Chapter – 1: Introduction

1.1 <u>Deaf can drive</u>:

One of the most common questions people who are deaf receive is whether or not they can drive. And how? The worldwide misconception that if you can't hear, you can't drive has led to the undermining of deaf drivers and their ability to drive safely.

It is true that we need good senses to drive. And that we should be able to know when a car is honking or when a police car and ambulance are making sirens. But in no place, there should be written that a hearing test is a necessary condition in obtaining a driver's license. In fact, being able to see is far more important than being able to hear when it comes to navigating the roads.

The need for the enhance accessibility for individuals with hearing impairments face challenges in obtaining a driving licence due to certain requirements, including hearing tests. However, it's important to note that this varies by country and jurisdiction. Some regions have adapted there, regulations to accommodate individuals with disabilities including hearing impairments offering alternative assessments or exemptions from certain requirements. Deaf individuals are those who have a significant hearing impairment, ranging from partial to complete inability to hear. This can occur from birth or develop later in life due to various factors such as illness, injury, or genetic conditions. Deafness can impact communication, social interactions, and daily activities, leading to a unique set of challenges and experiences for individuals within the deaf community. Deafness can be caused by a variety of factors, including:

1. Genetics: Some cases of deafness are inherited from parents who carry genes for hearing loss.

2. Congenital conditions: Deafness may occur at birth due to genetic factors, maternal infections during pregnancy (such as rubella or cytomegalovirus), or complications during childbirth.

3. Acquired conditions: Deafness can develop later in life due to factors such as exposure to loud noises, infections (such as meningitis or otitis media), head trauma, aging (presbycusis), certain medications, or diseases like Ménière's disease.

4. Environmental factors: Prolonged exposure to loud noises, such as machinery, music concerts, or firearms, can damage the delicate structures of the inner ear and lead to hearing loss.

5. Autoimmune disorders: Conditions like autoimmune inner ear disease can cause inflammation and damage to the inner ear, resulting in hearing loss.

6. Ototoxicity: Certain medications, such as some antibiotics, chemotherapy drugs, and high doses of aspirin, can damage the inner ear and cause hearing loss (ototoxicity).

1.2 Issues in a deaf driver:

Research has been conducted in a wide range of countries over the years and it bears witness that deafness does not have any sort of negative impact on a deaf person's ability to drive. Deaf people may have a limited sense of hearing, but they are far more visually aware and cautious of their surroundings at all times. [1]

Some even argue that people who have hearing loss have an increased ability to drive safely because deafness enhances their peripheral vision and other senses. Even on the basis of global statistics, Deaf people are lesser in the thick of traffic accidents than hearing people. Seeing as driving is a visual activity on the whole, this supports the ability of deaf drivers to effectively operate a vehicle.

There are more than one way deaf drivers use to drive safely. Some pay attention to visual cues, such as the flashing lights of an emergency vehicle or cues from other drivers on the road.

1. Drivers who are deaf also utilise special electronic devices in their cars to alert them when emergency or other vehicles are nearby, such as using a lighted panel.
2. Car horns can also be detected using this system and give deaf drivers the notification they need to proceed with caution.
3. Others use panoramic mirrors to enhance their visual perception, which gives them a better sense of the other vehicles and objects around their automobile. For instance, noticing other drivers move to the side of the road is an indicator that an emergency vehicle is approaching.

Driving is an important human right to maintain for all. The prohibition of this right would mean an automatic restriction to the access to education, employment, medical, and any other necessary services, and lead to a myriad of socio-economic disadvantages. [1]

1.3 Project Organization:

The aim of our project is to enable deaf drivers to detect the presence of approaching vehicles using vibrations and light signals, allowing them to respond accordingly. We got the motivation to work on this idea from a real-life incident of our HOD, ma'am. Our respectable Dr. Bhavna Jharia ma'am, Head of the Electronics and Telecommunication Engineering Department gave us the problem statement that how can a deaf person be granted a driving license. Since the person is unable to hear any type of sound signal so how can he be able to sense the presence of the vehicle approaching his vehicle from back. She got this problem statement from her college professor while she was pursuing her course from the IIT Roorkee. Her professor had a child who was deaf by birth, so the professor asked ma'am to think a possible solution about it.

1.4 Summary:

Chapter 1 is about introduction to our idea which can be summarised as: the project aims to empower deaf drivers by enabling them to detect approaching vehicles through vibrations and light signals, thus addressing a significant challenge faced by the deaf community. This initiative was inspired by a real-life problem posed by Dr. Bhavna Jharia, based on her personal experience and academic background, highlighting the importance of inclusive solutions in ensuring equal access to essential services like driving.

Chapter – 2: Literature Review

2.1 Some related work:

The right to drive for people with hearing loss has been a hot topic of debate around the world. In almost all major continents, people who are deaf are issued licenses to drive. Be it North America (United States of America, Canada, Mexico), South America (Brazil, Chile, Argentina), European Union (all countries), Australia, Asia and Middle East (India, Japan, New Zealand, Bhutan, Sri Lanka, Nepal, Malaysia, Philippines, Saudi Arabia, Qatar, Kuwait, Russia, Uzbekistan), and Africa (Kenya, South Africa, Nigeria). [2]

According to the World Health Organization (WHO), Pakistan has a population of 30 million people with disabilities. Out of which, over 10 million people are those who have some level of hearing loss. [2]

We have used some references of some of the real cases and we were eagerly interested to work upon this project. After studying below cases we came to know the importance of this world wide issue. We have mentioned works of some of the experts below along with their projects.

Our respectable Dr. Bhavna Jharia ma'am, Head of the Electronics and Telecommunication Engineering Department gave us the problem statement that how can a deaf person be granted a driving license. Since the person is unable to hear any type of sound signal so how can he be able to sense the presence of the vehicle approaching his vehicle from back. She got this problem statement from her college professor while she was pursuing her course from the IIT Roorkee. Her professor had a child who was deaf by birth, so the professor asked ma'am to think a possible solution about it. She started to take care of his child and observed his daily routine, noted down the problems the child used to face and wrote down the issue in the year 1996 – 98. In the Seventh semester when we were confused to decide and propose a idea for the major project, after many useless ideas not based on real life based problem and failed attempts we approached our mentor Dr. Bhavna Jharia who guided us and gave this problem statement. After putting so many efforts and research we came to know that she had already worked upon the same issue.

For many years, the Pakistani Deaf Community has been trying to get their driver's licenses approved. The leading forces of deaf community leaders and social organisations in Sindh, from Danish Kadah, Media Deaf Interpreter (MDI), Media Deaf Karachi (MDK) to Syed

Qassim Naveed Qamar, who is Special Assistant to CM Sindh on Department Of Empowerment Of Person With Disabilities (DEPD), led to the Chief Minister acknowledging the seriousness of the realisation of their right. The necessary amendment in the Second Schedule of the Motor Vehicles Ordinance, 1965 was then directed to be made for issuance of a commercial or private driving license to hearing-impaired persons. Following the instruction, the bill for the right of Deaf people to obtain a driving license was debated in the Provincial Assembly of Sindh and passed as legislation. So many people, supporters, and activists from in and outside the community who put their sweat and blood in this major triumph gathered together at Karachi Press Club and celebrated their gain of unconfined access to mobility. Connect - Hear also played an integral role and interpreted for the individuals involved in the historical movement as they spoke about the struggles they used to face without this right and how appreciative they are for this favourable result. On the word of Murad Ali Shah, who is the Chief Minister of Sindh [2]:

Firstly, the issuance of driving license to deaf persons would be an implementation of guarantees provided in the Constitution, ordains of the relevant statute and the declaration in the UN Convention on the Rights of Persons with Disabilities (UNCRPD) regarding the equality of the hearing-impaired persons, which would in turn make them feel empowered and motivated. [2]

Secondly, the hearing-impaired persons would get ease of access and mobility, as they would be able to move freely in their own vehicles without being a burden on anyone. [2]

Thirdly, the hearing-impaired persons would be able to make a livelihood by getting employed in jobs, which require driving skills such as drivers, transportation of goods, delivery persons, and courier services etc. [2]

CM Syed Murad Ali Shah presenting one of the many first driver's licenses to Mansoor Abdul Majeed, a person with hearing loss, at the CM House in Karachi on December 3, 2019. "We have been driving cars for years. But now, we will be driving them legally. The development will help us reduce our dependence on others," 42-year-old Mansoor Abdul Majeed, who works at a local factory and received his license from the chief minister, said. "We were fighting for this right for several years," Majeed added. "The traffic police told us that we could not drive because we could not hear. After getting disappointed by the license branch, I discussed the idea with my friend, Irfan Sharif, who invented the device which we used to convince the authorities." Irfan Sharif, who has a profound level of hearing loss, worked on the Surrounding Notifier (TSN) device. Irfan Sharif is a school teacher and part-time programmer who was born without a sense of hearing. In 2017, he started working on the idea of developing a device to help fulfil the legal requirements of a driver’s license. A light blink on the dashboard of the car or motor when there is any sound signal, which helps the driver look into the rearview or side mirrors and act accordingly. Irfan had found a gadget that vibrated and flashed when his baby would cry and decided to convert it into the traffic surrounding notifier system. The electronic device proved to be a ground breaker and made it easier for the authorities to issue driver’s licenses to people with hearing loss. “We are not inferior to anyone,” Majeed said. “We need our due rights.” [2]

Engineer Jan Říha realized that recent advances in machine learning and edge computing have opened up a tremendous opportunity to assist the hearing-impaired in these situations, and perhaps even save lives. He developed a small device called PionEar that uses an audio classification algorithm to recognize the sounds of emergency vehicles, then provide a visual cue to alert the driver. Not only was the unit designed to be simple to use, but it was also pretty simple to create, thanks to some great off-the-shelf hardware and the Edge Impulse machine learning development platform. The device hardware, featuring a Syntiant TinyML Board. At the heart of the PionEar is a Syntiant TinyML Board. With an Arm Cortex-M0+ processor and 256 KB of flash memory, this is a very capable platform for mobile devices. And with an NDP101 Neural Decision Processor onboard, Syntiant’s TinyML can make short work of running inferences with machine learning models that have been highly optimized for resource-constrained devices by Edge Impulse. The board also has several sensors, including just the sort of high-quality microphone that is needed to build PionEar, making it an all-in-one solution for many use cases. The TinyML board slowly sips power, so it can operate on a small LiPo battery for several days without a recharge. But Říha also included a solar cell and MPPT charge controller such that, under ideal conditions, the user can install the device, then just forget about it. A custom PCB is wired to the TinyML board to provide the alert system — a series of LEDs in the pattern of the PionEar logo. A light sensor is also included such that the LEDs are not too bright under conditions of low light, potentially distracting the driver. The PionEar’s custom casing - With the hardware sorted out, Říha turned his attention to building the machine learning classification pipeline with Edge Impulse Studio. The first step in building a classifier is either tracking down an appropriate dataset, or collecting that data manually. Fortunately, in this case, there are many publicly available options to choose from. Data was taken from multiple datasets containing the sounds of emergency vehicle sirens, other road sounds, as well as talking and other normal, ambient sounds that may be encountered while driving. A diverse, high-quality dataset is an essential component in creating an accurate, well-generalized machine learning model, so always take care to not breeze through this step.

The dataset was uploaded to Edge Impulse using the Data Acquisition tool, which automatically assigned labels based on the file names, and also split the data into training and test sets. After that, Říha begin work on designing the impulse. Created with a simple GUI, this impulse defines how data flows through the pipeline, from a raw audio sample to a prediction of its class. [3]

Preprocessing steps were added to split the audio into small segments, then extract the most relevant features to minimize the amount of hardware resources that would be needed downstream. Finally, the features were forwarded into a neural network classifier that can distinguish between normal, background noises and the sirens of emergency vehicles. A few model hyperparameters were adjusted, and the data augmentation feature was turned on to help the model to better generalize to unseen conditions, then the training process was initiated. After it completed, metrics were provided to assist in understanding how well the model is performing. A very nice average classification accuracy of 96.7% was observed. To validate that result, the more stringent Model Testing tool, which uses data that was not included in the training process, was also utilized. This backed up the previous result, showing a 96.3% rate of accuracy. [4]

That is excellent for a proof of concept, so Říha used the Deployment tab in Edge Impulse Studio to deploy the full classification pipeline to the physical hardware — you do not want to have a reliance on the cloud while driving, not to mention the privacy concerns associated with sending a constant stream of audio from the inside of your car over the public Internet. The model performed very well. Since the Syntiant TinyML Board is fully supported by Edge Impulse, this is very simple to do. There are a number of options available, ranging from downloading a prebuilt binary containing the full pipeline, to an NDP101 library that can be used when building a custom application. After deployment, Říha took the PionEar out for a real-world test in the car to see how well it performed. It was demonstrated as being smart enough to not trigger inappropriately, and when an emergency vehicle passed by with sirens on, the device lit up and alerted the driver exactly as would be expected. Not only is the PionEar easy to build, but it is also inexpensive. [3]

2.2 <u>Summary</u>:

Chapter 2 can be summarised as follows: the debate over driving rights for the deaf spans continents, with many countries issuing licenses to the deaf community. Pakistan recently made strides in this area, passing legislation to grant driving licenses to the hearing-impaired.

Innovators like Irfan Sharif developed the Surrounding Notifier device to aid deaf drivers, while Engineer Jan Říha created the PionEar, a device using machine learning to detect emergency vehicle sounds and provide visual alerts. These advancements reflect a growing recognition of the rights and capabilities of the hearing-impaired in driving safely and independently.

Chapter – 3: Methodology

3.1 **Proposed model**:

Our first approach to make this project was using machine learning and deep learning. In this we would have trained a machine learning model with a variety of sound signals of different types of vehicles. The model would have sensed the sound signal of the vehicle using the mic-module. The mic- module will process the sound signal of vehicle received from the back. Since the sound signal need to be filtered out as it contains the environmental noises which can be filtered using an appropriate filter. The Signal received after filtration would be very weak so it needs to be amplified using an appropriate amplifier (may be one or two amplifiers used depending on the requirement). Now the amplified signal is sent to the microcontroller (UNO-Arduino) which processes the amplified sound signal and pass on this signal to the machine learning model program installed on a Rasberry-Pi which after processing the signal will send this information signal to a screen which displays the type of the vehicle.

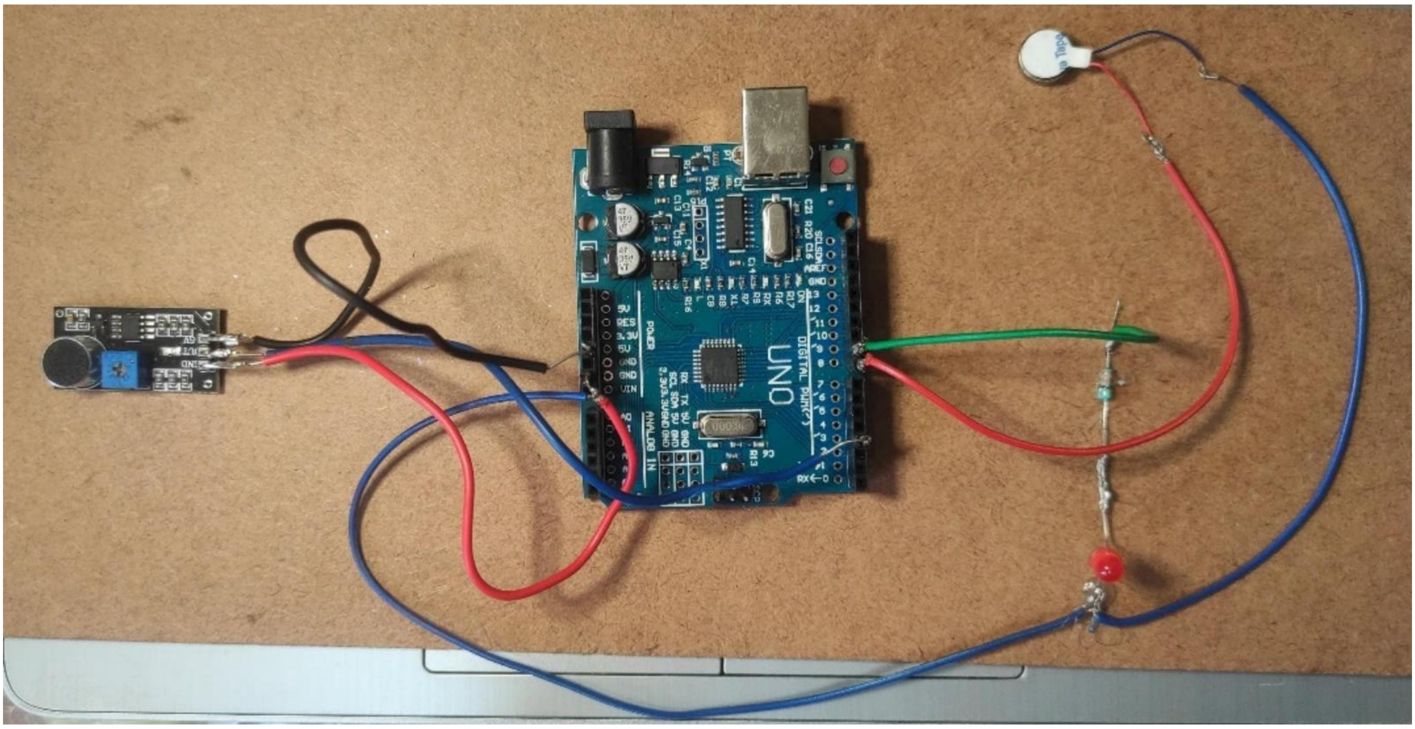

Fig.3.1 Proposed model

The microcontroller is connected to two other components – vibration motor and Light Emitting Diode (LED). The vibration motor is fixed at the right-hand side of the vehicle in a bracelet which vibrates when a vehicle approaches the deaf driver. The Light Emitting Diode (LED) acts as a visual attention drawer for the deaf driver. This completes our requirement that deaf driver will be able to sense the approaching vehicle. But we were unable to meet the requirement of the components and also, we were stuck in the machine learning model training code. So, we thought of another alternative method to complete this project mentioned below.

3.1.1 Circuit diagram:

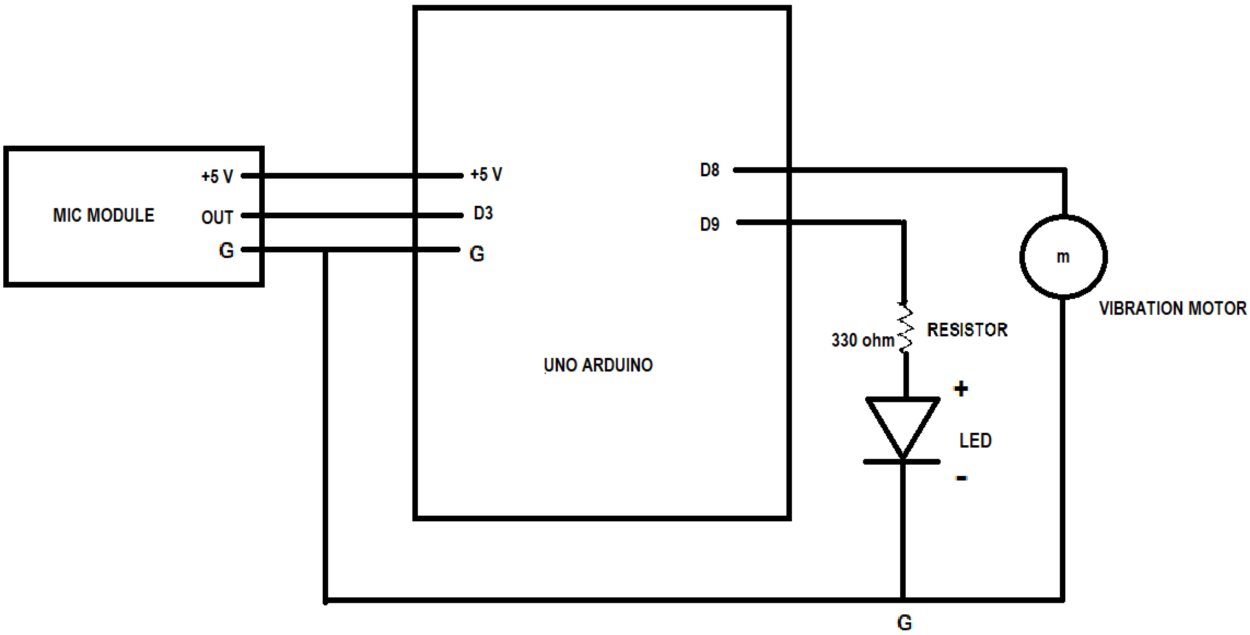

Fig.3.2 Circuit Diagram

The architecture of our model encompassed meticulous construction and strategic connections of various components to ensure seamless operation and desired outcomes. The construction and connection of these components were pivotal in achieving the functionality and efficacy of our device. At the core of our device lies the microphone module, serving as the primary input interface for capturing sound signals from the surrounding environment. The microphone module was meticulously integrated into our system by establishing essential electrical connections with the Arduino microcontroller board. To power the microphone module, we connected its 5V pin to the corresponding 5V pin on the Arduino board, thus providing the necessary voltage supply for its operation. Simultaneously, the ground (GND) pin of the microphone module was securely linked to the GND pin on the Arduino board, completing the circuit and ensuring a stable electrical reference. This robust electrical connection facilitated the seamless transfer of analog audio signals from the microphone module to the Arduino board for further processing. For the transmission of sound data to the Arduino microcontroller, we designated digital pin 3 (D3) as the designated port for the microphone module's output signal. By establishing a direct electrical link between the output pin of the microphone module and digital pin 3 on the Arduino board, we facilitated the transfer of analog sound signals into the digital domain, enabling subsequent signal processing and analysis by the Arduino microcontroller. This connection mechanism formed the backbone of our input subsystem, allowing our device to efficiently capture and interpret incoming sound waves from the environment. With the input part of our Arduino system successfully configured and operational, we shifted our focus towards implementing the output subsystem, tasked with translating processed audio data into tangible visual and tactile feedback. For the visual component of our output system, we employed light-emitting diodes (LEDs) as the primary means of conveying sound information in the form of light signals. The LED, a versatile semiconductor device capable of emitting light when forward-biased, was integrated into our device by establishing a direct electrical connection with the Arduino microcontroller. Specifically, the positive terminal of the LED was securely linked to digital pin 9 (D9) on the Arduino board, enabling the microcontroller to regulate the illumination of the LED based on the processed audio input. Concurrently, the negative terminal of the LED was grounded, ensuring a complete circuit and facilitating the controlled emission of light in response to varying sound stimuli. In tandem with the visual output subsystem, we devised a tactile feedback mechanism utilizing vibration motors to provide users with haptic sensations corresponding to the captured sound signals. The vibration motor, a compact electromechanical device capable of generating controlled vibrations upon activation, was seamlessly integrated into our device to augment the user experience. To establish electrical connectivity with the Arduino microcontroller, the positive terminal of the vibration motor was connected to digital pin 8 (D8) on the Arduino board, allowing for precise control over the intensity and duration of vibrations produced. Additionally, the negative terminal of the vibration motor was grounded to ensure electrical continuity and facilitate the efficient operation of the haptic feedback subsystem. Through meticulous construction and strategic integration of the aforementioned components, our device successfully achieved the conversion of sound waves into both visual and tactile stimuli.

3.1.2 Working:

In our project, we embarked on the creation of a device aimed at transforming sound waves into both visual and tactile stimuli. The working of the proposed model can be explained as follows: the first step in the receiving the sound signal of the approaching vehicle. The sound is received using the microphone module. It senses the sound signal beyond a certain amplitude. The received sound signal is sent to the micro-controller used (UNO Arduino) connected to the microphone module. Inside the micro-controller the sound signal is used for the signal processing using the UNO Arduino programming code which is being fed to the micro-controller so that it can perform the task of signal processing. When the controller detects the increase in the amplitude of the sound signal then it sends the signal to the vibration motor to vibrate and the light emitting diode to blink as the response detection of the sound signal. There are sounds present in the environment which we may think will also be detected by the microphone module but it is not like that, it all depends on the sensitivity of the microphone. The sensitivity can be decreased by rotating the dial in the anticlockwise direction on the microphone module. Similarily, the sensitivity can be increased by rotating the dial in the clockwise direction on the microphone module. When the sensitivity is low, it is not that much efficient to detect the feeble sound. On the other hand, when the sensitivity is kept high, it is able to detect the most feeble sound signal. The vibration motor is attached to a bracelet attached to the accelerator on the right hand side so that vibration motor is always in close contact with the driver's skin. When a sound signal beyond a certain amplitude is detected by the microphone module vibration motor starts to vibrate for a fixed duration of time. The time duration for which the vibration is to be made can also be adjusted by making the changes in the micro-controller programming code. The time duration in the program is in the milliseconds. For example, 3000 msec is set currently. It can be varied depending in the application. Along with the vibration motor, the LED also blinks for a short duration of time to draw the attention of the deaf driver towards it. The vibration and blinking of the LED indicates that a vehicle is approaching the vehicle of deaf driver. Hence, our goal is being fulfilled of making the deaf driver to sense the approaching vehicle.

3.2 Issues in Preparing:

When we were trying to figure out a model our first approach to make this project was using machine learning and deep learning. In this we would have trained a machine learning model with a variety of sound signals of different types of vehicles. The model would have sensed the sound signal of the vehicle using the mic-module. The mic- module will process the sound signal of vehicle received from the back. Since the sound signal need to be filtered out as it contains the environmental noises which can be filtered using an appropriate filter. The Signal received after filtration would be very weak so it needs to be amplified using an appropriate amplifier (may be one or two amplifiers used depending on the requirement). Now the amplified signal is sent to the microcontroller (UNO- Arduino) which processes the amplified sound signal and pass on this signal to the machine learning model program installed on a Rasberry-Pi which after processing the signal will send this information signal to a screen which displays the type of the vehicle.

Since we were not able to figure out the problem at that point of time in the above mentioned approach so we started looking for an alternative method to complete the task by referring to various articles being published on the IEEE standards website, google scholar, youtube, etc. Then thought of starting the approach which we have applied in the current proposed model. With all the efforts and thorough study we were able to build the proposed model successfully.

3.3 Summary:

Chapter 3 can be summarised as follows: The seamless connection and coordination between the microphone module, Arduino microcontroller, LEDs, and vibration motors enabled the realization of our project's objectives, empowering users with a unique audiovisual and tactile experience. By leveraging the capabilities of modern electronics and innovative design methodologies, our device exemplifies the convergence of technology and creativity in the realm of sensory augmentation and human-computer interaction.

Chapter – 4: Implementation of Proposed Model

4.1 Software used for programming:

The software used for programming of the UNO Arduino in the proposed model we have used Arduino 1.8.19, Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online. We can tell our board what to do by sending a set of instructions to the microcontroller on the board. To do so we use the Arduino programming language (based on Wiring), and the Arduino Software (IDE), based on Processing. Over the years Arduino has been the brain of thousands of projects, from everyday objects to complex scientific instruments. A worldwide community of makers - students, hobbyists, artists, programmers, and professionals - has gathered around this open-source platform, their contributions have added up to an incredible amount of accessible knowledge that can be of great help to novices and experts alike. Arduino was born at the Ivrea Interaction Design Institute as an easy tool for fast prototyping, aimed at students without a background in electronics and programming. As soon as it reached a wider community, the Arduino board started changing to adapt to new needs and challenges, differentiating its offer from simple 8-bit boards to products for IoT applications, wearable, 3D printing, and embedded environments. The Arduino software is easy-to-use for beginners, yet flexible enough for advanced users. It runs on Mac, Windows, and Linux. Teachers and students use it to build low-cost scientific instruments, to prove chemistry and physics principles, or to get started with programming and robotics. Designers and architects build interactive prototypes, musicians and artists use it for installations and to experiment with new musical instruments. Makers, of course, use it to build many of the projects exhibited at the Maker Faire, for example. Arduino is a key tool to learn new things. Anyone - children, hobbyists, artists, programmers - can start tinkering just following the step-by-step instructions of a kit, or sharing ideas online with other members of the Arduino community. There are many other microcontrollers and microcontroller platforms available for physical computing. Parallax Basic Stamp, Netmedia's BX-24, Phidgets, MIT's Handyboard, and many others offer similar functionality. All of these tools take the messy details of microcontroller programming and wrap it up in an easy-to-use package. Arduino also simplifies the process of working with microcontrollers, but it offers some advantage for teachers, students, and interested amateurs over other systems: Inexpensive, Cross-platform, Simple and clear programming environment, Open source and extensible software, Open source and extensible hardware.[5]

Some of the earlier versions of this software are: Arduino 00xx, Arduino 1.0.x, Arduino 1.8.x, Arduino 1.8.16. Current version is ARDUINO 1.8.18. It is very easy to use. Given below are the steps to download and install Arduino IDE software.[5]

Windows

1. Download the latest release (The download will start after you click this link. Check your browser's download manager or the Downloads folder on your computer to find the downloaded file)
2. Double-click the executable (.exe) file.
3. Follow the instructions in the installation guide.
4. When completing the setup, leave *Run Arduino IDE* ticked to launch the application, or launch it later from the Start Menu.

macOS

1. Download the latest release (The download will start after you click this link. Check your browser's download manager or the Downloads folder on your computer to find the downloaded file)
2. Double-click the disk image (.dmg) file.
3. Drag and drop the Arduino IDE application into the Applications folder.
4. Launch Arduino IDE the same way you would launch any other application (such as ⌘ + Space for Spotlight and search for "Arduino").

Linux

1. Download the latest release
2. Find the AppImage file in your file manager.
3. Make the AppImage file executable:
    1. Right-click the file.
    2. Choose Properties,

    3. Select the Permissions.
    4. Tick the *Allow executing file as program* box.
4. Double-click the AppImage file to launch Arduino IDE.

If Arduino IDE fails to open, and you see the text `dlopen(): error loading libfuse.so.2` or `AppImages require FUSE to run`, you may be missing some dependencies. Follow these steps:

1. Open the Terminal application.
2. Enter this command:

   `sudo apt-get -y install libfuse2`

3. Press Enter and wait for the process to complete.
4. Close the Terminal window.
5. Try launching Arduino IDE again by double-clicking the AppImage file.

   Additional download options

- For a portable installation on Windows or Linux, use a “ZIP file” option:
    - *ZIP file* (Windows)
    - *ZIP file 64 bits (X86-64)* (Linux)
- For more control in mass deployment, use the *MSI installer* package (Windows Installer) file.
- Nightly builds – preview incoming releases.
- IDE 1 (legacy)

4.1.1 Simulation Software:

The simulating software used in the proposed model is Tinkercad. It is an amazingly powerful easy-to-use tool for creating digital designs that are ready to be 3D printed into super-cool physical objects. We will be guided through the 3D design process via easy hands-on "Lessons", that teach us the basics of Tinkercad before moving on to more complex modeling techniques. Tinkercad was founded by former Google engineer Kai Backman and his cofounder Mikko Mononen, with a goal to make 3D modeling, especially the design of physical items, accessible to the general public, and allow users to publish their designs under a Creative Commons license. In 2011, the tinkercad.com website was launched as a web-based 3D modeling tool for WebGL-enabled browsers, and in 2012 the company moved its headquarters to San Francisco. By 2012, over 100,000 3D designs had been published by users. In May 2013, Autodesk announced at a Maker Faire that they would acquire Tinkercad.In March 2017, Autodesk recommended users of the soon-to-be-retired 123D Sculpt migrate to Tinkercad (or Maya LT). In May, Autodesk discontinued its 123D Circuits (Circuits.io) "Electronics Lab"[6]. The program's features were merged into Tinkercad. Given below is the link to use tinkercad online:

4.1.2 Simulation Software Work:

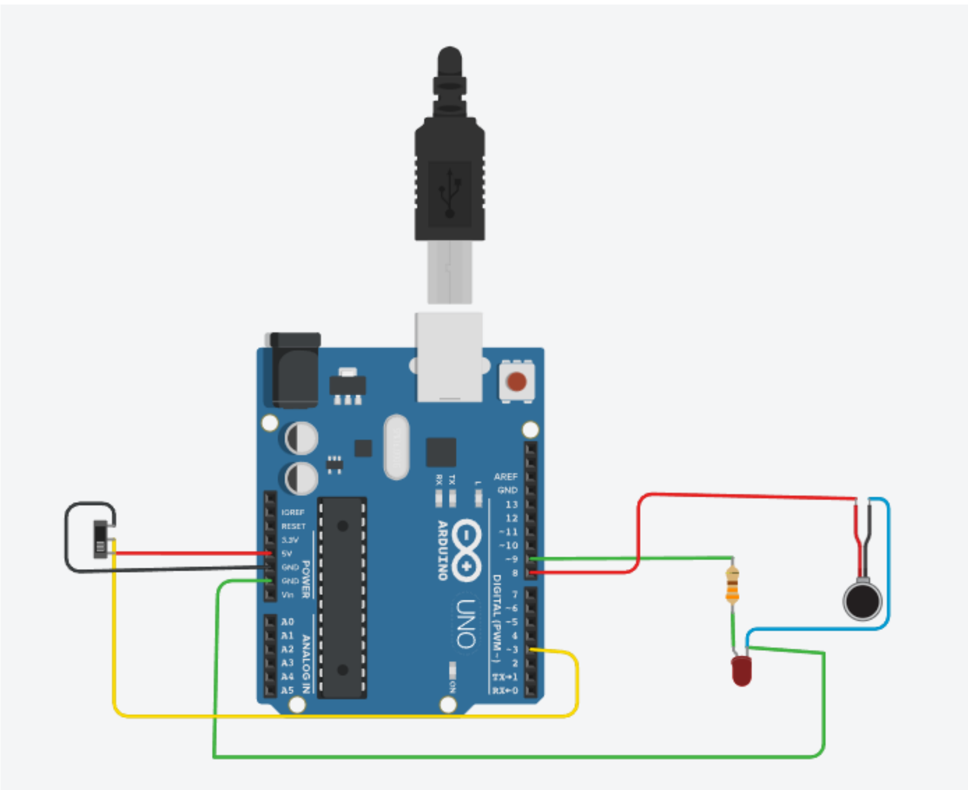

Fig.4.1 Simulation Circuit

4.1.3 Code Explanation:

This Arduino code is designed to create a simple system that reacts to the input from a microphone sensor (connected to pin 3) by activating a vibration motor (connected to pin 8) and an LED (connected to pin 9). Here's a breakdown of how the code works:

1.Variable Declaration: Three integer variables are declared at the beginning of the code: mic to represent the pin number for the microphone sensor, motor for the pin number connected to the vibration motor, and led for the pin number connected to the LED.

2.Setup Function: In the setup() function, the pinMode() function is used to configure the specified pins as either inputs or outputs. Pin mic is set as an input pin, while pins motor and led are set as output pins. Additionally, the Serial.begin(9600) function initializes serial communication at a baud rate of 9600, allowing data to be sent from the Arduino to a connected computer for debugging purposes.

3.Loop Function: The loop() function contains the main code that executes repeatedly as long as the Arduino is powered on.

- Serial.println(digitalRead(mic)): This line reads the digital value (either HIGH or LOW) from the microphone sensor connected to pin mic and prints it to the serial monitor. This allows the user to monitor the sensor's output in real-time.
- if(digitalRead(mic) == 0): This conditional statement checks if the digital value read from the microphone sensor is LOW, indicating that a sound has been detected.
- digitalWrite(motor, HIGH): If a sound is detected, the vibration motor connected to pin motor is turned ON by setting its output to HIGH.
- digitalWrite(led, HIGH): Similarly, the LED connected to pin led is also turned ON by setting its output to HIGH.
- delay(3000): A delay of 3000 milliseconds (3 seconds) is introduced to keep the motor and LED activated for a specified duration after detecting a sound.
- else: If no sound is detected (digital value is HIGH), the else block is executed.
- digitalWrite(motor, LOW): The vibration motor is turned OFF by setting its output to LOW.
- digitalWrite(led, LOW): The LED is also turned OFF by setting its output to LOW.

This code essentially creates a system where the vibration motor and LED are activated whenever a sound is detected by the microphone sensor. The duration for which the motor and

LED remain activated can be adjusted by changing the value in the delay() function. Program Code for the UNO Arduino is in [Appendix].

4.2 Hardware Components:

Component List

Name	Quantity	Component
U1	1	Arduino Uno R3
M1	1	Vibration Motor
R3	1	330 Ω Resistor
D1	1	Red LED
S2	1	Mic Module

Table.4.1 Hardware Components

After the successful completion of the circuit diagram in the fig.3.2

1. Microphone module: It is also known as a sound sensor or sound detector module, is an electronic component that detects sound waves and converts them into electrical signals. The basic operation of a mic module involves several key components and processes:
   a) Sound Waves Detection: The microphone module contains a small diaphragm or membrane that vibrates in response to sound waves in the surrounding environment. When sound waves hit the diaphragm, it vibrates, causing corresponding variations in air pressure.
   b) Transduction: The mechanical vibrations of the diaphragm are transduced into electrical signals through the use of a transducer, typically a piezoelectric or electromagnetic element. This transducer converts the mechanical energy of the diaphragm vibrations into electrical signals.
   c) Signal Amplification: The electrical signals generated by the transducer are typically weak and need to be amplified for further processing. A built-in amplifier within the microphone module boosts the amplitude of the electrical signals to a level that can be effectively processed by other electronic components.
   d) Signal Conditioning: The amplified electrical signals may undergo further conditioning to filter out unwanted noise and enhance the clarity of the detected sound. This may

involve the use of filters or signal processing algorithms to isolate specific frequencies or characteristics of interest.

e) Output: The conditioned electrical signals are then output from the microphone module in a format that can be easily interfaced with other electronic components or microcontrollers. This output can take various forms, such as analog voltage levels, digital signals, or pulse-width modulation (PWM) signals, depending on the specific design of the microphone module.

Overall, a microphone module operates by detecting sound waves, transducing them into electrical signals, amplifying and conditioning these signals, and finally outputting them for further processing or analysis by other electronic components. These modules are commonly used in a wide range of applications, including audio recording, voice recognition, and sound detection systems.

Fig.4.2 Mic Module

2. Arduino Uno: It is a microcontroller board based on the ATmega328P chip. It is the most popular board in the Arduino family due to its simplicity, versatility, and ease of use. The Arduino Uno works by providing a platform for users to easily program and control electronic projects.

Here's how it works:

1) Microcontroller: At the heart of the Arduino Uno is the ATmega328P microcontroller. This chip contains a central processing unit (CPU), memory (both Flash memory for storing the program and SRAM for runtime data), and various input/output (I/O) pins.

2) Input/Output Pins: The Arduino Uno has a set of digital and analog input/output pins that can be used to connect to sensors, actuators, and other electronic components. These pins can be configured as either inputs or outputs and can be controlled using the Arduino programming language.
3) Programming Interface: The Arduino Uno can be programmed using the Arduino Integrated Development Environment (IDE), which is based on the C and C++ programming languages. Users write code in the IDE and upload it to the Arduino board via a USB cable. The IDE handles compiling the code into machine-readable instructions and uploading it to the microcontroller's Flash memory.
4) Power Supply: The Arduino Uno can be powered via a USB cable connected to a computer or a USB power adapter. It can also be powered using an external power supply connected to the board's barrel jack.
5) Clock: The ATmega328P microcontroller has an internal clock that determines the speed at which it executes instructions. The Arduino Uno's default clock speed is 16 MHz.
6) Integrated Components: The Arduino Uno includes several integrated components, such as a voltage regulator, which ensures a stable supply voltage for the microcontroller and other components, and an onboard LED connected to pin 13, which can be used for basic visual feedback in programs.

Overall, the Arduino Uno provides a user-friendly platform for prototyping and developing electronic projects by offering a simple interface for programming and controlling microcontroller-based systems. Its open-source nature and extensive community support make it an ideal choice for beginners and experienced makers alike.

Fig.4.3 Uno Arduino R3

3. Vibration motor: It is also known as a vibrating motor or vibro-motor, is a type of electric motor that generates vibrations when powered. It typically consists of a small, eccentric weight attached to the motor's rotating shaft. The basic operation of a vibration motor involves the following steps:

1) Power Supply: When a voltage is applied to the terminals of the vibration motor, it begins to draw current from the power source.
2) Electric Motor: The vibration motor contains an electric motor, usually a DC motor, which converts electrical energy into mechanical rotational motion. This motor is responsible for driving the eccentric weight.
3) Eccentric Weight: Attached to the shaft of the electric motor is an eccentric weight. This weight is offset from the motor's axis of rotation, causing it to exert a centrifugal force when the motor spins.
4) Centrifugal Force: As the motor rotates, the eccentric weight generates a centrifugal force due to its offset position. This force causes the entire motor assembly to vibrate.
5) Vibration Output: The vibrations produced by the vibration motor can be transmitted to a surface or structure to which the motor is mounted. The intensity and frequency of the vibrations depend on factors such as the speed of the motor, the size and weight of the eccentric weight, and the voltage applied to the motor.

Vibration motors are commonly used in various applications, including mobile phones for haptic feedback, gaming controllers for tactile feedback, and industrial machinery for vibration alerts or conveying purposes. They provide a simple and efficient means of generating controlled vibrations for a wide range of purposes.

Fig.4.4 Vibration Motor

4. Light-emitting diode (LED): It operates by harnessing the properties of semiconductor materials to produce light when an electric current flows through it. Within the LED's structure, a p-n junction forms between two different types of semiconductor material: p-type (positively doped) and n-type (negatively doped). When a forward voltage is applied across the p-n junction, electrons from the n-type material are injected into the p-type material, where they recombine with holes, releasing energy in the form of photons. The energy of these photons corresponds to the bandgap of the semiconductor material, determining the color of the emitted light. LEDs are highly efficient light sources, converting a high percentage of electrical energy into light with minimal heat dissipation, making them widely used in various applications for illumination, displays, indicators, and more.

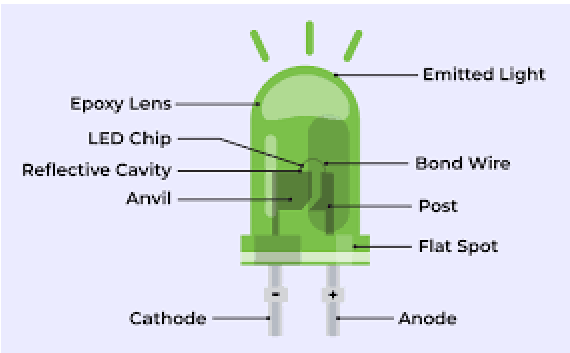

Fig.4.5 Light Emitting Diode (LED)

5. Adapter: Some Arduino boards like UNO, MEGA and DUE, come with an AC socket that can be used to power the boards and to supply additional voltage if needed A power supply adapter that provides from 7 to 12V (Volts) of DC (Direct Current) is required. We have used an adapter which provides a power supply of 12 V.

Fig.4.6 Adapter

Combination and proper assembling of all the hardware and software components combines to give our proposed model

4.3 Summary:

Chapter 4 can be summarised as follows: the proposed model utilizes Arduino 1.8.19 for programming and Tinkercad for simulation. Arduino provides a user-friendly platform for programming microcontrollers, while Tinkercad enables the creation of digital designs for 3D printing. The Arduino code controls a system that reacts to sound input from a microphone sensor by activating a vibration motor and an LED. The hardware components include a microphone module, Arduino Uno, vibration motor, LED, and an adapter for power supply. This combination of hardware and software components forms the basis of the proposed model, allowing for the detection of sound signals and corresponding visual and tactile feedback.

Chapter – 5: Conclusion & Future Scope

5.1 Conclusion:

The prevalence of hearing impairments in today's society underscores the importance of innovative solutions to address safety concerns for those affected. Our project aimed to mitigate risks faced by individuals with hearing loss or diminished auditory capabilities, particularly while navigating roadways. By developing a system to alert them to vehicles approaching from behind, we sought to empower them with timely information, enabling them to take appropriate defensive actions, such as yielding or adjusting their position on the road. Throughout the course of our project, we recognized the critical need for inclusive solutions in transportation. The ability to drive independently is not only a matter of convenience but also of fundamental freedom and autonomy. By equipping individuals with auditory impairments with the means to safely operate vehicles, we aimed to promote their inclusion in society and facilitate their participation in daily activities. Access to transportation is essential for accessing employment, education, healthcare, and social opportunities, and our project sought to bridge the gap for those facing auditory challenges. Through extensive research, development, and testing, we have successfully designed a system that integrates seamlessly with existing vehicles, providing real-time alerts to drivers regarding approaching vehicles. Our solution prioritizes simplicity, reliability, and effectiveness, ensuring ease of use for individuals with varying degrees of hearing impairment. Furthermore, our system is adaptable to different environments and driving conditions, enhancing its practical utility and relevance in diverse settings. In addition to enhancing safety on the roads, our project contributes to the broader societal goals of accessibility and inclusivity. By advocating for the issuance of driving licenses to individuals with hearing impairments, we challenge existing norms and perceptions surrounding disability and transportation. Driving is often perceived as a privilege reserved for those with perfect hearing, but our project highlights the potential for technology to level the playing field and empower individuals with diverse abilities. Looking ahead, we envision further refinements and advancements to our system, guided by feedback from users and stakeholders. Continuous improvement is essential to ensuring the long-term viability and impact of our solution. Moreover, we recognize the importance of collaboration with regulatory bodies, healthcare professionals, and advocacy groups to promote policy changes and support initiatives that promote accessibility in transportation. In conclusion, our project represents a significant step towards addressing the unique challenges faced by individuals with hearing impairments in the realm of transportation. By leveraging technology to enhance situational awareness and promote safe driving practices, we strive to empower individuals to lead independent, fulfilling lives. As we continue to innovate and advocate for inclusivity, we remain committed to creating a more accessible and equitable society for all.

5.2 Future Scope:

Our model has the potential for further enhancement through the use of more efficient components and integration with machine learning. This approach could lead to even greater accuracy and effectiveness. Additionally, there's always room for exploration beyond our current ideas. Future students may discover entirely new approaches that push the boundaries of this technology even further. Here's what's been improved: Clarity: Removed unnecessary pronouns ("You") and clarified the purpose of the statement, Conciseness: Combined sentences for better flow, Emphasis: Emphasized the potential of machine learning and future advancements, Formality: Used more formal language ("potential for further enhancement" instead of "can be enhanced more"), Flow: Improved sentence structure for smoother reading.

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Appendix

```
int mic=3;
int motor=8;
int led=9;

void setup() {
  pinMode(mic,INPUT);
  pinMode(motor,OUTPUT);
   pinMode(led,OUTPUT);
   Serial.begin(9600);
  // put your setup code here, to run once:
}
void loop() {
  Serial.println(digitalRead(mic));
  if(digitalRead (mic)==0)
  {
    digitalWrite(motor,HIGH);
    digitalWrite(led,HIGH);
    delay(3000);
  }
  else
  {
    digitalWrite(motor,LOW);
    digitalWrite(led,LOW);
  }        // put your main code here, to run repeatedly:
}
```