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Wearable Iot Technology: Unveiling the Smart Hat

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Abstract— **Nowadays, a lot of peoples are having disorder known as visual impairment in which eyes cannot see objects in normal view. According to WHO, at least 2.2 billion peoples are suffering from the visual impairment and more than 30 million are permanently blind. Due to which they need guidance to travel somewhere otherwise they can't walk. Risky conditions arise when visually challenged people need to identify the items in front of them while crossing the roads. However, the technology gets advanced rapidly in the past few years but there is no budget-friendly way to improve the visual defect for the blind people. The development of smart hat is the primary goal of the project to help the blind people. In this project, ultrasonic sensors serve as the input device and buzzers as the output as the feedback to the user. Smart Blind walking hat has potential to enhance the lifestyle of the visually impaired persons in the society.**

Keywords— ***Wearable IoT, Arduino AT mega 328 Microcontroller, visually impaired person, ultrasonic sensor obstacle detection***

I. INTRODUCTION

In today's era, most of the peoples are suffering from some kind of disorder. One of the disorders known as visual impairment is widely come across in the recent few years. People face issues with the identification of the items which results in the difficulty to interact with their environment by the physical movement. A person has 5 senses of organ in which eye plays crucial role for the human, as they help the individual to recognize and visual the surroundings for the brain. Blindness coins to a state in which people's loss their ability to see anything, including even light or we can say lack of vision. Visually challenging and impaired people struggle to perform their daily routine works. These kinds of peoples need guidance or assistance especially while crossing the roadways, footpath, seeing the front obstacles etc. Such kind of conditions motivates us to bring the smart hat for the blind peoples.

Over the last decades, researcher have done lot of work in this field like developing the intelligent systems to assist the visually impaired peoples to detect the obstacles and alert them from the obstacles. The aim is to guide blind peoples in their travelling and alert them when their walking path is blocked by different objects, peoples or obstacles etc. It can be challenging to have smart stick all the time and it is difficult to carry them as fact it can be inconvenient. In order, help the visually impaired humans to move freely, a system has been developed to assist them with their day to day

chores. As among these advanced technologies, the "Blind Walking Hat "comes to be a remarkable and promising system which is designed to enhance mobility and secured feeling for the visually impaired. This paper aims to highlight on the impact of the Blind walking Hat and the potential of technology to create more independent environment. The suggest framework includes the Arduino microcontroller, Hat, ultrasonic sensor, servo motor. The entire system can be break down in two units which are Physical/Hardware sensing unit and Alert modules. The Physical sensing unit deals with the input signals required for the working. So, for obstacle detection we have used the ultrasonic sensor which having the range of 80 m - 100 m. The ultrasonic sensor senses the obstacle and the range of the object. The sensor is cost effective and having small in size after that the signal sent to the processing unit which is alert section by the sensor. After that alert unit receives the signal which is reflex, electromechanical which is used as signal for the servo motor. Servo motor is an actuator that can rotate its handle from 0 to 180 degree. It used to control the angular position having two types of pins which are GND needs to connect to the ground and another one is signal pin receives the PWM control signal from the Arduino's pin.

II. LITERATURE SURVEY

Some of the previous related works of literature review are as follows: -

The authors in [1] and [2] used the micro controller of AT MEGA 328, ultrasonic sensor, and servomotor for object detection. Ultrasonic Sensor emits waves, which in turn measures the distance of target objects through the air using "non-contact" techniques. The internal analog to digital converter is used to detecting an obstacle along with its displaying of the distance by using almost accurate distance measurement. The micro controller senses the environment by receiving the data using ultrasonic sensor and by

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controlling the output by displaying LCDS, speaker, motors, GS module.

In [4] and [3] the authors developed a model of mechanized and automated disinfectant with ultrasonic sound sensor and servomotor and Arduino board. The Arduino Nano micro controller is used. The rack and pinion systems are used as the mechanism for getting the liquid from the automated hand sanitizer. The servomotor is used for rotating the nozzle of the hand sanitizer. The disinfectant, which contains the ultrasonic sensor, will detect the user's hand and will then rotate it with the help of servomotor.

In [5] and [6] real time dangling object sensing design is done for mobile headset for visually impaired people. The two major algorithms such as elevation angle measurement and ultrasonic sensor depth alignment are made and are communicated with the blue tooth to the walking route to the headset. The headset is then used to communicate further to the user to give him a warning about the obstacle, which is present Infront of him

In [7] and [8] a smart blind walking hat and stick has been innovated which are connected together and uses infrared sensor to check the front area of the visually impaired by radiating signals through micro controller. It manages the parts of the system that alerts the user about the obstacle's dimensions, composition and position. The design, which had been proposed, was cost friendly, fast and easy to use for the visually challenging people in the countries.

In [9] and [10] a smart hat has been developed for the third world countries, which is cost friendly and simple to use. The proposed system by the authors uses an accelerometer and partitions the fall from other normal activities using an adaptive threshold set in triaxial directions and tells the people to move in a fixed line path using the angular displacement obtained from a gyroscope. Some sensors are also attached to cover the 360-degree range.

The author in [11] and [12] develops VibroCap, a helping hat that is made to find an obstacle and cation the blind people. With the use of PVDF (polyvinylidene Fluoride) ultrasonic sensors, the hat finds an obstacle located on the torso of the human body and detecting them in a general way is not possible but with the help of blind walking stick it is possible, three vibrations inform depending upon the distance the visually impaired person.

The author in [13] and [14] develops a smart aiding and walking stick for the blind people where the stick is retrofitted with ultrasonic sensors and water sensors sensing water and obstacles in front. The water sensors, which are unified there, then trigger the distinct buzzer. The model is made with a remote control featuring wireless RF, which automatically presses the buzzer.

In [15] and [16] the project was focused on developing a modernized version of ultrasonic blind walking stick, which consists of Arduino integrated environment, which is used to program the micro controller. Two ultrasonic sensors are used, one is used to detect the obstacle and the other is used to detect pit at a depressing level of 18cm. The controller here used is ATMEGA 328.

In [17] and [18] an open platform for the development of visual assistant devices for setting the benchmarking of the platform. A curious user dashboard using augmented reality for each object in the environment has voice assistant and communication with the user on command. A wearable computer captures video and other data extracts obstacles for the user and then detects it avoiding collision with the obstacle.

The cons [19] and [20] of walking stick are user should have to be in close contact so that he can sense the location of obstacle to avoid bumping while waggling. Uses TCRT1000, DYPME-007, GSM, GSP and many different sensors, which will help users to navigate easily indoor and outdoor wrong with monitoring health. It can also detect obstacle, pit, water on ground to some level, pulse rate detection, body temperature measurement of user and alert another person by sending issue of health to other emergency conditions.

III. METHODOLOGY

We divided this project into two components: software component and hardware component. The hard work component consists of ultrasonic sensors HC-SR041, Arduino, and buzzers. The software component consists of a program that is written in C++. We have used the three ultrasonic sensors that will help in detecting obstacles on 3 sides i.e., front, right, and left. The ultrasonic sensor sends waves that reflect after deviating from the obstacle and are received by the receiver of the ultrasonic sensor.

We have a buzzer that alerts the blind whenever the person is near an obstacle. It can detect any object from 2cm to 360cm of object. We are using a different type of Arduino and not the regular Uno as the size of the project is very small. We have chosen Arduino Micro as our microcontroller. We have used HCSR04 ultrasonic sensor size is very important for our project and our requirement is just sensing that also within a range of 360cm. We have used two active buzzers. Firstly, the reason behind using an active buzzer was the power source we are using is DC. We could have used a passive buzzer which could have decreased our cost but then we would have needed a separate oscillator which would have increased the size and complexity of our project. We used 2 buzzers because we wanted to offer the blind person the direction from which obstacle is coming or the person is moving. the obstacle is coming from the right then the right buzzer rings, if the obstacle is approaching from the left direction, the left buzzer rings, if the obstacle is approaching from the front, both buzzer rings.

Discussing the sensor placement, one ultrasonic sensor is placed on the forehead to detect the obstacles from the front, one on the right side of the head, and another one on the left side of the head. The Arduino is placed on top of the head to make it reachable to all the sensors and buzzers. We have placed the battery beside the Arduino itself. One barrier is placed beside the right ear and another buzzer is placed beside the left ear to alert the user about the direction of the obstacle.

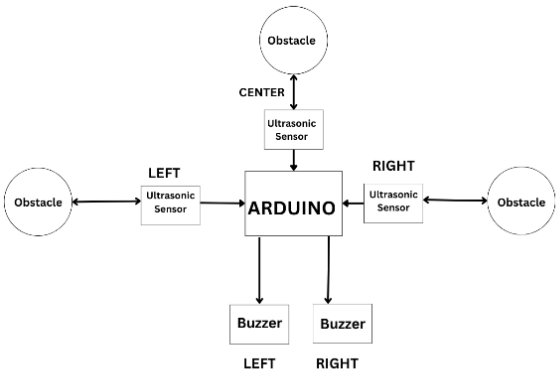

Fig .1. Block Diagram

In the above block diagram, we have tried to explain how the whole thing works. In the center, we have the Arduino, the microcontroller, which controls the whole system. The arrows that are coming from the ultrasonic sensor towards the Arduino is the reading that it has sensed. In the above image, it can be seen one arrow is moving out from the ultrasonic sensor and another arrow is moving into the ultrasonic sensor. The first arrow denotes the wave being sent and the second arrow denotes that wave returning after reflecting from the obstacle.

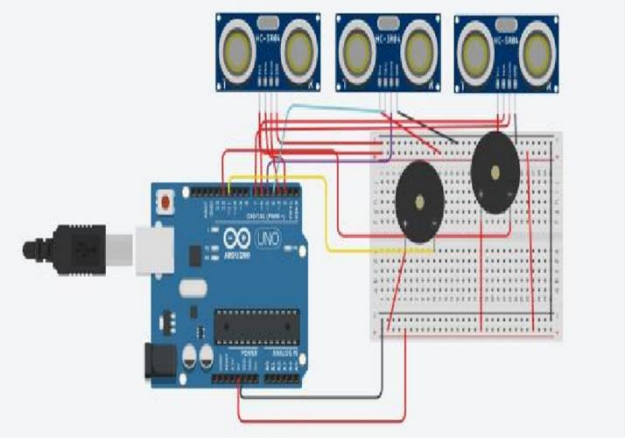

Figure .2 Tinker cad diagram of whole circuit

The term center left and right is the placement of each of the sensors. The sensors are placed in straight alignment so that there is no error in reading. The buzzers must be placed beside the ears so the person can hear them. The term left right written above the buzzers denotes the ear. Each of the sensors and buzzers is connected to a 5V power supply to power them. The other pins relate to their respective PINs as coded in the microcontroller.

The software is written in C++ in Arduino IDE and then compiled and uploaded. We have made the logic very simple so that we can decrease the complexity and increase the scope of future improvement. We are detecting only if the obstacle is within the range of 360cm. As we are using a low-cost ultrasonic sensor, we can't detect more than 360cm. Size was also an important factor. The min distance between the sensor and the obstacle is 100cm. We have used the buzzer and its placement with the help of conditional statements to alert the person about the obstacle. If the distance of the obstacle on the right is less than 100cm, then the right buzzer rings and the user is alerted by the buzzer's ring if an obstacle is approaching from the left side, the left buzzer rings,

and in case an obstacle approaches from the front, all the buzzers ring thereby altering the user.

To make the project we need various components to produce the desired results as per the requirements of the user and the targeted groups.

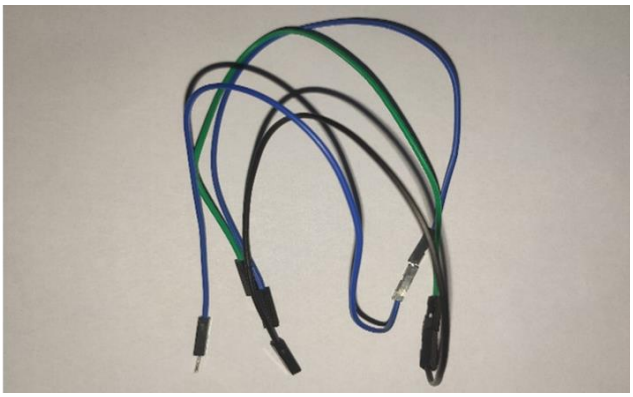

Figure .3 Jumper wires

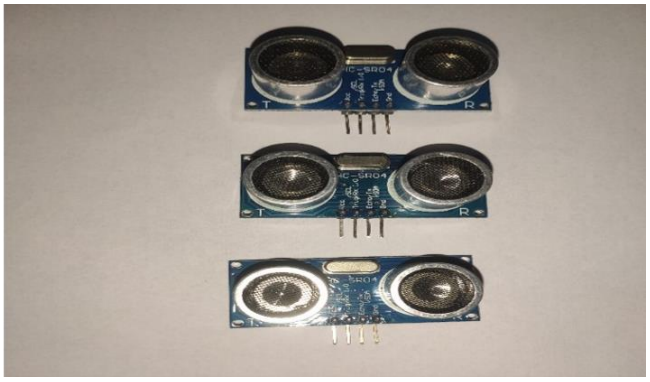

Figure .4 Ultrasonic sensors

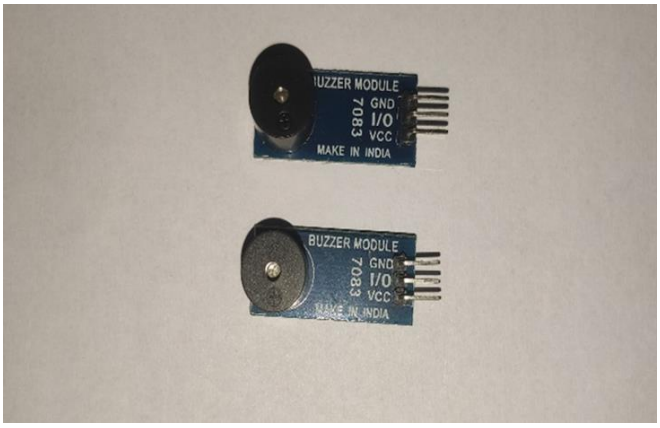

Figure .5. Buzzer

The integration of the buzzer, ultrasonic senor, Arduino uno is done with the help of a breadboard. The breadboard is an integrating device between all the components which will be powering all the components and thus making the project running successfully.

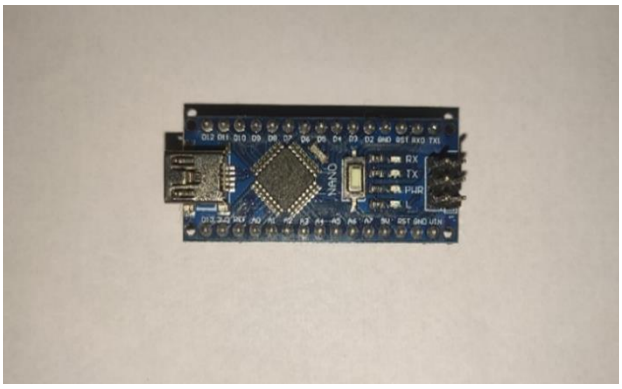

Figure .6 Arduino Nano

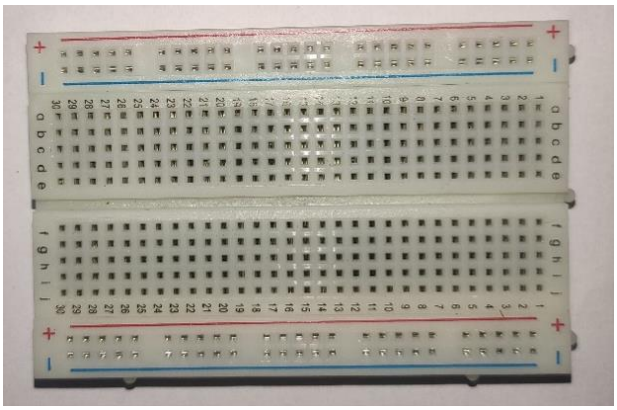

Figure .7 Breadboard

IV. RESULTS

There are two segments of the work hardware and software. The hardware part is the integration of all the components and the software part is the coding part, which is to be loaded into the Arduino nano on the basis of which the application result will be produced. The Arduino nano will contain the range of values within which when the ultrasonic sensors detect any objects the buzzer will be sounded giving alert and real time mechanism for the visually impaired and the blind people.
For the hardware part the integration between the components is required to be done to make sure the connection is ongoing and current is flowing through them all. At first the ultrasonic sensor contains 4 pins . Arduino Nano namely VCC, echo, trig and ground pin. The ground pin and the VCC pin will be connected to the VCC and the ground of the Arduino. The trig pin and the echo pin will be connected to the digital pin as per the digital high and low value the sound waves will be emitted and will be received and then the distance value will be calculated on the basis of the speed of sound which is 343 m/s. The Arduino then decides on the basis of the code whether to trigger the buzzer or not. If the buzzer if triggered that means the object is in a nearby-threatened range.

The buzzer contains 3 pins namely VCC, I/O and the ground pin. The VCC is used to power up the buzzer and the ground pin is used to connect with the ground of the Arduino. The I/O pin is used to send a trigger the output of the buzzer whenever required. The buzzer pin is connected to the digital pin of the Arduino nano.

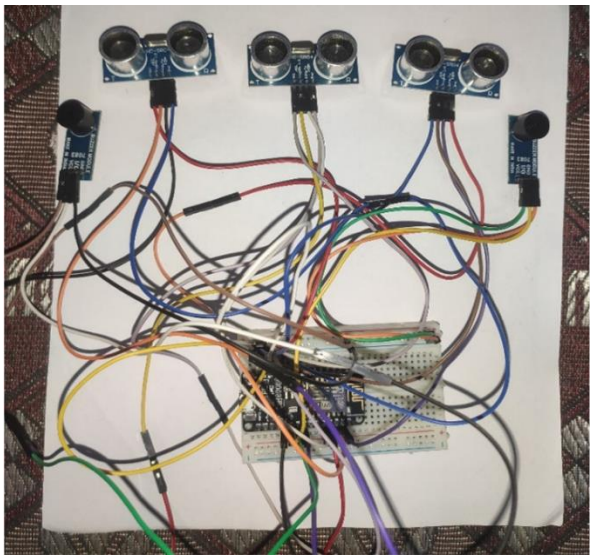

Figure .8. Full circuit of smart blind walking hat

As we can see from the above image there are three ultrasonic sensors placed at 3 ultimate positions which will be placed one at the front, and the other two on two sides. For every ultrasonic sensor there will be an individual buzzer, so the user will get to know from which the object is coming or is present. To understand for a fact, if the ultrasonic sensor detects an object on the right-hand side based on the preferred range of 110cm. the buzzer present on the right-hand side will be triggered alarming the visually impaired or the blind person about the object in front of them.

The second part of the model is to deploy the code in the software mode. The code which is the sketch of the Arduino uno is to be written which will help in taking the decision that at what distance the buzzer will ring or nor. The brute force steps to assign to implement the following are as follows:
follows:

a) At first assign define the trigger and echo pin for 3 ultrasonic sensors
b) The maximum distance is set as 110 cm which means the ultrasonic sensor will be taking values up to a distance of 110 cm
c) After assigning the values it's time to calculate the distance between the sensors and the objects for all sensors present at the front, left and right
d) If the distance measure is less than the maximum distance then the buzzer is raised in case the object is detected from left and right side
e) If the distance detected is in front then both the buzzers are detected making the blind person know the position of the obstacle in front of it
f) If there is no object present then both the buzzers are at low and will not be triggered.

Now after the code is written it is then uploaded to the Arduino nano from which it can make decisions whether to trigger the buzzer or not. If the object is present in the radius of 110 cm, then the buzzer will be raised giving real time alert to the user.

The model is tested and experiment by integrating both the hardware and the software part and then placed on the hat. When the model is integrated and placed on the hat the results were taken to understand the accuracy and behavior of the model. The following table shows the values which were taken during the experimentation of the showcasing smart walking blind hat.

Table .1. Results Table

S. No	Distance from obstacle (cm)	Elevation in cm	Obstacle detected
1)	10	155	Yes
2)	30	150	Yes
3)	50	130	Yes
4)	80	80	Yes
5)	110	110	No
6)	140	20	No

As we can see from the above table the values of the obstacle within 110 cm are detected even at an elevation of 155cm. The height is required here because the hat will be worn on top of the head for which the elevation angle is needed through which the angle of depression is calculated and then the obstacle value is detected or not. The value is then plotted in tabular format after taking may readings.

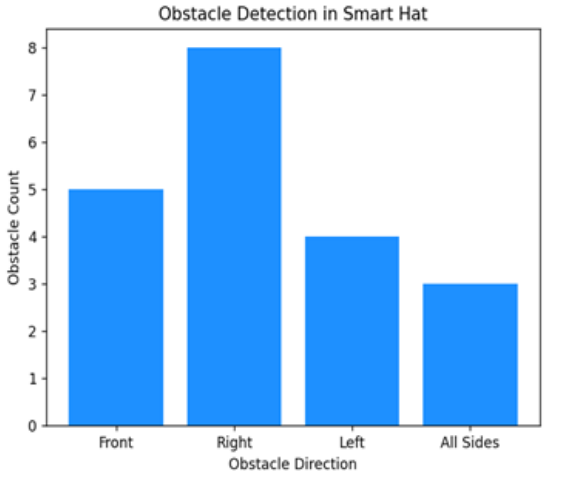

Figure .9. Accuracy count of the number of objects detected

In the above graph, that the X-axis represents different obstacle directions. As in this project, we have three ultrasonic sensors, so the X axis basically represents the direction at which the ultrasonic sensors are placed. The Y axis represents the count of the obstacle. The count mentioned above are based on data collected by ultrasonic sensors.

The below image basically shows the prototype of this project. We have placed an ultrasonic sensor on the front side of the cap which detects the obstacle that comes from front. The ultrasonic sensor at right side detects the obstacle that are approaching from the right direction and along with it, a buzzer is attached near the right ear to alert the person about the direction of the obstacle. The same thing is done with the left ultrasonic sensor. Person is wearing the prototype and the hat is detecting the obstacles and then the buzzer is ringing as per the user requirements.

Figure.10. Prototype

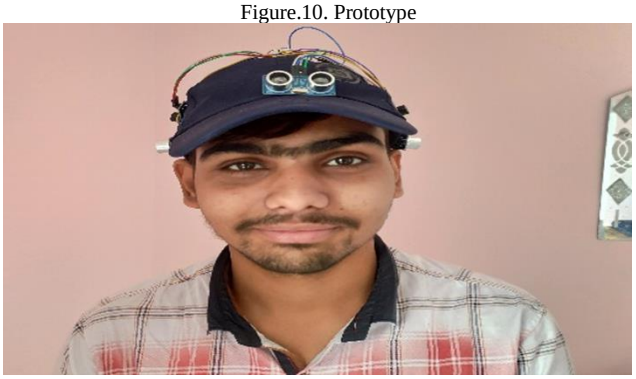

Figure .11. Person wearing the prototype

Figure .12. Side view of person wearing the prototype

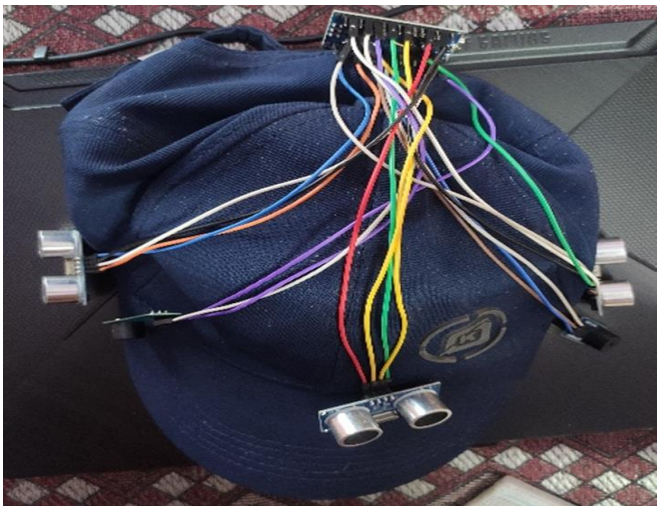

Figure .13. Ariel view of the prototype

V. Conclusion

Blind is the disability of a person which occur due to an accident happen in past. A blind person cannot see the world with his naked eyes. So, in order to experience the world and reduce the problem face to a blind person we made a hat by using Arduino. This is because he feels like a normal person. We make a hat which is feel like a normal hat but it has special characteristics like it is light and inexpensive. In hat, we use three ultrasonic sensor which is placed at the right, left and straight at the top of hat so he measures the distance with objects like table, chair and almirah etc. in all directions. We integrate some other tools like buzzer to enhance the productivity of hat which also helps to improve the accuracy in terms of distance. In this, we place two buzzers at near of right and left ear which produce the beep sound which object come in range to sensor to indicate them. It gives accurate distance between object and sensor. It helps blind person to find another way to move. Compared with traditional system or canes, we also integrate the tool buzzer which produce the sound when object is nearer to the sensor to indicate the right direction produce the sound when object is nearer to the sensor to indicate the right direction.

VI. Future Work

Sometimes, even with the use of stick can harm the life of people. After time passes, the stick condition is worse and safety is not guaranteed. The stick cannot detect all results truly. It detects results in variation and its accuracy is not 100%. So, in future, there are some changes which we have done in near future to help the blind person. In this, we install the camera in hat, to detect the image of object. By using buzzer and Bluetooth device it speak that object is nearby sensor which is install in ear. In this, with the help of camera, it detects the person and it increase the safety of person by knowing all the details of the blind person with the help of Internet. But it is not very light and we install it all time in the ear. There is another use of ultrasonic sensor in which it detects the water by using ultrasonic waves. In this, it detects the water droplets and send request to the buzzer to indicate the blind person to avoid the collision to objects. We also integrate with the mobile phone for perfect accuracy and keep track of all the records. These are the future work which will done on this project.

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