volume 5, Issue 3, June 2016, ISSN (Online): 2277-5420.

[5] J. R. Babu, C. Shekharaiah and G. M. Kumar, "A Navigation Tool For Visually Impaired Persons", 2015 2nd International Conference On Computing For Sustainable Global Development (INDIACom), New Delhi, 2015, pp. 938-940.

[6] S. Bharathi, A. Ramesh, S. Vivek, "Effective Navigation For Visually Impaired Wearable Obstacle Avoidance System", 2012 International Conference on Computing, Electronics and Electrical Technologies.

BIOGRAPHIES

Shreyas Joshi
Student at Dept. of Electronics & Telecommunication, P.E.S. Modern College of Engineering, Pune, Maharashtra, India

Nikhil Kanawade
Student at Dept. of Electronics & Telecommunication, P.E.S. Modern College of Engineering, Pune, Maharashtra, India

Manisha Gaikwad
Student at Dept. of Electronics & Telecommunication, P.E.S. Modern College of Engineering, Pune, Maharashtra, India

Ramgopal Sahu
Asst. Professor at Dept. of Electronics & Telecommunication, P.E.S. Modern College of Engineering, Pune, Maharashtra, India

Kirti Adoni
Asst. Professor at Dept. of Electronics & Telecommunication, P.E.S. Modern College of Engineering, Pune, Maharashtra, India