

## **Smart Glass for Blind People**

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### **Abstract**

Blind mobility is one of the major challenges encountered by visually impaired persons in their daily lives. Their life and activities are greatly restricted by loss of eyesight. They normally travel using blind navigation system or by their accumulated memories in their long term exploration. The main objective of the present work is to develop a low cost, reliable, portable, user friendly, low power and robust solution for smooth navigation. This paper (Smart Glasses for Blind People), as meant are the glasses are for visually impaired people. It has an in-built sensor in it which spreads ultrasonic waves in the direction the person is going by scanning at most 5-6 meters of 30° range. As soon as the obstacle is detected, the sensor detects it and sends it to the device which generates an automated voice in the earphone connected to the person's ear.

### **Key words**

Arduino, IVRS, microcontroller, ultrasonic, voice-assistant.

### **1. Introduction**

On an approximation 285 million people are visually impaired across the globe, among which 39 million are blind and 246 have low vision according to WHO statistics of 2011 [1]. About 90% of the world's visually impaired live in low-income settings whereas 82% of people living with blindness are aged 50 and above. India is now home to the world's largest number of

blinds. Out of the 37 million blind people worldwide, over 15 million are from India. The worst thing is that 75% of these are cases of avoidable blindness. India has an acute shortage of optometrists and donated eyes for the treatment of corneal blindness. While India needs 40,000 optometrists, it has only 8,000. Blind people are usually dependent on assistance from others. The assistance can be from human beings, dogs or some special electronic devices. There are already many existing devices which help a blind person in walking. The most common is the simple walking stick or cane. The blind man uses it to detect the obstacles by sweeping the cane back and forth but unfortunately sometimes the blind man gets aware about the obstacle too late. With the recent advances in technology normal walking cane has been modified to a blind stick with an ultrasonic sensor attached to it. It has several limitations. Therefore, the solution that has been portrayed in this paper is cost effective, reliable, robust and portable device which would help a blind person to walk on the streets almost like any other pedestrian.

## **2. Literature Review**

In a rapidly flourishing country like our innumerable number of attempts has been made for the welfare of especially able people of our society. One of such attempts is the project "Project Prakash"[2], an empathetic attempt towards the blind children to help them gain knowledge of a set of obstacles around them by using their brains. Sheth et al [3] worked on how a blind people can be able to detect any type of pits, potholes and several ups and downs by using a smart white cane where they have used ultrasonic sensors. In this device a multilingual system for audio feedback cannot be used because it can record only for 680 seconds. The idea that can be seen in [4] has an ultrasonic sensor, a water sensor and a pit sensor. It also consists of a GPS system but here the user needs to give the present location as the input itself. The method of doing so has not been mentioned herein. In [5] it can be observed that it consists of a video camera on the frame itself as well as a computer processing unit precise enough to get fit in the pocket and the software that provides images of objects close by to transparent displays on the eyepieces. The major limitation of this device is that it is not at all suitable for completely blind people. It is recommended only for people with low vision or night blindness. There is another new attempt of assisting the blind people which is named as H.A.L.O or Haptic Assisted Location of Obstacles [6]. It consists of rangefinders that would take input from the ultrasonic sensors and output feedback to pulse vibration motors which are placed on the blind man's head. When the person gets closer to the object, the intensity and frequency of the vibration are increased. The main limitation is the use of vibration motor. The vibrations as an output feedback are far way irritating for any blind person.

### 3. Objective

The main objective of our present work is to provide a reliable, cost effective, low power solution for a blind people which would help them to move almost like any other normal pedestrian. The cost of this system makes it affordable for the majority of the society which in turn an effective device for them to spend on, just for once and assures wonderful travel guidance for them.

### 4. Working Principle

#### 4.1 Ultrasonic Sensor

Ultrasonic Sensor is a transducer which uses the physical characteristics and various other effects of ultrasound of a specific frequency which may transmit or receive the ultrasonic signal of a particular strength. These are available in electromagnetic or piezoelectric versions. The piezoelectric type is generally preferred due to its lower cost and simplicity to use comparatively than other types [7].

The system mainly lies on the principle of Ultrasonic Range Finding sensor or simply an ultrasonic sensor. It works on 40 KHz ultrasonic sound wave which when triggered by its transmitter module, its receiver module receives back the echo of the triggered signal, having a sensing angle of 30°. The block diagram of an ultrasonic sensor is shown below in Fig.1.

The propagation velocity of the ultrasonic wave is approximately 340m/s at 15°C of air or atmospheric temperature. The ultrasound velocity depends by the propagation medium and its temperature; hence the velocity in air is calculated using the equation 1, where t is the temperature in °C.

$$V= 340+0.6(t-15) \text{ m/s} \quad \dots\dots\dots (1)$$

In this study, a room temperature of 20°C is assumed; hence the velocity of ultrasound in the air is taken as 343 m/s. It is because the travel distance is very short; the travel time is little affected by temperature. It takes approximately 29.15µsec for the ultrasound to propagate waves through 1cm distance; hence it is possible to have 1cm resolution in the system [7].

#### 4.2 IVR System

IVR System or Interactive Voice Response System which basically works on segmented recorded voice clips to be logically merged and amended as per requirements. The SD Card

module is directly interfaced to the Arduino board to store the segmented voice clips of the IVR system we built in different languages and is programmed on the Arduino board. The languages can be changed over sequentially by two wire terminals kept open outside, when no command is currently being played by the IVR, if the two wires are touched to each other for a moment, the next language, as per the programmed sequence inside, will be played. Currently the system is programmed for only English and Hindi, and many more languages will be added in near future.

### 4.3 Circuit Planning

The 5 ultrasonic sensors are well placed on the spectacle to sense 4 directions and one on the knee cap for detecting smaller obstacles, block diagram shown in Fig.2.

It requires  $5 \times 4 = 20$  pin-outs from Arduino to be interfaced with them. The terminals of a sensor are as follows: 1. Vcc, 2. Trigger, 3. Echo, 4. Gnd, among which Vcc and Gnd can be common to all 5 sensors and hence prevents wastage of GPIO pins of Arduino and to make room for other components to be interfaced into the single board alongside the sensors. Other components need to be interfaced are the SD card module which needs 6pins and the 3.5mm Audio module (self-made) needs 3pins. Arduino has 13 Digital pins and 6 analog pins and among which 20( $5 \times 4$ ), 6, 3 pins are thus required for the complete interfacing of all three major components and it is clear that pins will fall short, thus we kept shorted 5-6 pin-outs of Vcc & Gnd (which are nothing but power source for the sensors) each in the self-made Audio module so that only Trigger and Echo pin of each separate sensor needs to be directly interfaced to Arduino and rest can be by-passed through the audio module itself. The Audio of the IVR system can be received by a headphone through the self-made 3.5mm audio module which is basically filtering the audio received in form PWM bits signal from the Arduino board.

### 4.4 Priority System of Working

The System works on priority to guide the blind man which can be readily changed as per requirements. Currently set priorities are described below:

- If there is an obstacle within 80cm detected by the knee cap sensor then the person will be alerted about it.
- If there is an obstacle detected by the front sensor within 120 cm then the person will be directed to move left.
- If there is an obstacle detected by the left sensor within 100cm, along with the previous point, then the person will be directed to move right.

- If now an obstacle detected by the right sensor within 100cm, along with the previous point, then the person will be directed to step back.
- If now there is an obstacle detected by the sensor at the back within a range of 80cm, along with the previous point, then the person will be alerted that it is a congested area and system is unable to guide.

## 5. Experimental Results

First of all, this system is just a guidance system and it doesn't do anything on its own but just guides the blind person how to traverse. In no way does this system guarantee if a blind person use this, he will be able to walk similar to a normal person because system needs time to process the sensor values and guide them so they need to be walking at an appropriate speed so as to allow the system to process and guide them, it won't be similar to a normal person who can see. This system has been tested on 10 blind persons and some limitations and usage problems has been traced. They are as follows:

(1) The sensor being highly directional, at times it may happen if there may be a diagonally situated obstacle in between front and right sensor, the guidance frequently changes, but it happens for a specific range and not always at every spot, 2-3 out of 10 people faced this problem.

(2) If not placed appropriately, the knee cap sensor may overlook or may not sense obstacles of 10-15cm height lying on the ground, which may be steps, speed breakers, etc. 3-4 out of 10 people faced this problem

(3) Front part and appropriate level of smaller obstacles for knee cap sensor worked flawlessly most of the time.

(4) The blind man should normally be on its straight path, as per their feeling, unless and until system guides them to turn in any direction, otherwise it was noticed that some kind of avoidance of an obstacle may happen.

The graph showing the statistics of problems faced by how many people is shown in Fig.3. The waveform of received ultrasonic signal having no obstacle and having an obstacle in path, are shown in Figures 4 & 5 respectively.

The sensor results are considered thrice for each distance which is at a difference of 5cm than the previous distance noted. Average result has been taken for each case. Travel time of the wave is used to calculate the distance in between. Results of measurement are shown in Table 1. The formula to calculate the distance is given in equation 2

$$\text{Distance (cm)} = (\text{Travel Time} * 10^{-6} * 34300) / 2 \dots\dots (2)$$

The experimental result along with the actual distance is shown in Table 1. The difference between actual and measured distance has been noticed to be considerable especially for lower distances, hence %error has been calculated and shown in Table 1. The graph for this error, i.e. difference between actual and measured distance is also observed in the graph of Fig.6.

## 6. Tables and figures

### 6.1 Table 1. Distance and Error Calculation

S.No.	Actual Distance (cm)	Travel Time (µSec)	Measured Distance (cm)	% Error
1	5	390	6.68	33.77
2	10	720	12.34	23.4
3	15	1060	18.18	21.2
4	20	1270	21.78	8.9

### 6.2 Figures

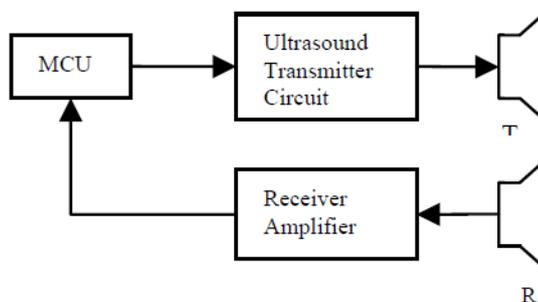


Fig.1. Block Diagram of Ultrasonic Sensor

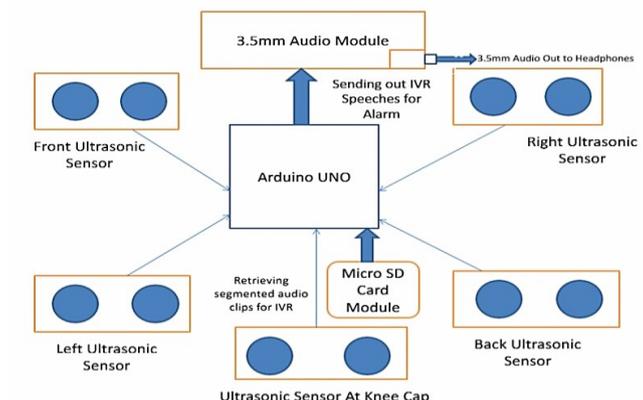


Fig.2. Block Diagram of the System

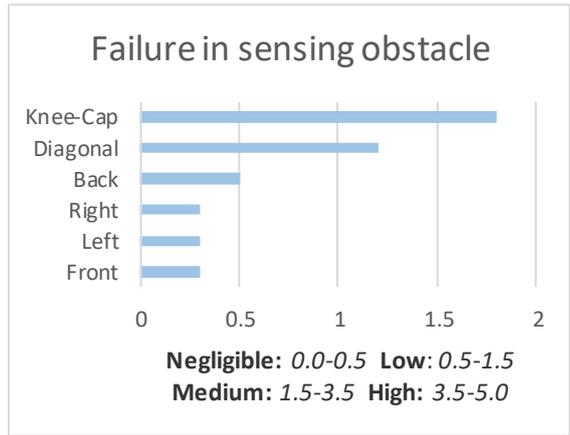


Fig.3. Failure Rate of Sensing

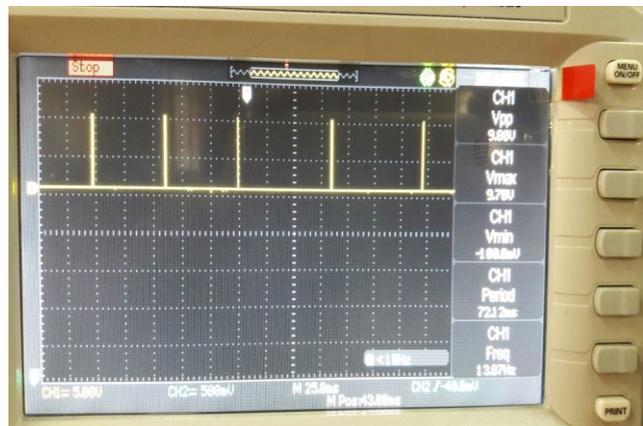


Fig.4. Received Waveform with no obstacle

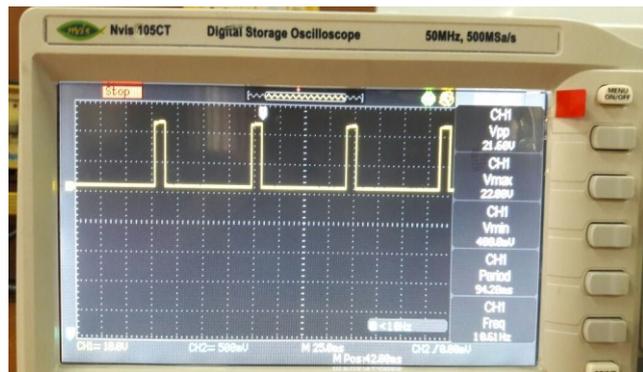


Fig.5. Received Waveform with an obstacle in path

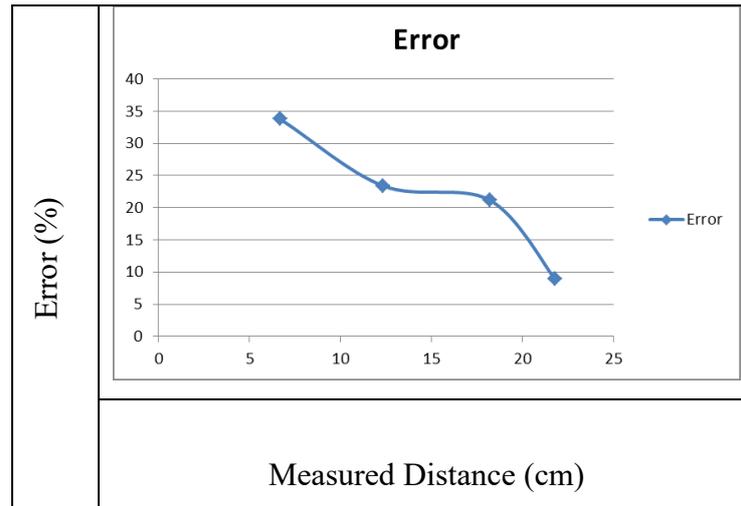


Fig.6. Error in Distance Calculation

## 7. Salient Features

**MULTILINGUAL AUDIO FEEDBACK SYSTEM:** The system uses a 10 language based audio feedback system so that it can be used comfortably by people all over the globe.

**VERSALITY:** This device is capable of detecting the obstacles in five directions(front,right,left,back as well as at below)

**COST EFFECTIVENESS:** The device is available at a cost of Rs.1495 but the price will decrease a lot on mass production.The price is quite affordable for blind people with low economic condition.

**DESIGN:** The design of the device makes it suitable to be used comfortably by the blind person over the blindstick which he needs to carry each and everytime he moves out of his house.

## Conclusion

The paper objective is underlined by the necessity of voice assistant system for the increasing number of blind people all over the globe. The "Smart Glass for Blind People" is practically, a feasible device and can be conveniently carried by any blind person. It does have a few limitations which we'll target to solve in its future developments.

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