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DESIGN AND IMPLEMENTATION OF A NAVIGATION SYSTEM FOR VISUALLY IMPAIRED PERSON

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Abstract - *One of the most severe type of disability that a person has to endure is blindness. A blind person suffers both physically and mentally. This paper provides a prototype of a navigation system for visually impaired person. This system comprises of three features –object detection, day-night detection and fire detection. The system consists of ultrasonic sensor, voice chip, microcontroller, buzzer and speaker. The navigation device will be able to satisfy both the physical and the mental needs of a visually impaired person. Recently, many researchers are trying to find out a solution to meet this challenge in an easy and organized way. The navigation system consists of tools for the users which will make the device more interactive. Accordingly, it also describes the prototype on the basis of software and hardware for a low-cost and user-friendly system that will help to alleviate the complexity associated with safety navigation system.*

Keywords: Microcontroller, Ultra sonar, Voice Chips, Fire Sensor, Day-light sensor.

1. INTRODUCTION

At the age of modern technology, blindness is a great challenge to scientist and researcher. A huge amount of research is going on about interfacing the prototype device with visually impaired people. According to the world health report, about 314 million people are visually impaired; among them, 45 million are blind which shows almost 45 million people are depended on other humans for movement, information and environmental interpretation due to the blindness [1]. A visual perception is a loss of independence either physiologically or neurologically or both.

In modern society of social independence, the visually impaired, like everyone else, deserve independence. They require assistive devices for navigating. In particular, outdoor navigation has always been a challenging problem for their mobility [2]. Thus, in order to overcome navigation concerns of visually impaired, there is a significant need for a new navigation system to help the blind people in the visualization [3]. Such systems are suitable for outdoor navigation. Voice based navigation device has three activities: Ultrasonic sensor and day-night sensor which gives output after recognizing voice. Similarly, fire sensor sounds an alarm with the help of a buzzer. Ultrasonic transducer transmits signal. When it reflects, ultra sonar senses and gives a voice output. Day-night sensor observes whether it is day or night. When light falls on LDR, it refers it as day and vice –versa. In case of fire alarm, when fire is detected, the buzzer produces a sound. However, many blind support systems in present world use GPS which is expensive. The reason of using ultrasonic transducer is that it is popular and relatively inexpensive and also small enough to carry. Unlike conventional systems, blind support system can provide a new dimension of real time assistance and man-made vision along with obstacle detection [4].

2. SYSTEM OVERVIEW

The block diagram of the proposed system is shown in Fig. 1. The main aim of the research is to design a navigation system for the blind and visually impaired person based on voice recognition and ultrasonic sensor for obstacle detection. The advantage of this system is voice based announcement for easy navigation i.e. the user gets the voice which tells about the directions that he/she needs to move to reach the destination. Here, instead of sounding an alarm, the user can directly hear the recorded sound using voice recognition system [4]. Ultrasonic sensor senses the obstacles in its path by transmitting the ultrasonic waves continuously. If any obstacle comes in its vicinity then the ultrasonic waves and this information are passed to the microcontroller. The microcontroller provides a sound of alert through voice message. The controlling device of the whole system is a microcontroller [5]. The user needs to give a destination location through voice to voice recognition system which is interfaced with microcontroller. The microcontroller operates according to

stored code and provides the navigation directions of destination with the help of ultra sonar through voice circuit interfaced with microcontroller [6]. Also, this system is equipped with fire sensor and day-night sensor. Fire sensor can sense fire, on the other hand, day-night sensor can sense day or night

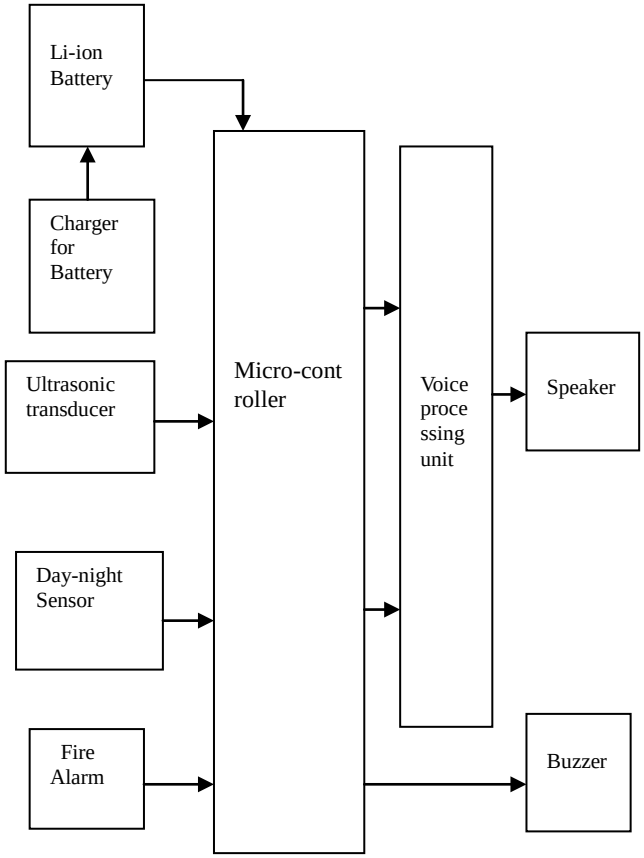

Fig. 1: Block diagram of visually impaired system

3. DESIGN CONSIDERATIONS

While designing "NAVIGATION SYSTEM FOR VISUALLY IMPAIRED PERSON", it was given focus on some basic needs that is deprived by fate of visually impaired person. The considerations were:

a. Design of a navigation device at low cost
b. Design of a navigation device which is portable.
c. Design of a navigation system which will not be annoying to users
d. Adding some safety features
e. Achievement of high performance

Almost all navigation system for visually impaired person was done by using GPS or stick [1-9]. A GPS based navigation system is costly and stick is not user-friendly to the users. Therefore, special attention was given to the low cost and a user friendly system.

4. FEATURES

This device includes three features: i) obstacle detection, which is primary objective of this design ii) day night sensor, which gives information about day or night iii) fire alarm.

5. THE OVERALL SYSTEM

5.1 Obstacle Detection:

The functional block diagram of the system is depicted in Fig. 2. To meet the requirement of obstacle detection, ultrasonic transducer is used to detect obstacle. Ultrasonic transducer consists of two parts (i) ultrasonic transmitter (ii) ultrasonic receiver.

i) Ultrasonic transmitter: It will send a signal out into its surrounding area. Before transmitting the ultrasonic wave, ultrasonic wave generator will generate ultrasonic wave [10]. After that, ultrasonic transmitter will transmit the ultrasonic waves toward a surface to locate the obstacle. Typically, the range of an ultrasonic transducer is three meter.

ii) Ultrasonic receiver: If the ultrasonic wave detects the obstacle, it will produce a reflected wave. An ultrasonic receiver is used to receive the ultrasonic waves reflected from the obstacle [10]. The signal is compared with a reference signal to detect obstacles on the road surface.

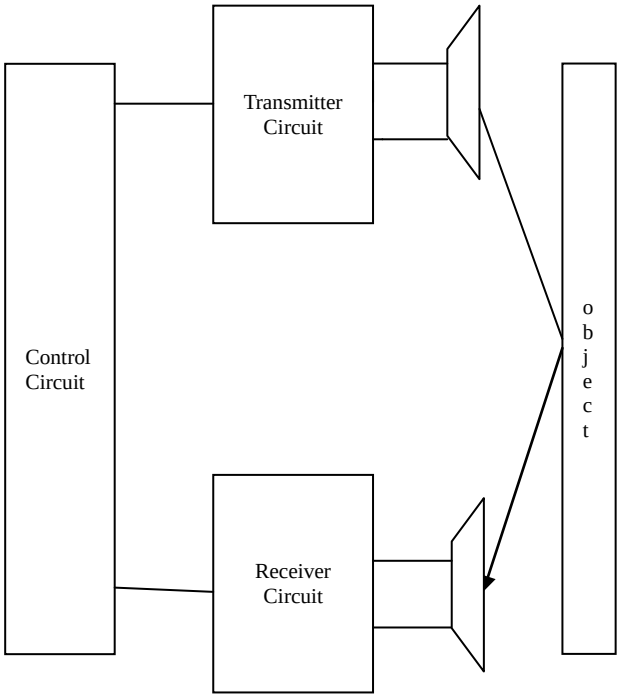

Fig. 2: Functional block diagram of ultrasonic transducer

5.2 Fire Detection:

An additional feature of this system is fire sensor. A fire detector detects fire. It consists of a thermistor, a BD 135 transistor, a variable resistor and a buzzer. When a fire or very high temperature is detected by thermistor, buzzer starts to operate sounding an alarm. It was focused on designing a sensitive alarm to detect the presence of high temperature which can be caused by fire accident. Fixing alarm at a loud sound enables the surrounding people to be alert which might help to save not only the life of the person carrying the system but also others as well. This sensor must activate during an emergency status.

5.3 Day-night Detection:

As it is very important for a blind person to realize whether

it is day or night, a new feature is included in the device which is not available in previous devices**.** For this purpose, a day-light sensor is used in the system which makes the detection of day or night easy. This section consists of an operational amplifier, a LDR and a variable resistor. Op-amp is connected with microcontroller. When a voltage difference exists in output of an op-amp, microcontroller can sense. On the other hand, microcontroller is interfaced with voice processing unit.

5.4 The Voice Chip:

Almost all previous alarming system used buzzer to sound an alarm [1-7]. This is very annoying. The buzzer is successfully replaced by Voice chip. A variety of range of voice chip is available. But, Win bond ISD 1760 is used in this device as it is the most suitable voice chip to meet the desired requirements. This chip works on three modes [11]. This chip is recorded by the voice using microphone and played it by push button and a speaker. MIC+ and MIC – pins of ISD 1760 is connected with microphone and is used to record voice. PLAY pin is a low pin and used to playback the sound. SP + and SP – pin connects a speaker for the required voice output. This chip can store 3 recorded voices each of 40 seconds [11]. So, using a single chip, two recorded voices can be played at a speaker for two desired objectives. Thus, for obstacle detection and day-night sensing only a single voice chip is used.

5.5 Other Components:

Microcontroller PIC16F73 devices are available only in 28-pin packages, while PIC16F74/77 devices are available in 40-pin and 44-pin packages [12]. A 28 pin package microcontroller IC is used in this device instead of 40 pin package because it is 3 times cheaper than 40 pin package. The difference is that 28-pin packages have 3 I/O ports while 40 pin packages have 4 I/O ports. The main purposes of using micro controller are listed below:

1. To control the RESET pin of voice chip
2. To control the PLAY pin of voice chip
3. To control the FORWARD pin of voice chip
4. SIG pin of Ultra sonar is interfaced with microcontroller
5. Differential outputs of two op-amps are received by these pin.

LM324N is an operational amplifier or comparator that is one of the basic parts for both day night sensing and fire sensing [13]. From the basic theory of op-amp devices, it is known that an op-amp output is high when there is a difference between the input voltages [14]. Here, one input voltage is found from the sensors and other is provided by a source via an adjustable resistance called reference input voltage. For both case Reference input voltages are adjusted by variable resistors. If output is high, it drives the microcontroller.

Here, a NPN Transistor is operated as a switch [14]. When an op-amp measures voltage difference between two inputs during fire sensing, a suitable gate voltage is developed on transistor, hence, drives the buzzer.

LDR senses day or night. When the light level is low, the resistance of the LDR is high and vice-versa. When resistance is high of LDR due to low intensity of light, speaker makes sound [14]. However, when light shines onto the LDR, its resistance decreases the LED lights. Then, recorded voice in voice chip is heard as saying “DAY”.

The measurable data of Ultrasonic detection is as shown below:

Table-1: Ultrasonic transducer measurable data [10].

Principle of measurement	Ultrasonic wave
Typical application	Obstacle detection
Range of measurement	2.5 meter
Mean of output	Impulse width
Rated working voltage	+ 5 VDC
Frequency of sensor	40 KHz

6 . SIMULATION

Three individual programming codes for three features are developed and simulated for testing purpose to meet the desired requirements of the device using ‘Mikro C’ and ‘Proteus’ software respectively. And, the combined programming code is developed using these individual programming codes. For simulation, Proteus 7.7 version is used. Mikro C pro_pic_2011_build.5.40 version is used to develop programming codes.

The figure 3 indicates that LED D1 and D2 is glowing which means both op-amps have a high output.The implemented device also follows this procedure. Again, red symbol at 37, 39 and 40th pin of microcontroller indicate that RESET, PLAY and FORWARD pins of voice chip are kept at high state. So, no voice is played at the output since these pins of voice chip are at low state.

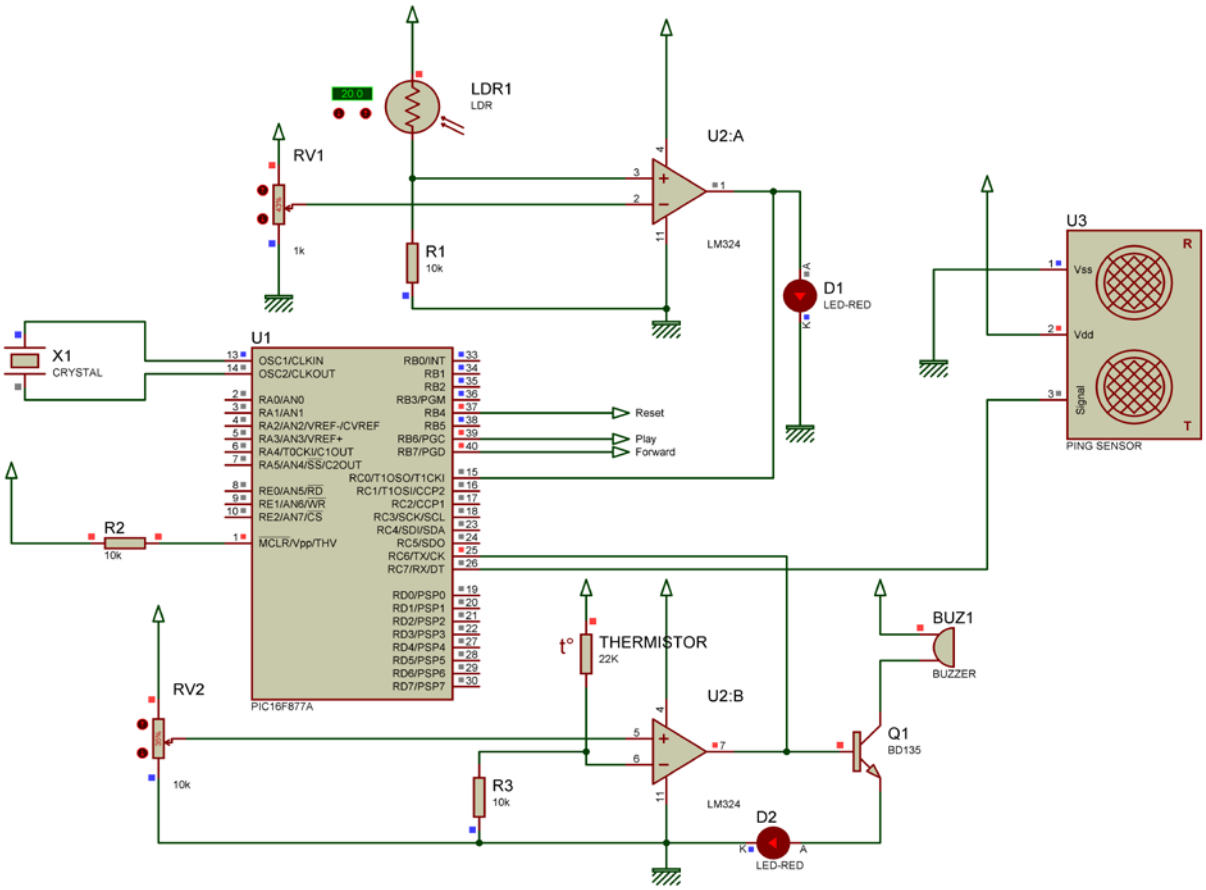

Fig. 3: Combined simulation output by LED lighting

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7. SYSTEM IMPLEMENTATION

The desired implemented circuit is shown in Fig. 4. For the system advantage, it was coded to the microcontroller part by part. Firstly, it was loaded from transducer coding with a loader. After loading, the ultra-sonar started detecting obstacle. The day-night detection coding is done as well. Then, combined coding is loaded to the microcontroller. The total circuit worked, although sometimes it showed some disturbance. By adjusting the variable resistor, desired output was achieved. Here, many LED was used to get desired output. LED was used to make sure that the circuit was OK and error-free. Figure 4 shows the implemented circuit on breadboard. Ultra sonar, thermistor and voice chip are indicated in the upper portion of the circuit. On the other hand, the rest of the circuit elements are indicated in the lower portion. It seems that all push buttons are not necessary. But they had played important role while recording. Again, user can record his or her desired voice using these push buttons. The cost details of the implemented system is given in Table-2, where it is noticed that the total cost (2,500 BDT) is in the capacity of the blind people.

Table-2: Cost details of the system

Equipment	Quantity	Price(BDT)
Microcontroller	1	100
Voice chip	1	600
Ultrasonic transducer	1	800
Capacitors	12	40
LED	5	10
Crystal oscillator	1	40
Resistors	7	15
Microphone	1	150
Push buttons	6	20
Voltage regulator	1	20
Op-amp(LM324N)	2	20
LDR	1	10
Others		675
Total		2500 BDT (31.25$)

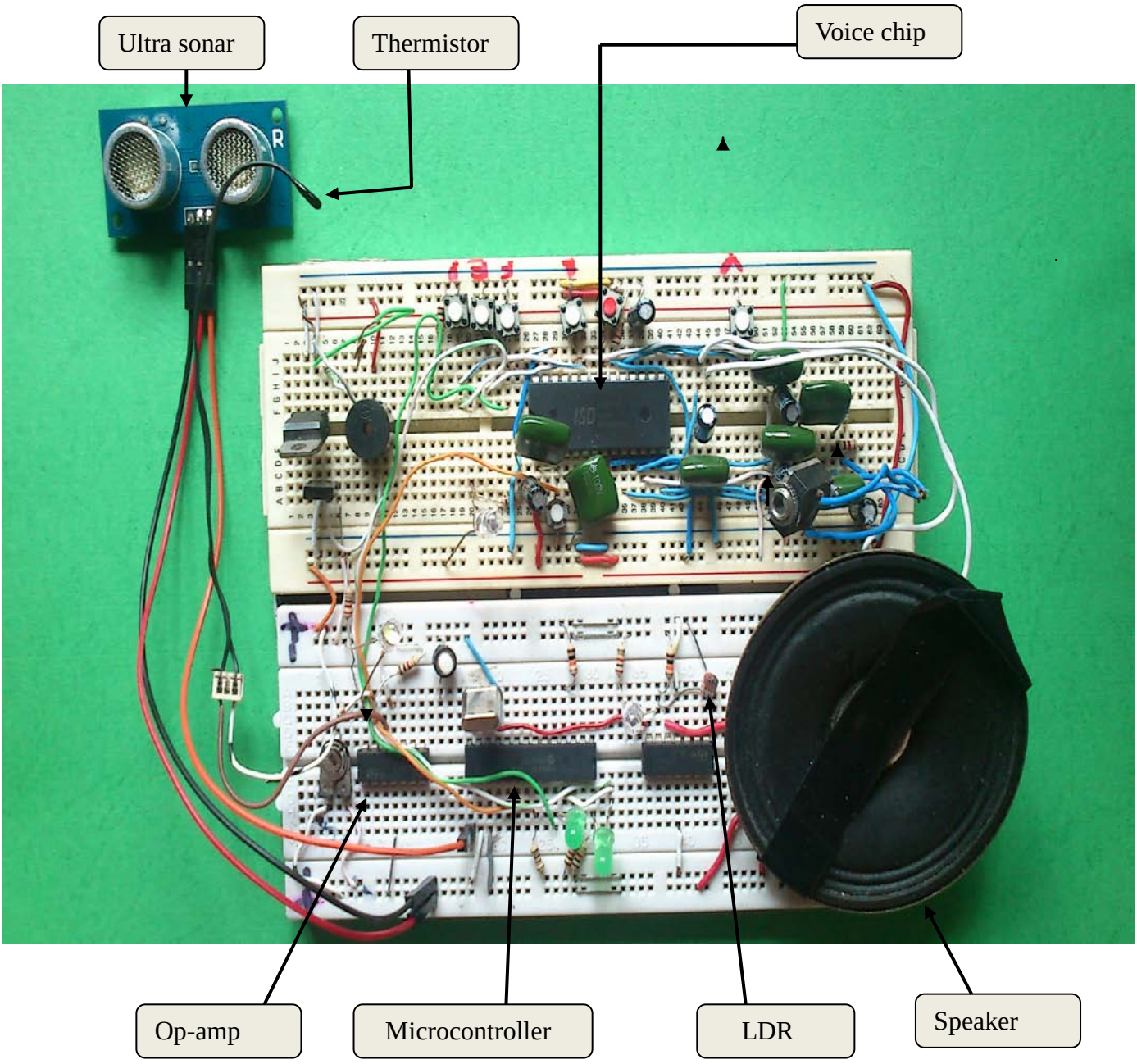

Fig-4: The overall arrangement of implemented circuit.

8. SYSTEM ADVANTAGES

Though this navigation device shows some disadvantages, but it carries some extraordinary features that increase the value of this device as a good system such as:

1. Firstly as it is light weight, it can easily suit to any disabled person to carry and operate in a simple way.
2. The navigation device can operate with all feature at a time which is absent for comparing in other devices.
3. Since it was implemented without using GPS or GSM device which are expensive and sensible, so cost is minimized.
4. Here, any types of cane or stick are strongly omitted so there is no risk of damage. Moreover, it is portable which can be kept in hand and pocket when it is useless.

9. SYSTEM LIMITATIONS

The system has some limitations as given below:

1. GPS or GSM module is not used in the system. As a result, the current position of blind people is difficult to locate.
2. As features are sensor based, so it shows some disturbance.
3. Fire alarm sensor gives alarm by buzzer which gives noisy sound.

10. FUTURE RESEARCH

Further enhancement and expansion of the current system, implies the need of further investigation in many purpose.

1. With the application of RFID tag on objects, the device could support the user to find them in a domestic environment. The navigation device could

also help the blind to move in a shopping mall, while the system supplies the needed information about the tagged products on the shelves: e.g. the name, price, description, and other types of information.

2. Personal assistant: It can be used as a personal assistant by developing software which will allow in the near future. The blind person will be able to select the destination and the paths, to store in the system's memory.
3. Mapping spaces: The navigation support system will read every kind of environment information and help the blind to make mental maps of such spaces.

11. CONCLUSION

This research presented a navigation aid system which helps blind people to navigate safely. This system allows the blind person to avoid obstacles by voice recognition and warning system through buzzer. The goal is to make a system that will be cost effective and easier for the physically challenged person to handle. In order to make it easier for the person to use, ultra sonar is fixed for detecting obstacles in particular direction. Therefore, the person does not require moving of any types of cane around to detect barriers. Moreover, blind people can easily walk with the device and the ultra-sonar will simply detect the problems and help the person to move around it. This system will be an effective, low-cost solution for reducing navigation system for visually impaired and partially sighted people

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