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Third eye for the blind using arduino and ultrasonic sensors

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Abstract
Third eye for the blind is an innovation with the help of the multidiscipline subjects like computer science, electronics engineering and health science which helps the blind people to navigate with speed and confidence by detecting the nearby obstacles using the help of ultrasonic waves and notify them with a buzzer sound or vibration. According to WHO 39 million people are estimated as blinds worldwide. They are suffering a lot of hardships in their daily life. The affected ones have been using the tradition white cane for many years which although being effective, still has a lot of disadvantages. This will be a wearable technology for the blinds. One of the main peculiarity of this device is that it will be affordable. The Arduino Pro Mini 328- 15/16 MHz board is worn like a device. This will be equipped with ultrasonic sensors, consisting of module. Using the sensor, visually impaired can detect the objects around them and can travel easily. When the sensor detects any object it will notify the user by beep or vibration. Thus this is an automated device. Thus this device will be of a great use for the blinds and help them travel different places.

Keywords: arduino, wearable band, buzzer, blind, people, compact, ultrasonic, obstacles

1. Introduction
With the improvement of the living standards of the people, we have become so materialistic that we have forgotten how the physically disabled people live a tough life. They undergo rigorous, apathetic and indifferent behaviour towards them for being physically disabled. They become dependent on other people in a way for their day to day routine chores. Blind and impaired persons always depend on other people for their locomotion. Eye are prime sense of organ in perceiving the outside environment; dysfunction of such prime sense organ severely effects the knowledge perceiving capability of the outside environment. Therefore, going around to places in such environment is a very big challenge because the blind people cannot depend on their own eyes and thus face many difficulties [1].

The objective of this project The Third Eye for the Blind is to design a product which is very much useful to those people who are visually impaired and those who often have to rely on others. Third eye for Blind project is an innovation which helps the visually impaired people to move around and go from one place to another with speed and confidence by knowing the nearby obstacles using the help of the wearable band which produces the ultrasonic waves which notify them with buzz sound or vibrations. It allows the user those who are visually impaired to walk freely by detecting the obstacles. They only need to wear this device as a band or cloth on their body.

According to WHO or the World Health Organization, 39 million people are estimated as blinds worldwide. They are suffering a lot of hardship in their daily life. The physically disabled ones have been using the traditional way that is the white cane for many years which although being effective, still has a lot of disadvantages and limitations. Another way is, having a pet animal such as a dog, but it is really expensive. Thus the aim of the project Third eye for the Blind is to develop a cheap, affordable and more efficient way to help the blind people to navigate with greater comfort, speed and confidence. This is the wearable technology for the blinds which helps resolve all the problems of the existing technologies. Now a days there are so many technologies, things and smart devices for the visually impaired people for the navigation, but most of them have certain problems for the blind people and the major drawbacks are that those things need a lot of training and efforts to use. One of the main peculiarity of this innovation is, it is affordable for everyone, the total cost being less than $25 or ~1500 INR. There are no such devices available in the market that can be worn like a cloth and having such a low cost and simplicity. With the use of this improvised device in a large scale, with improvements in the prototype, it will drastically benefit the community of the visually impaired or the blind people. The walking cane is a simple and purely mechanical device dedicated to detect the static or the constant obstacles on the ground, uneven surfaces, holes and steps via simple tactile-force feedback. This device is light, portable but limited to its size and it is not used for dynamic obstacle detection [4].

These devices operate like the radar and the system of the device uses the ultrasonic waves fascicle to identify the height, direction and the speed of the objects. The distance between the person and the obstacle is measured by the time of the wave travel. However, all the existing systems inform the blind the presence of the object at a specific distance in

front of or near to him. These details helps the user or the blind people in detecting the obstacles and thus change the way and walk accordingly. Information about the objects and their place in the way of the walking like an obstacle and their characteristics can create additional knowledge to enhance the space manifestation and memory of the blind or the visually impaired people. To overcome, the above mentioned limitations this work offers a simple, efficient, configurable virtual for the blind.

2. Literature Survey

Over the last few years or we can say over the last decades, research has been conducted for new devices and technologies to design a good and reliable and efficient system for blind or visually impaired people to detect the obstacles and warn or alert them at danger places or the obstacles. There are some systems which has some limitations and clampdown.

Shoval *et al*. in [1] developed a Navbelt, an obstacle avoidance wearable portable computer which is only for indoor navigation. Navbelt was equipped with two modes, in the first one the system information was translated to audio in different sounds. One sound for free for travel direction and other for blocked, it was difficult for the person to differentiate the sounds. Other problem was the system would not know the user momentary position.

D. Yuan *et al*. in [2] have discussed about the virtual white cane sensing device based on active triangulation that can measure distances at a rate of 15 measurements/second. A blind person can use this device for sensing the environment, pointing it as if it was a flash light. Beside measuring distances, this device can detect surface discontinuities, such as the foot of a wall, a step, or a drop-off. This is obtained by analysing the range data collected as the user swings the device around, tracking planar patches and finding discontinuities. Benjamin *et al*. in [3] introduce a laser cane with three photo diodes and three laser diodes function as receiver making an optical triangulation. The laser cane generally detects the obstacle in three specified directions. One is 45º to the ground for overhanging obstacles, the second one is parallel to the ground and third one is for sharp deepness. The laser cane has no data or technology or we can say system for determining the location and the position of the obstacle, rather it is just like a hit and trial method. J. Na proposed an interactive guide system for indoor positioning of this, which can"t detect the obstacles and hurdles. The system is not suitable for the outdoor activities. Sabarish. S in [4] have described the development of a navigation aid in order to assist blind and visually impaired people to navigate easily, safely and to detect any obstacles. The system is based on a microcontroller with synthetic speech output. In addition to this, the device consists of two vibrators, two ultrasonic sensors which is mounted on the user's shoulders or any other body part and another one integrated into the cane. M.A Ungar S [5]. has proposed methods for the visually impaired people for the urban cities. But they didn't considered about the people who cannot afford costly equipment and devices. This limitation is overcome by the device third eye for the blind. Ms. Pooja Sharma [6] has discussed that the obstacles can be detected, but it has many limitations on the angles and the distance. On contrary, this project will have a wide angle for the detection where the sensors range will be wide.

In today's world of innovations, there are many innovations for the visually impaired people like the white cane with the cane with a red tip for helping the movements of the blind people. There are many different types of canes used in today's world with growing technologies such as as the white cane, the smart cane [7], and the laser cane [8]. The cost of the trained dogs is also very high and is not affordable option [9]. A survey found [10] that the remote guidance system is very difficult to carry and thus the wearable band will be more optimized version.

Likewise Guide Cane, this invention also has a control button on the handle, and the button has four different directions. This invention of the Third eye for blind has the same shortcomings or limitations as the Guide Cane where there will be a difficulty to save space for the cane or to place the smart cane like the other. Other than that, cost is also a problem in this project as it uses ultrasonic sensors and many servo motors. If the cost is high, users may not be able to afford for it\ because the average income of the visually-impaired people is usually less. Smart Cane has been designed by students from Central Michigan University where this invention uses Radio Frequency Identification (RFID). RFID is used to detect objects or obstacles in front of the user and detects the RFID tag that has been placed in several locations to navigate the users. This invention is just like a normal stick but is provided with a bag, which the user to wear. The bag provides electrical power to the invention and informs the user through speakers inside the bag. For users who cannot hear, there are special gloves that will vibrate at every finger, in which different vibrations in each finger have different meanings. However, this invention has several shortcomings and is only suitable for small areas. This is because it only detects the area with RFID tag otherwise this invention only works as a regular blind cane.

3. System Architecture

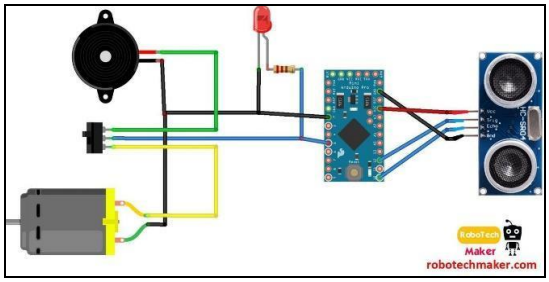

Fig 1: Circuit Diagram of the device

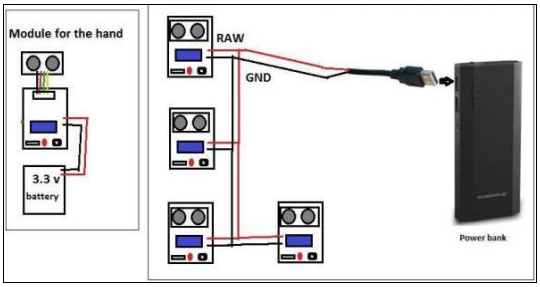

Fig 2: Detailed circuit diagram

The device or the wearable band is circuited with the Arduino. The LEDs and the buzzer are connected to the Arduino and similarly the ultrasonic sensors are also connected to the Arduino board. The soldering is done according in the Arduino and the connections are established.

4. Existing System

The existing system consists of the devices or the supports like white cane for helping them to detect the obstacles and travel to places, pet dogs, smart devices like vision a torch for blinds. But, there were many limitations and problems in this existing systems like in the white cane, it may easily break or crack. The white cane may get stuck at the pavement cracks of the different objects. Whereas the pet dogs cost is huge and need a lot of training.

5. Proposed System

The design is based on a special wearable device based on the Arduino board which can be worn like a cloth for blinds or a band. This device is equipped with five ultrasonic sensors, consisting five modules which are connected to the different parts of the body. Among them, two for both the shoulders, another two for both the knees, and one for the hand. It's the choice of the visually impaired people, they can either use one band or put it anywhere on their body wherever they are comfortable. With the use of these five ultrasonic sensors in the device and by wearing it on the body, the blind can detect the objects in a five dimensional view around them and can easily travel anywhere by detecting the obstacles. When the ultrasonic sensor detects obstacle the device will notify the user through vibrations and sound beeps. The intensity of vibrations and the rate of beeping increases with decrease in distance and this is a fully automated device.

The features of the Third Eye for Blind will help the visually impaired people in many ways. By wearing this device, they can fully avoid the use of the white cane and such other devices. This device will help the blind to navigate without holding a stick which is a bit annoying for them. They can wear the device as a band or like a cloth and it can function very accurately and they only need a very little training to use it as it is quite simple, efficient and easy to operate and wear.\

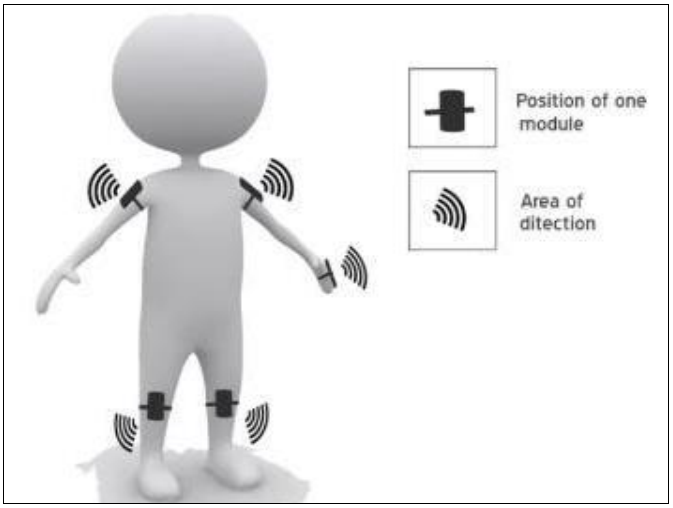

Fig 3: Position of the modules

6. Working Operations

This proposed system consists the equipment like Arduino mini pro, ultrasonic sensor, pref board, vibrating motor, buzzers for detecting the obstacles and letting the user know about the obstacle, Red LEDs, Switches, Jumper cable, power bank, Male and female header pins, 3.3 volt old mobile battery which is unused or discarded, some elastic and stickers to make the device wearable as a band for wearing for the users.

The wiring of the device is done in a following manner. The Ground of LED, buzzer and vibration motor are connected to GND of the Arduino. The +ve of the LED and the middle leg of switch is connected to the Arduino pin 5. The +ve of the Buzzer is wired to the first leg of the switch and the +ve of the Vibration motor is wired to the third leg of the switch.

The Ultrasonic sensor are wired accordingly. The Ultrasonic sensor pin VCC is connected to the Arduino pin VCC, Ultrasonic sensor pin GND is connected to the Arduino pin GND, Ultrasonic sensor pin Trig is attached to the Arduino pin 12, Ultrasonic sensor pin Echo is connected to the Arduino PIN 12. The switch used here is for selecting the mode. (Buzzer or vibration mode.)

We first cut the pref board in 5 X 3 cm dimension and solder the female headers for the arduino to the board. Then soldering of the buzzer is carried out. Then using the glue connect the vibrating motor and solder the wires to it. Then connection of the LED is done. Then connect the switch. Connect the header pins for ultrasonic sensors and for the battery input. Then solder all the things and connect the arduino and ultrasonic sensor to the board. Also connect the elastic band to all the modules. For making the module for the hand, connect the ultrasonic sensor to the board by using 4 jumper cables. Then connect a 3.7 volt mobile battery to this module. Then connect the elastic band. In the end after all the cnnections are done to the Arduino board, upload the code to each arduino board and power the 4 other modules using a power bank.

Fig 4: Module for hand

The US sensor is a transducer, and is used in pair as transreceiver. The transmitter emits the US waves and if obstacles are present in the path, the US waves hits the obstacles and gets reflected back, the reflected wave is received by the receiver. The US sensor is a combination of one transmitter and receiver. The time interval between sending and receiving of the US signal is calculated, this time interval is used to calculate the distance between sensor and the obstacle.

The equuation for the distance calculation between the sensor and the object is as follows:

D = (HPTW * SV)/2
Where, D = Distance in cm.
HPTW = High time of pulse width.
SV = Sound velocity in cm/s.

The sensors which are placed in waist belt are in such a manner that the Ultrasonic pulses of sensors must not be overlapped one over the other. Sensors has a field of view (coverage) of about 60 degrees for 4 feet distance, as the distance from the sensor increases, the coverage angle decreases.
Thus, the objective is to cover a wide angle to detect the obstacles with the help of the ultrasonic sensors to help the blind and make it easy for them to move around easily without any hassle.
Hence, the distance calculation is calculated and the sensor detects and the further procedure of the buzz sound to the user is carried out.

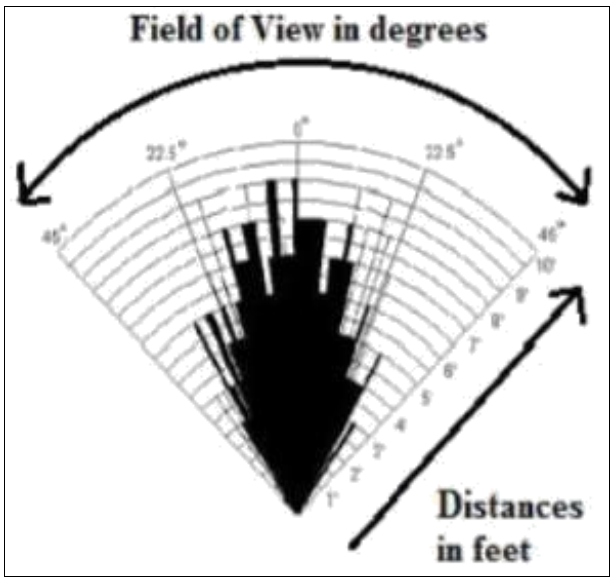

Fig 5: Angle of field of detection

Thus, this way Third Eye for Blind will be designed for the visually impaired people and will make it very easy and convenient as it will be a wearable device and thus will help the user in travelling and detecting the obstacles while walking very easily.

7. Results and Discussion

The presented system is designed and configured for the use of the blind and visually disabled people. This device is able to handle several states that the visually impaired people face. This device responds to the user in all the circumstances which is faced by the blind people with the help of the use of the Ultrasonic sensors and the Arduino Board.
Case 1: When the obstacle or the object is in the left it will tell the user that: The obstacle is in left
Case 2: When the obstacle is in right it will say: The obstacle in right.
Case 3: When the obstacle is in front, the device will say: the obstacle is in front.
Similarly for all the directions like left, right, back etc it will notify the user wearing it.

8. Conclusion

Thus, this project proposed the design and architecture of a new concept of Arduino based Virtual Eye for the blind people. A simple, cheap, efficient, easy to carry, configurable, easy to handle electronic guidance system with many more amazing properties and advantages is proposed to provide constructive assistant and support for the blind and visually impaired persons. The system will be efficient and unique in its capability in specifying the source and distance of the objects that may encounter the blind. It is able to scan and detect the obstacles in the areas like left, right, and in front of the blind person regardless of its height or depth. With the proposed architecture, if constructed with at most accuracy, the blind will be able to move from one place to another without others help.

9. Future Enhancement

The entire project can be made in the form of jacket, so that the device doesn't need to be wear one by one. By specifically suing the specialized boards that are designed, using them instead of Arduino and also by using high quality ultrasonic sensors makes and gives faster response which make the device capable of working in crowded places and thus this will be implemented in the future enhancement of this device.

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