School of Computer Science and Engineering

ALTERNATE EYES FOR BLIND PEOPLE.

A project submitted
in partial fulfillment of the requirements for the degree
of
Bachelor of Technology
In
Computer Science and Engineering

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DECLARATION

We hereby declare that the thesis entitled "ALTERNATE EYES FOR BLIND PEOPLE" submitted by us (Aditya Sarangarajan, Abhijay thakur, R B Nishanth, K Namithaa, Satyam Singh),for the award of the degree of Bachelor of Technology in Programme to VIT is a record of bonafide work carried out by us under the supervision of Prof. SHARAN CHANDRAN M.

We further declare that the work reported in this thesis has not been submitted and will not be submitted, either in part or in full, for the award of any other degree or diploma in this institute or any other institute or university.

Place :

Date : Signature Of the Candidates

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We thank the Head of the Department, Computer Science and Engineering Department, Vellore Institute of Technology, Vellore. For their extremely valuable recommendations, crucial times, and meetings we had with them while working together.

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EXECUTIVE SUMMARY

Globally, 40 million people are predicted to become blind by the World Health Organization. In their daily lives, they encounter numerous challenges. For an extended period, those affected were compelled to rely on traditional white cane, which has several disadvantages despite being beneficial. The biggest problem for those who are confused is figuring out where they are.

Through the use of their other senses such as touch and hearing—this research aims to help blind people become less blind. A buzzer is also included in the framework to provide vibration indications and a warning sound.

This framework offers a robust, small, force-free, resilient, and reasonably priced solution for routes requiring observably quick reaction times. A technological advancement known as the "third eye for the blind" combines science, software engineering, hardware design, and other disciplines to enable visually impaired people to see and navigate the world with confidence. It functions by identifying objects in the immediate vicinity using ultrasonic waves and notifying the user through a vibration or beep. This technology has the potential to change the lives of blind people. This integrates a module with an ultrasonic sensor. The user can travel more efficiently and see nearby objects with this sensor-module. When it detects an object in any area, this sensor alerts the user by vibrating or beeping.

ABSTRACT

Vision is the most valuable and significant gift that God has given to all of his creatures, but especially to humans. Unfortunately, there are those who cannot see the beauty of the world with their own eyes. According to WHO estimates, 40 million people will become blind worldwide. They face several challenges in their daily lives. The main challenge is getting confused people where they need to go. This research aims to help blind or visually impaired people overcome their loss of vision by utilizing other senses, such as touch and sound.

With this framework, routes with noticeably quick reaction times have a reliable, affordable, force-free, compact, and robust solution. Thus, giving blind people virtual vision is the initiative's main objective. A technological innovation that blends science, software engineering, hardware design, and other disciplines is called the third eye for the blind.

People who are visually impaired can see and explore the world with confidence and independence thanks to this device, which uses ultrasonic waves to detect nearby objects and alert the user with a vibration or beep. This technology could be a game-changer for the blind. An ultrasonic sensor is built right into this module. This technology will guarantee the blind's freedom of movement, which will benefit them greatly.

INTRODUCTION

People who are blind or visually impaired have traditionally used the traditional white cane, which has some advantages but drawbacks as well. Nowadays, individuals with visual impairments can navigate using a wide range of gadgets and smart technologies, but most of them are large and complicated to use. This invention is especially notable because it is inexpensive for everyone, costing less than $25 (1500 INR) in total. There are no such inexpensive, user-friendly devices that fit like watches available on the market. The community will benefit greatly from it if the prototype is modified and widely implemented. A wearable that allows people with external disabilities to move around independently indoors is considered an advanced wearable for the visually impaired.

i.e., People with sight impairments can still move around on their own. When someone needs to go about a house or other indoor location by themselves, this device comes in very handy. The device determines an obstacle's distance using an ultrasonic module and a microcontroller. A buzzer and sound notify the person who is clearly obstructed of the obstacle's distance. As a result, they are able to move in different directions without colliding. Upon completion of the task, a glove with a wearable band attached would be produced, with each section linked to a PCB that functions with the highest precision and consistency.

1.1 **Objective**

The World Health Organisation estimates that 40 million people worldwide are blind. They have a lot of challenges to overcome every day. The traditional white cane, while helpful, has a number of drawbacks and has been used for a considerable amount of time by those who are affected. Another option is to keep a dog as a pet, but this has significant expenses.

The project's goal is to provide a more affordable and effective means of assisting people who are blind or visually impaired in travelling more swiftly, conveniently, and self-assuredly.

1.2 **Motivation**

This is the first wearable gadget designed specifically for the blind that addresses every problem with previous iterations. The blind and visually handicapped can move more easily with the help of numerous gadgets and technological developments available today, but many of them are large and complicated to operate.

This invention's main selling point is that everyone can use it.This product is unique in that it is inexpensive, simple, and fits like a garment. It is not available anywhere else.

With improvements made to the prototype and a large-scale implementation, the community will benefit immensely.

1.3 **Background**

A third eye for the blind is a technological advancement that vibrates or buzzes the user to alert them to obstacles in the surroundings using ultrasonic waves. People who are blind can now move quickly and confidently thanks to this. All they need to do is wear it as a bracelet or an article of clothing.

The first wearable gadget that uses ultrasonic waves to detect obstacles was made expressly for blind people. triggering a buzzer sound or feeling to warn the user.

1. LITERATURE REVIEW:

[1] M. V. S. Arvitha, A. G. Biradar and M. Chandana, "Third Eye for Visually Challenged Using Echolocation Technology," 2021 International Conference on Emerging Smart Computing and Informatics (ESCI), Pune, India, 2021, pp. 391-395, doi: 10.1109/ESCI50559.2021.9397015.

It is an integrated framework that can identify water puddles, stairs, and obstructions in the path using two ultrasonic and two infrared sensors. The Arduino UNO board receives data from the sensors in real-time or continuously and processes it. Following processing, the message—which is interpreted as a warning—is played via a headphone by the Arduino UNO board. The system is powered entirely by a power bank. This development's primary peculiarity is that anybody may access it.

[2] H. Hesham, L. Khalil, A. Hafez and M. Hussein, "Design, Simulation, and Implementation of connected IoT for Disabled People," 2022 2nd International Mobile, Intelligent, and Ubiquitous Computing Conference (MIUCC), Cairo, Egypt, 2022, pp. 279-283, doi: 10.1109/MIUCC55081.2022.9781761.

It is an integrated framework in IoTHealthcare for people with impairments that can be conveniently controlled and monitored using wearables that are coordinated and a customizable application. The wearable technology together with the application will aid individuals who are visually, vocally, and audibly challenged, support the Alzheimer's community, and record a range of information about the patient's vitals.

[3] L. Albraheem et al., "Third Eye: An Eye for the Blind to Identify Objects Using Human-Powered Technology," 2015 International Conference on Cloud Computing (ICCC), Riyadh, Saudi Arabia, 2015, pp. 1-6, doi: 10.1109/CLOUDCOMP.2015.7149661.

This program makes use of human resources, built-in cameras, and accessibility features on smartphones to describe every photo or video that people with visual impairments have taken. Actually, selecting the finest technology to use in the development of the proposed application requires a great deal of work. To aid visually impaired individuals in identifying items, a comprehensive evaluation of assistive technology is being created.

[4] F. Carpi, G. Frediani and D. De Rossi, "Electroactive elastomeric actuators for biomedical and bioinspired systems," 2012 4th IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob), Rome, Italy, 2012, pp. 623-627, doi: 10.1109/BioRob.2012.6290761.

The paper shows how innovative devices that enable biomedical and bioinspired systems that would be impossible with current technology may be made by integrating fluid-based hydrostatic transmission with dielectric elastomer actuation. They presented and spoke about three samples of the applications that our lab is now developing.

[5] J. Bai, S. Lian, Z. Liu, K. Wang and D. Liu, "Virtual-Blind-Road Following-Based Wearable Navigation Device for Blind People," in IEEE Transactions on Consumer Electronics, vol. 64, no. 1, pp. 136-143, Feb. 2018, doi: 10.1109/TCE.2018.2812498.

This creates a navigational device. The locating, wayfinding, route following, and obstacle avoiding modules are the fundamental components of a navigation system. However, because the interior environment is complex, changing, and often full of dynamic objects, it is still challenging to take obstacle avoiding into consideration during route following. They have devised a unique solution to this issue that uses a dynamic subgoal selection system to help users avoid obstacles while also guiding them toward their goal. For the benefit of blind people on their daily journeys, this plan is the centerpiece of an extensive navigation system that is installed on a pair of wearable optical see-through spectacles.

[6] "Methodology to Build a Wearable System for Assisting Blind People in Purposeful Navigation|IEEEConferencePublication|IEEEXplore."https://ieeexplore.ieee.org/document/9092068(accessed Nov. 04, 2022).

The building procedure for a wearable device with eyesight that aids the blind in navigating challenging interior environments was suggested by Andres A. Diaz et al. in their system [3]. The proposed system can identify objects, obstacles, and pedestrian places of interest, such as doors, seats, stairs, and computers. It can also create a path that allows the user to reach other locations and securely accomplish objectives (purposeful navigation). The six components that make up the gadget are: floor segmentation; constructing an occupancy grid; avoiding barriers; detecting things of interest; route planning; and offering haptic feedback to the user.

[7] Khan, Akif; Khusro, Shah. Journal of Ambient Intelligence and Humanized Computing , May 2022, Vol. 13 Issue: 5 p2841-2871, 31p., Database: Supplemental Index

According to Khan et al., the availability of ubiquitous devices like smartphones, smartwatches, and wearable support bands is an increasing trend [4]. Smartphones and smartwatches are becoming a necessary everyday tool for those who are blind or visually impaired. Activities that promote independence, self-reliance, and productivity. The talkback and voice functionality among the accessibility features. Having an assistant helps blind people use their phones more easily for reading books, sending messages, exchanging photos, and making calls, among other things. But there are other problems with the accessibility services that are available right now, such as delayed These abilities include, but are not limited to, locating objects of interest in a complex layout, selecting and accessing non-visual elements on a screen, interacting multimodally, and managing several linked devices. On different devices, there are labels, buttons, panel layouts, and other User Interface Artefacts (UIAs). The framework improves the user experience by streamlining UI components for blind-friendly smartphone and wearable user interfaces.

[8] Barontini, Federica; Catalano, Manuel G.; Pallottino, Lucia; Leporini, Barbara; Bianchi, Matteo. IEEE Transactions on Haptics , Jan/Mar2021, Vol. 14 Issue 1, p109-122, 14p. Publisher: IEEE., Database: Complementary Index

Barotini Federica et al. suggested[7] that a great deal of effort has gone into developing technological travel assistance. These systems can provide end users with spatial information about their environment through sensory substitution (auditory, haptic).Nevertheless, despite the encouraging study results, these concepts have only gained a small degree of acceptance in the actual world. This is often the consequence of actual end users participating infrequently enough during the conceptual and design phases. An advanced indoor navigation system based on haptic technology. People with vision impairments have consistently provided input at every stage of development. A processing unit to compute visual information for obstacle avoidance, an RGB-D camera, and a wearable device that may provide normal and tangential force cues for navigation in an unfamiliar interior environment comprise the system.

2. PROJECT GOALS:

The primary objective is to create cutting-edge wearable technology for the blind that addresses every problem with previous iterations. Today's blind and visually impaired can travel thanks to a variety of gadgets and technological advancements, many of which are massive and require specialised training to operate. The fact that this technology is available to everyone is its greatest selling point. The prototype should be of great use to the community once it has been improved and made widely available. The project aims to give blind or visually impaired people a more economical and efficient way to move more quickly, comfortably, and confidently.

3. TECHNICAL SPECIFICATIONS:

Hardware used:

1. Arduino nano:

Arduino nano The Arduino is an electronic device that combines hardware and software to create an electronic Arduino-based project. Arduino is a type of microcontroller that has additional features such as a USB connector and GPIO pins.

Fig 3.1 Arduino Nano

2. Ultrasonic sensor (HC-SR04):

The ultrasonic sensor is composed of three parts: a transistor, a receiver, and a transmitter. Transceivers serve as both a transistor and a receiver; they are usually the receiving component. Soundwaves are converted into electrical signals by transistors, while soundwaves from obstacles are converted into electrical signals by receivers. In essence, it employs sound waves to gauge how far away an obstruction is.

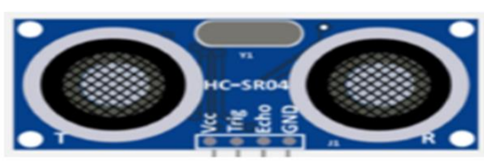


Fig 3.2 Ultrasonic sensor

3. **Perf Board:**

Perf board, sometimes referred to as DOT PCB, is a material consisting of a thin, rigid sheet that has been suitably drilled at uniform intervals across its surface. It is better to drill a dot rather than a square area. It makes it possible to connect electronic circuits simply.

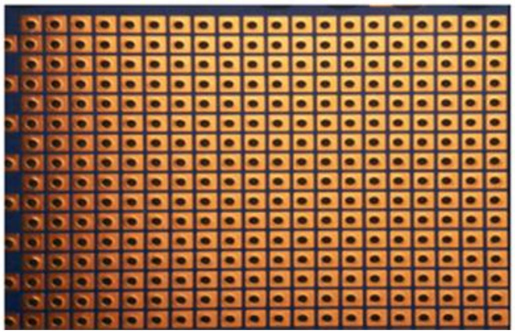


Fig 3.3. Perf Board

4. **Buzzer:**

An electrical device that transmits a sound signal to a channel is similar to a buzzer. A buzzer may be piezoelectric, electromechanical, or mechanical. It is a gadget that produces sound signals from audio signals.

Fig 3.4. Buzzer

5. **Battery:**

The positive terminal of a battery is known as the cathode and the negative end as the anode while it is generating electricity. Electrons that go from the negative terminal to the positive terminal through an external electric circuit originate at the negative terminal. Redox reactions take place when a battery is connected to an external electric load. These reactions transform high-energy reactants into lower-energy products and provide the electrical energy that results from this free energy difference to the external circuit. In the past, a device consisting of many cells was referred to as a "battery"; today, the word is used to describe devices consisting of just one cell.

Fig 3.5. Battery

SOFTWARE USED

Arduino software: Arduino UNO is one of the greatest programming software for all of the above-mentioned operations that complete the total project. The Arduino software is written in the C++ programming language, with some extra unique functions and methods added.

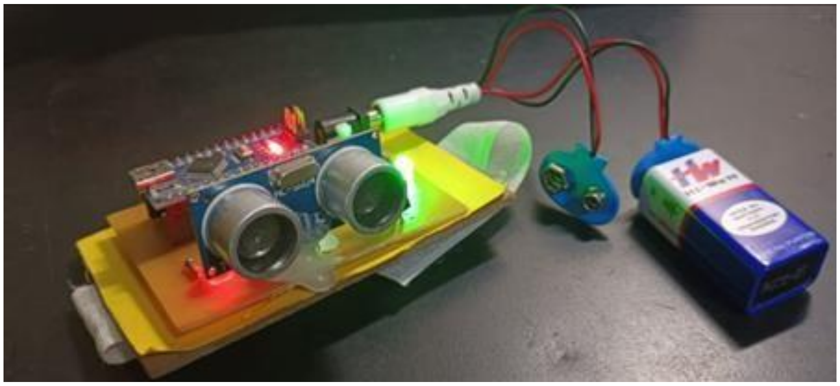
4. DESIGN APPROACH AND DETAILS:

4.1 Design Approach:

The ultrasonic sensor and the Arduino Nano are ready to connect. The ultrasonic sensor's input signal goes to the Arduino, which uses the right coding input to carry out the necessary operations, and the Arduino's output goes to the buzzer, which aids the blind person in identifying the obstacle. This fully automated device's vibration intensity and beeping rate increase as distance decreases.

Everything is set up for the Arduino Nano to connect to the ultrasonic sensor. The Arduino mini is supposed to be connected to the ultrasonic sensor. After receiving the input signal from the ultrasonic sensor, the Arduino board performs the following actions by following a set of coding instructions. A buzzer connected to the Arduino's output helps someone who is blind identify obstacles in their immediate environment. The LED, battery, and jump cables are all part of the device's system design.

These jump cables make it easier to connect the prototype's various hardware components, which include an ultrasonic sensor, buzzer, and LED. The Arduino receives the input signal from the ultrasonic sensor and uses the correct coding input to perform the required actions. The buzzer receives the output from the Arduino, assisting the blind person in identifying the obstacle. The Arduino-based third eye of the blind also has a battery, jumper wires, and an LED light built in. Arduino is to be linked to multiple pieces of hardware, including an LED, a buzzer, an ultrasonic sensor, and so forth.



Prototype design

4.2 Code:

```
#define button1 2 // this button use for only Alarm mode

#define button2 3 // this button use for Alarm & Vibrator mode

#define button3 4 // this button use for only Vibrator mode

#define buzzer 5 // this pin use for Alarm

#define motor  6 // this pin use for Vibrator Motor

#define echopin 7 // echo pin

#define trigpin 8 // Trigger pin

int Alarm=1, Vibrator=1;

int cm; // Duration used to calculate distance

void setup(){ // put your setup code here, to run once

Serial.begin(9600);// initialize serial communication at 9600 bits per second:

pinMode(button1, INPUT_PULLUP);
```

```
pinMode(button2, INPUT_PULLUP);

pinMode(button3, INPUT_PULLUP);

pinMode(buzzer, OUTPUT); //declare buzzer as output

pinMode(motor, OUTPUT); //declare vibrator Motor as output

pinMode(trigpin, OUTPUT); // declare ultrasonic sensor Echo pin as input

pinMode(echopin, INPUT);  // declare ultrasonic sensor Trigger pin as Output

delay(100);

}

void loop(){

if(digitalRead(button1)==0) Alarm=1, Vibrator=0; //only Alarm mode

if(digitalRead(button2)==0) Alarm=1, Vibrator=1; //Alarm & Vibrator mode

if(digitalRead(button3)==0) Alarm=0, Vibrator=1; //only Vibrator mode

// Write a pulse to the HC-SR04 Trigger Pin

digitalWrite(trigpin, LOW);

delayMicroseconds(2);

digitalWrite(trigpin, HIGH);

delayMicroseconds(10);

// Measure the response from the HC-SR04 Echo Pin

long ultra_time = pulseIn (echopin, HIGH);

  // Determine distance from duration
```

```
  // Use 343 metres per second as speed of sound

cm =  ultra_time / 29 / 2;

Serial.print("cm:");Serial.println(cm);

if(cm>=20 && cm<=100){

int d = map(cm, 20, 100, 20, 2000);

if(Alarm==1)digitalWrite(buzzer, HIGH);   // Turn on Buzzer

if(Vibrator==1)digitalWrite(motor, HIGH); // Turn on Vibrator

delay(100);

digitalWrite(buzzer, LOW); // Turn off Buzzer

digitalWrite(motor, LOW);  // Turn off Vibrator

delay(d);

}

if(cm<20){

if(Alarm==1)digitalWrite(buzzer, HIGH);   // Turn on Buzzer

if(Vibrator==1)digitalWrite(motor, HIGH); // Turn on Vibrator

}

if(cm>100){

digitalWrite(buzzer, LOW); // Turn off Buzzer

digitalWrite(motor, LOW);  // Turn off Vibrator

}
```

```
delay(10);

}
```

Implementation of code

code

```
pinMode(motor, OUTPUT); //declare Vibrator Motor as output

pinMode(trigpin, OUTPUT); // declare ultrasonic sensor Echo pin as input
pinMode(echopin, INPUT);  // declare ultrasonic sensor Trigger pin as Output

delay(100);
}

void loop(){

if(digitalRead(button1)==0) Alarm=1, Vibrator=0; //only Alarm mode
if(digitalRead(button2)==0) Alarm=1, Vibrator=1; //Alarm & Vibrator mode
if(digitalRead(button3)==0) Alarm=0, Vibrator=1; //only Vibrator mode

// Write a pulse to the HC-SR04 Trigger Pin
digitalWrite(trigpin, LOW);
delayMicroseconds(2);
digitalWrite(trigpin, HIGH);
delayMicroseconds(10);

// Measure the response from the HC-SR04 Echo Pin
long ultra_time = pulseIn (echopin, HIGH);
  // Determine distance from duration
  // Use 343 metres per second as speed of sound
cm =  ultra_time / 29 / 2;

Serial.print("cm:");Serial.println(cm);

if(cm>=20 && cm<=100){
int d = map(cm, 20, 100, 20, 2000);
if(Alarm==1)digitalWrite(buzzer, HIGH);   // Turn on Buzzer
```

Implementation of code

```
if(Alarm==1)digitalWrite(buzzer, HIGH);   // Turn on Buzzer
if(Vibrator==1)digitalWrite(motor, HIGH); // Turn on Vibrator
delay(100);
digitalWrite(buzzer, LOW); // Turn off Buzzer
digitalWrite(motor, LOW);  // Turn off Vibrator
delay(d);
}
if(cm<20){
if(Alarm==1)digitalWrite(buzzer, HIGH);   // Turn on Buzzer
if(Vibrator==1)digitalWrite(motor, HIGH); // Turn on Vibrator
}

if(cm>100){
digitalWrite(buzzer, LOW); // Turn off Buzzer
digitalWrite(motor, LOW);  // Turn off Vibrator
}

delay(10);
}
```

Implementation of code

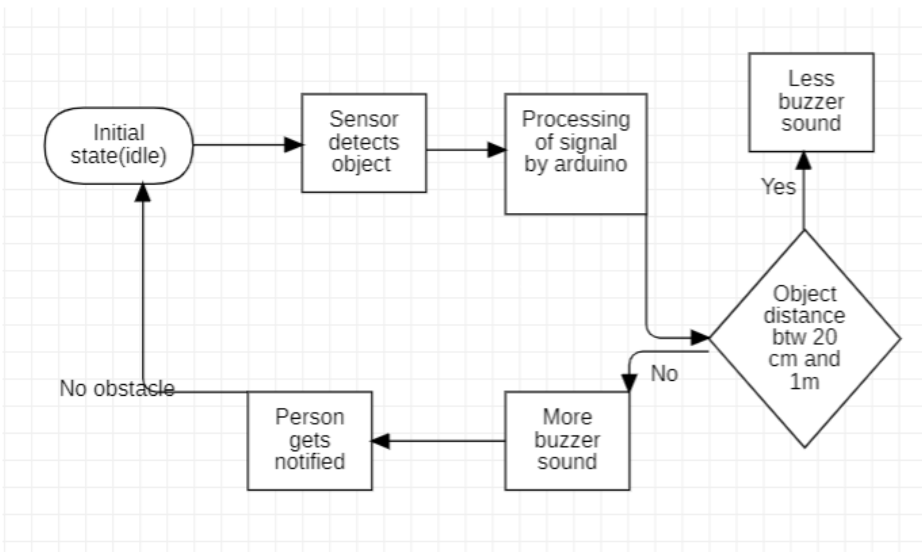
```
Success: Saved on your online Sketchbook and done verifying 3RD_EYE_FOR_BLIND

/usr/local/bin/arduino-cli compile --fqbn arduino:avr:nano:cpu=atmega328 --build-cache-path /tmp --output-dir
/tmp/2183808621/build --build-path /tmp/arduino-build-15269782C63117773645905E3BD1A8BE /tmp/2183808621/3RD_EYE_FOR_BLIND
Sketch uses 3128 bytes (10%) of program storage space. Maximum is 30720 bytes.
Global variables use 198 bytes (9%) of dynamic memory, leaving 1850 bytes for local variables. Maximum is 2048 bytes.
```

5. **PROPOSED SYSTEM:**

The ultrasonic sensor is intended to be connected to the Arduino mini. The Arduino board receives the input signal from the ultrasonic sensor and uses certain coding instructions to carry out the subsequent operations. The Arduino's output is linked to a buzzer, assisting the visually impaired individual in identifying nearby impediments. The device's system design includes jump cables, a battery, and an LED. These jump cables facilitate the connection of the prototype's several hardware parts, including an LED, buzzer, and ultrasonic sensor.

Everything is set up for the Arduino Nano to connect to the ultrasonic sensor. The Arduino receives the input signal from the ultrasonic sensor and uses the proper coding input to do the required tasks.



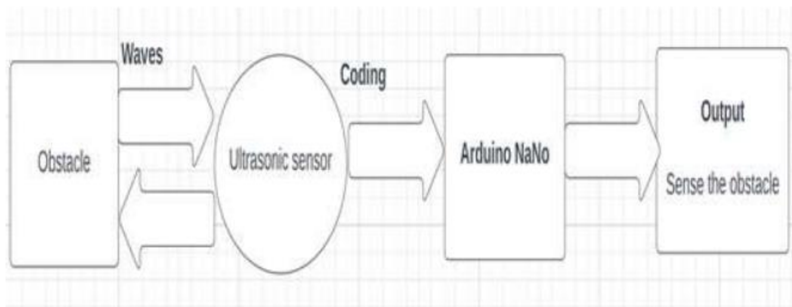
Block Diagram

6. **SYSTEM ARCHITECTURE:**

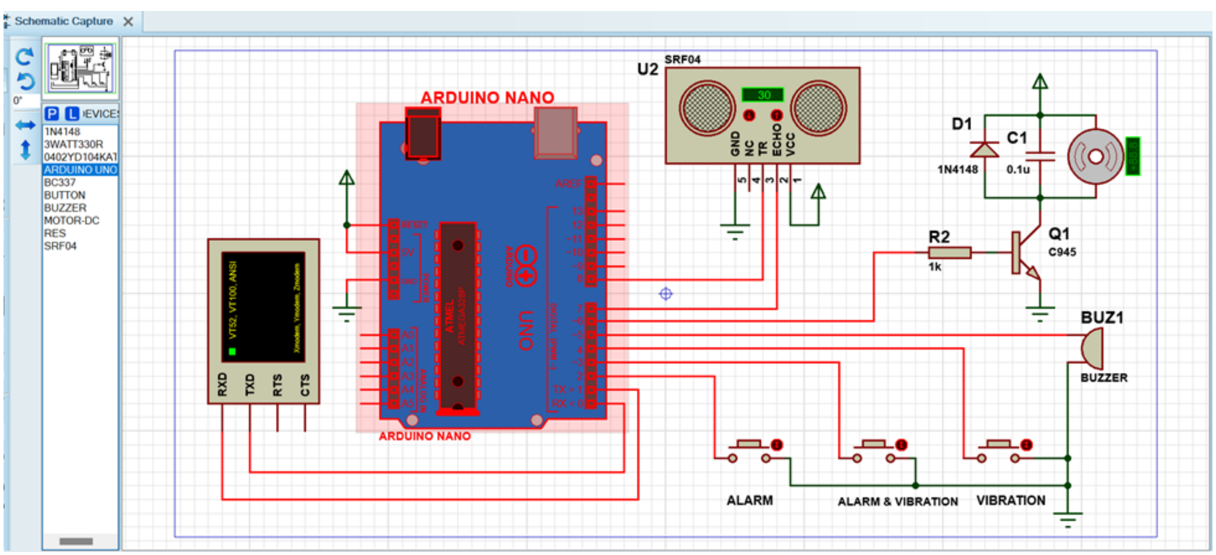
The ultrasonic sensor and the Arduino nano are ready to connect. The ultrasonic sensor's input signal goes to the Arduino, which uses the right coding input to carry out the necessary operations, and the Arduino's output goes to the buzzer, which aids the blind person in identifying the obstacle. An LED lightbulb, a battery, and jumper wires that enable various body components are also included in the system architecture of the Arduino-based third sight for the blind. Two for each shoulder, two more for each knee, and one for the hand are among them. Blind persons may easily move anywhere by using the five ultrasonic sensors to identify items in a five-dimensional perspective around them.

The gadget will vibrate and emit beeps to alert the user when the ultrasonic sensor finds an obstruction. This completely automated gadget has a beeping rate and vibration strength that increase as the distance decreases.

Everything is set up for the Arduino Nano to connect to the ultrasonic sensor. The Arduino receives the input signal from the ultrasonic sensor and uses the proper coding input to do the required tasks. The buzzer receives the output from the Arduino, assisting the blind person in identifying the obstruction. The Arduino-based third eye of the blind also has a battery, jumper wires, and an LED light built in.



Architecture Diagram



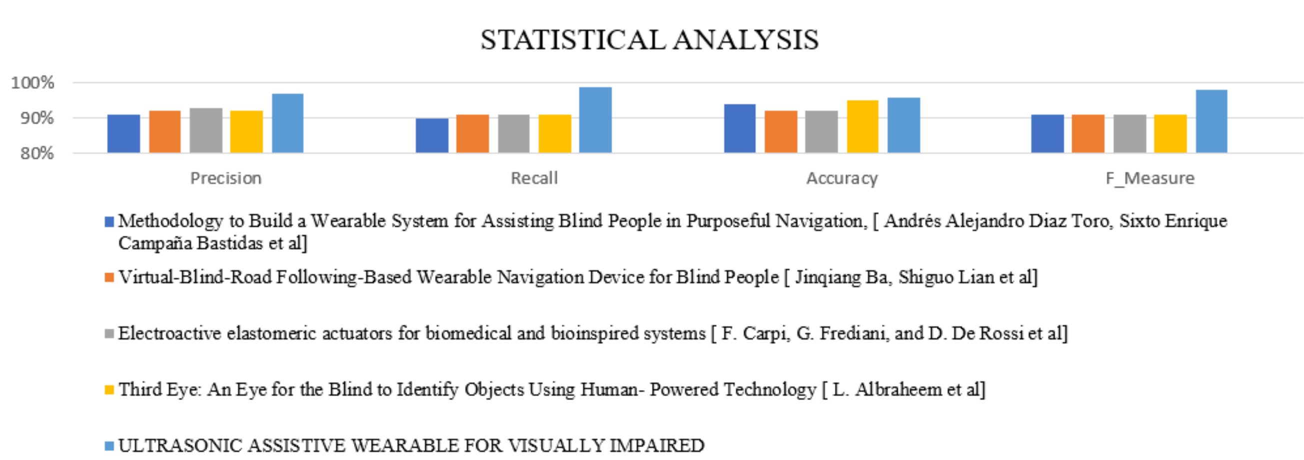
Simulated Circuit

7. RESULTS AND DISCUSSIONS& COST ANALYSIS:

An ultrasonic sensor interfaced with the Arduino Nano is tested separately. The findings needed for the proposed system are seen and recorded based on the individual's age. An audio signal is activated to warn the user through the buzzer sound. When the prototype senses a possible complaint, it modifies the audio output's intensity. In general, those with visual impairments can have their requirements met by the suggested method.

Statistical Analysis	**Precision**	**Recall**	**Accuracy**	**F_Measure**
Methodology to Build a Wearable System for Assisting Blind People in Purposeful Navigation, [Andrés Alejandro Diaz Toro, Sixto Enrique Campaña Bastidas et al]	91%	90%	94%	91%
Virtual-Blind-Road Following-Based Wearable Navigation Device for Blind People [Jinqiang Ba, Shiguo Lian et al]	92%	91%	92%	91%
Electroactive elastomeric actuators for biomedical and	93%	91%	92%	91%

bioinspired systems[F. Carpi, G. Frediani, and D. DeRossi et al]				
Third Eye: An Eye for the Blind to Identify Objects Using Human-Powered Technology [L. Albraheem et al]	92%	91%	95%	91%
ULTRASONIC ASSISTIVE WEARABLE FOR VISUALLY IMPAIRED [Our Proposed Research]	97.10%	98.7%	96%	98%



8. <u>CONCLUSION:</u>

Consequently, the project our team worked on provides a comprehensive explanation of the architecture and concept of an Arduino-based third eye, or supplementary vision, for blind people. A blind person in need can benefit greatly from the extraordinary features of an electronic guidance system that is straightforward to configure, has manageable hardware, and provides adequate and simple usage instructions. It is a remarkable gadget because of its straightforward architecture, ease of use, affordability, portability, and ease of handling.

About this project, one of its features is the ability to determine object distance, which presents a big challenge for blind individuals. Sound intensity rises with decreasing distance. Assuming the task guidance we were given is accurate, it will aid visually impaired individuals in moving toward any path without requiring third-party assistance.

It also helps them become independent from others, enabling them to complete tasks on their own when necessary, such as when they have work to complete. By doing this assignment, we are successfully resolving several issues related to the current route processes, such as carrying a stick while walking and using a third party to get from one location to another. This activity has a stronger impact on the local community and the wider public when it is used more widely and communicated to all visually impaired people.

9. REFERENCES:

[1] M. V. S. Arvitha, A. G. Biradar and M. Chandana, "Third Eye for Visually Challenged Using Echolocation Technology," 2021 International Conference on Emerging Smart Computing and Informatics (ESCI), Pune, India, 2021, pp. 391-395, doi: 10.1109/ESCI50559.2021.9397015.

[2] H. Hesham, L. Khalil, A. Hafez and M. Hussein, "Design, Simulation, and Implementation of connected IoT for Disabled People," 2022 2nd International Mobile, Intelligent, and Ubiquitous Computing Conference (MIUCC), Cairo, Egypt, 2022, pp. 279-283, doi: 10.1109/MIUCC55081.2022.9781761.

[3] L. Albraheem et al., "Third Eye: An Eye for the Blind to Identify Objects Using Human-Powered Technology," 2015 International Conference on Cloud Computing (ICCC), Riyadh, Saudi Arabia, 2015, pp. 1-6, doi: 10.1109/CLOUDCOMP.2015.7149661.

[4] F. Carpi, G. Frediani and D. De Rossi, "Electroactive elastomeric actuators for biomedical and bioinspired systems," 2012 4th IEEE RAS & EMBS International Conference on Biomedical Robotics and Biomechatronics (BioRob), Rome, Italy, 2012, pp. 623-627, doi: 10.1109/BioRob.2012.6290761.

[5] J. Bai, S. Lian, Z. Liu, K. Wang and D. Liu, "Virtual-Blind-Road Following-Based Wearable Navigation Device for Blind People," in IEEE Transactions on Consumer Electronics, vol. 64, no. 1, pp. 136-143, Feb. 2018, doi: 10.1109/TCE.2018.2812498.

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