EMPOWER

2023

IIT MADRAS
Indian Institute of Technology Madras

TEAM-5

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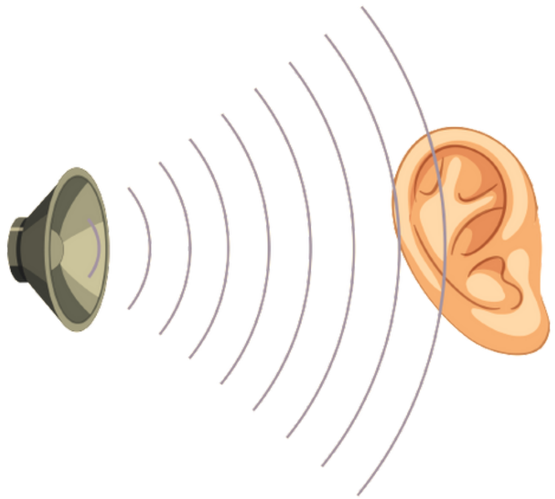
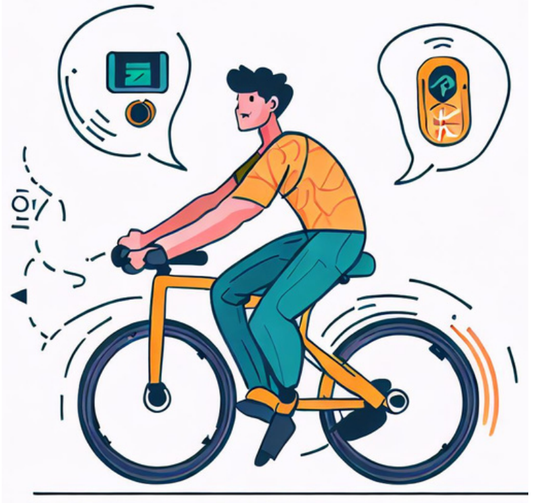
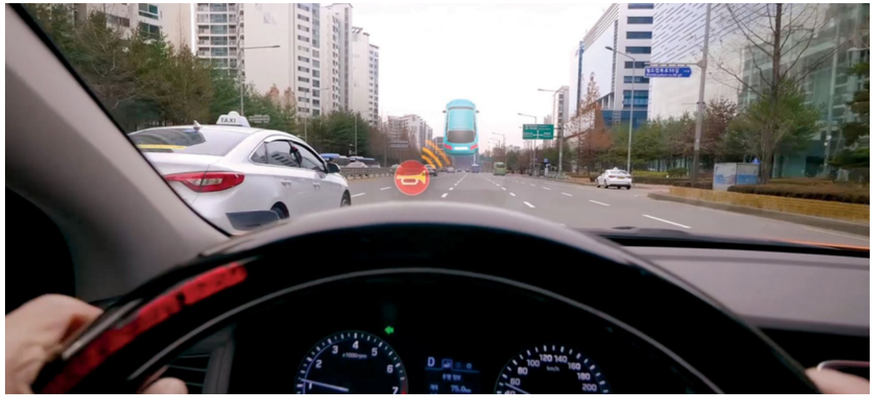
PROBLEM INTRODUCTION(PROBLEM STATEMENT - 5)

- Hearing impairment poses road safety challenges.
- A solution is required that detects traffic sounds and provides tactile alert to the hearing-impaired is required.
- Affordable, durable, eco-friendly driver safety system with tactile user feedback.





EXISTING PRODUCTS IN THE MARKET



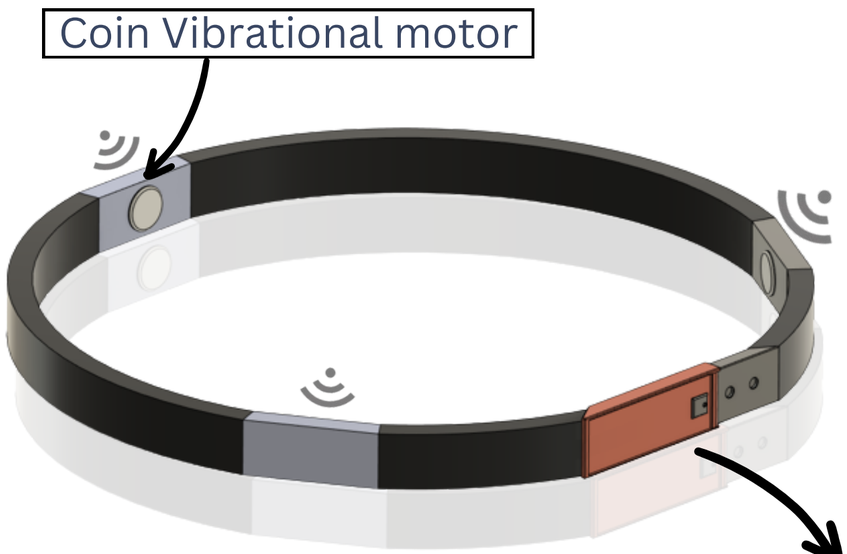
Hyundai's Assistive Device

- Technology employs AI for external sound analysis.
- Two systems: AVC and ATC, aiding hearing-impaired drivers with touch and visual senses.

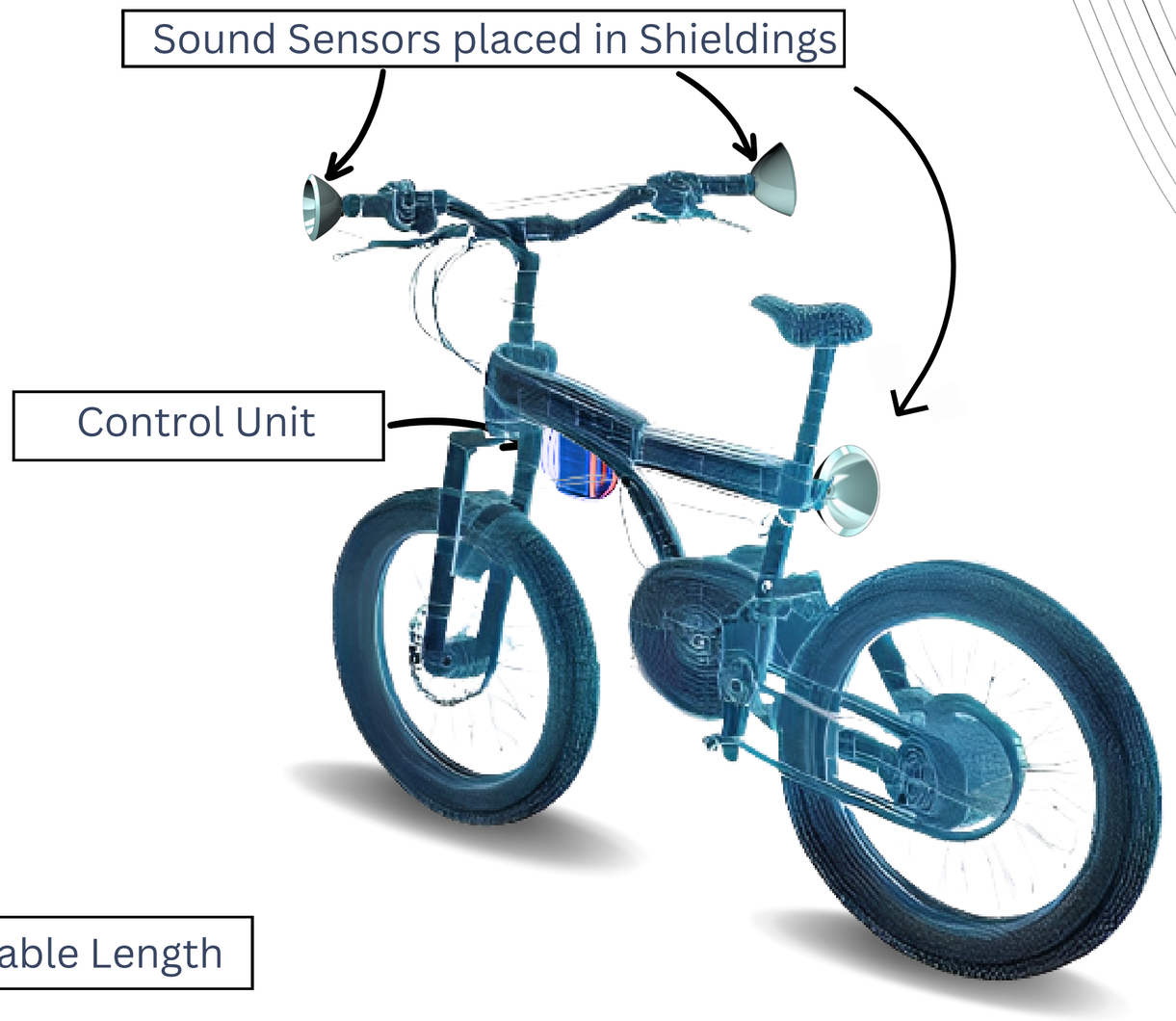
- Smartwatch tool converts vehicle horn sound to vibrations, aiding the deaf wearer's awareness of auditory signals.

Students of BIT, Indonesia

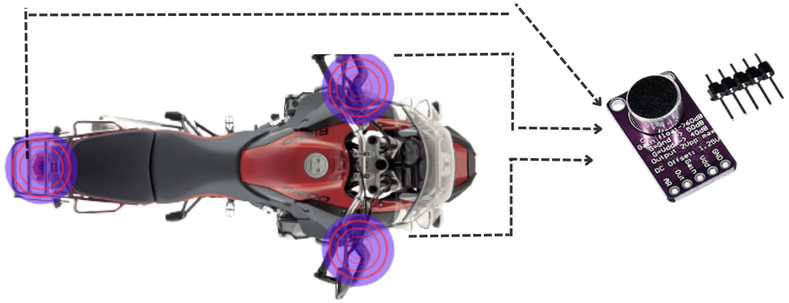
OUR PRODUCT



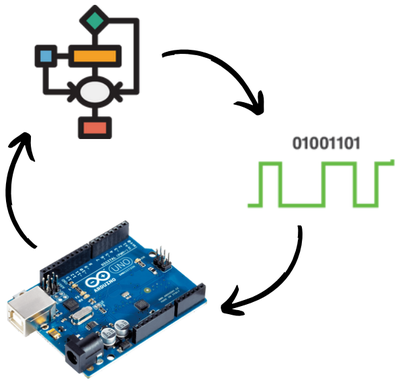
Wearable belt



Mounted Sensor Modules



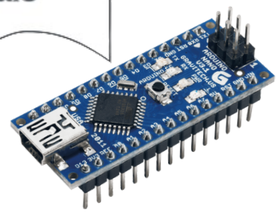
Signals from bike are captured



Effecient Horn Algorithm

Digital PWM Output

Wireless transmission of signals



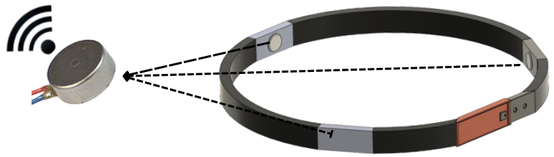
Vibrational signals received by sensors

Signal

No

Yes

Vibrations actuated



WORKFLOW

DEMONSTRATION VIDEO


HERCULES

ALGORITHM INTUITION

ALGORITHM INTUITION

Analog Signal

ALGORITHM INTUITION

Analog Signal

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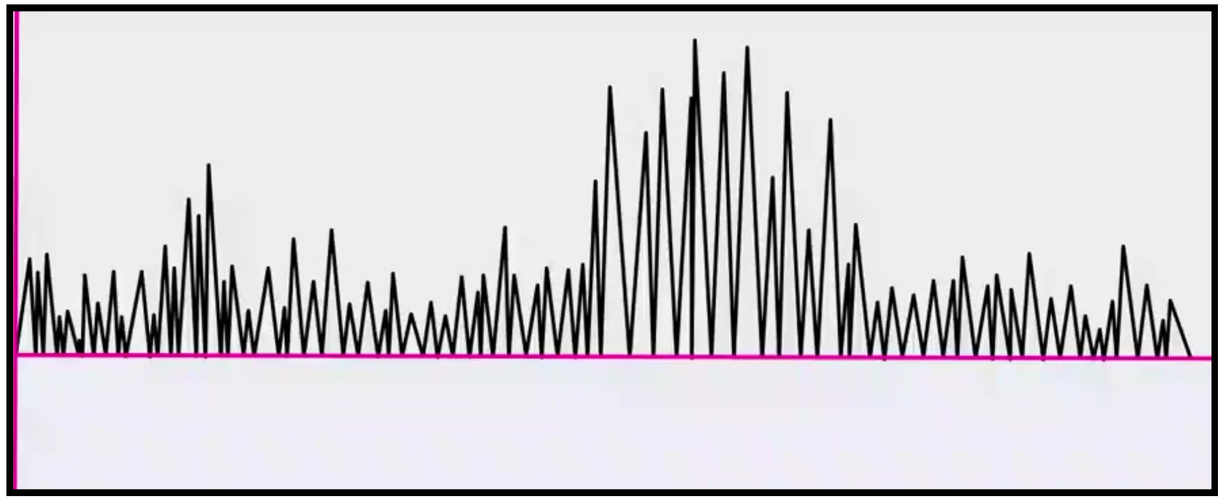
Absolute value
of the Signal

ALGORITHM INTUITION

Analog Signal



Absolute value of the Signal

Exponential moving average

b=0.75

Exponential moving averages

$$\frac{S_t}{1-b^t} = b \cdot S_{t-1} + (1-b) \cdot s$$

Weighted average with decaying weights

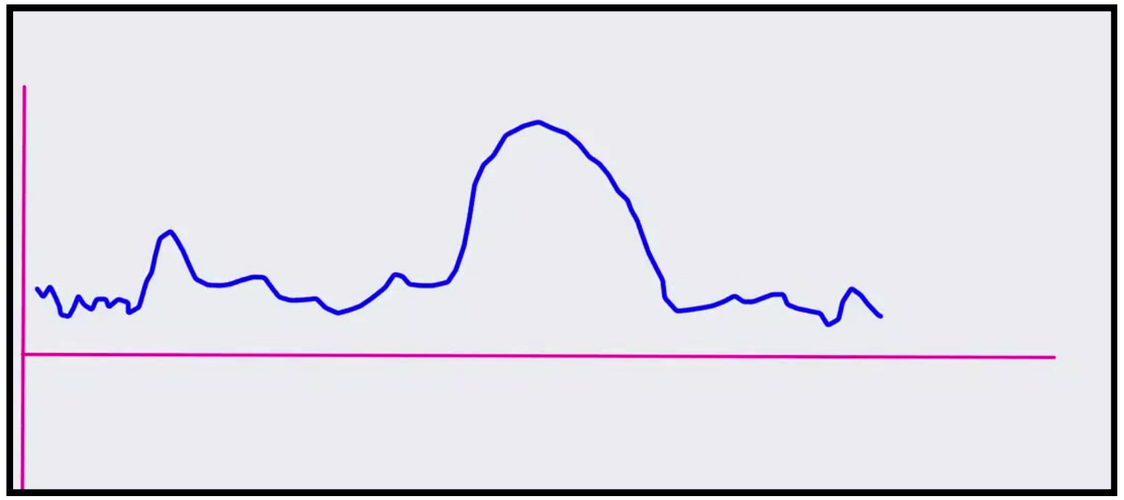
S_t : Processed Signal at time t
b : Exponential Weight
s : Analog value from sensor

Processed Signal

More weight to recent data

ALGORITHM INTUITION

Analog Signal



Absolute value of the Signal

Exponential moving average

b=0.75

Exponential moving averages

$$\frac{S_t}{1-b^t} = b \cdot S_{t-1} + (1-b) \cdot s$$

Weighted average with decaying weights

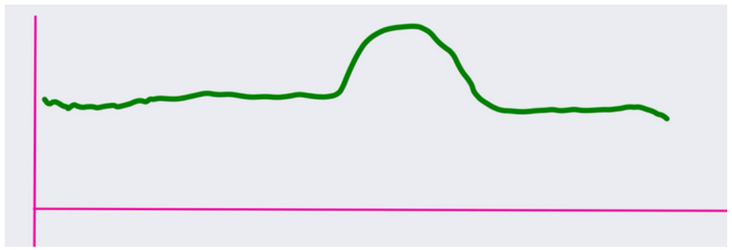
b=0.90

S : Processed Signal at time t
b : Exponential Weight
s : Analog value from sensor
α : Threshold off-set

Processed Signal

More weight to recent data

Threshold Signal



More weight to the average of previous data

ALGORITHM INTUITION:

Impulse Responses

Processed Signal

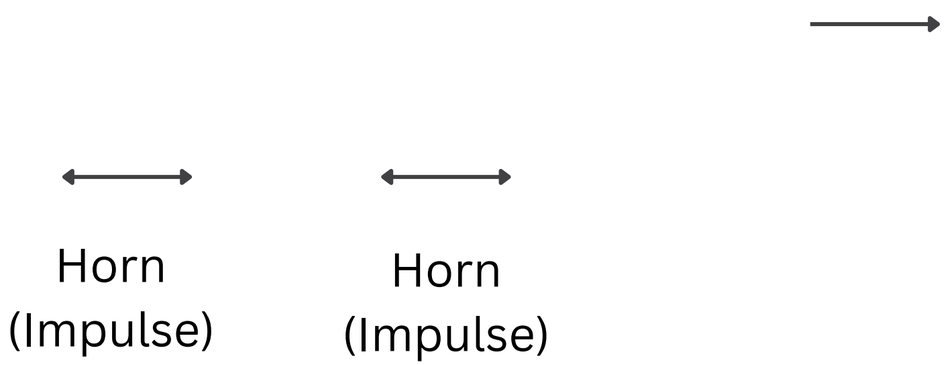
Threshold Signal

High Magnitude Response

Minimised Response

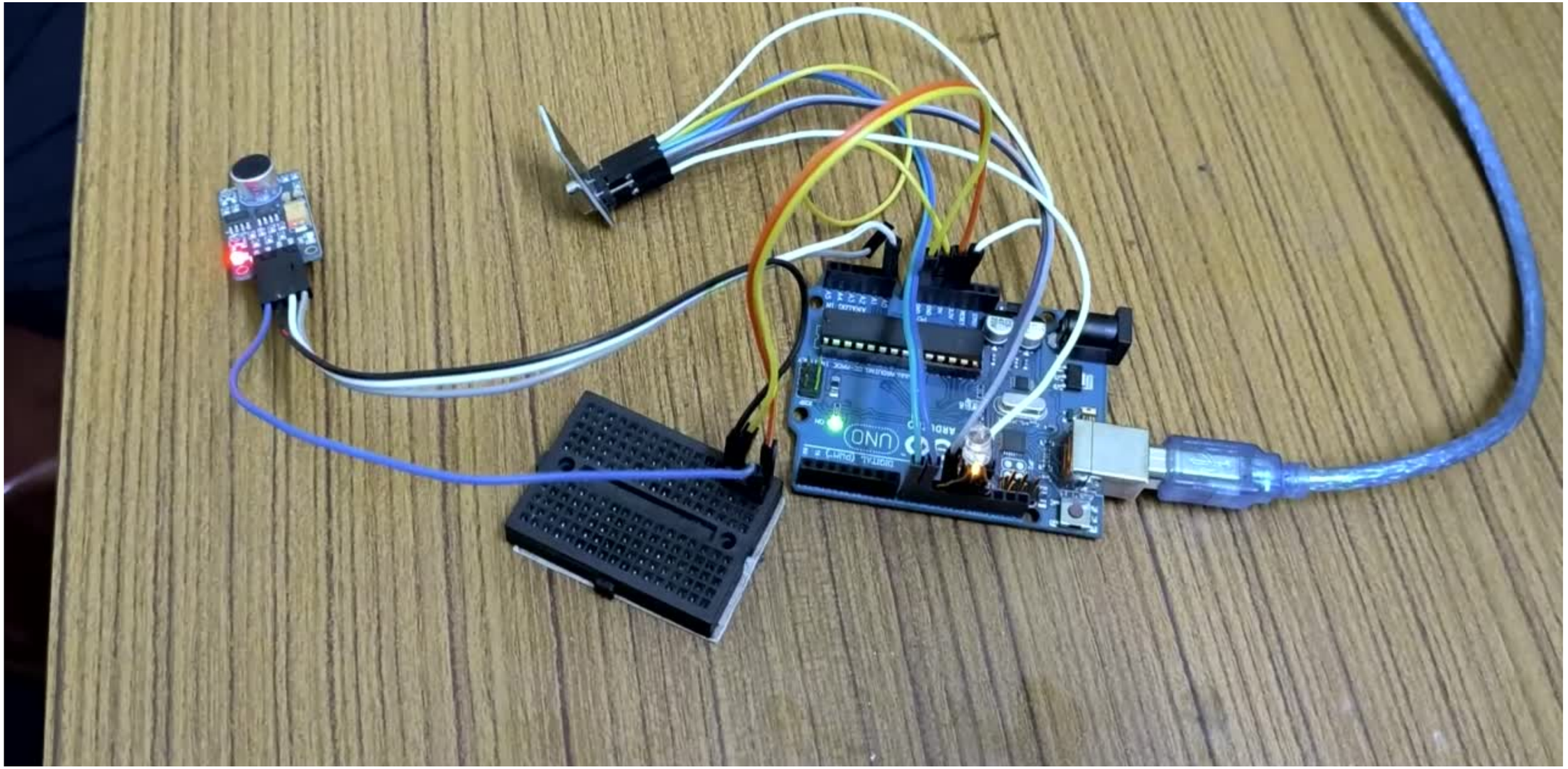
This difference in Responses is the key to the Horn Identification

ALGORITHM WORKING:



Detects Horns due to difference of behavior when impulsive input is given

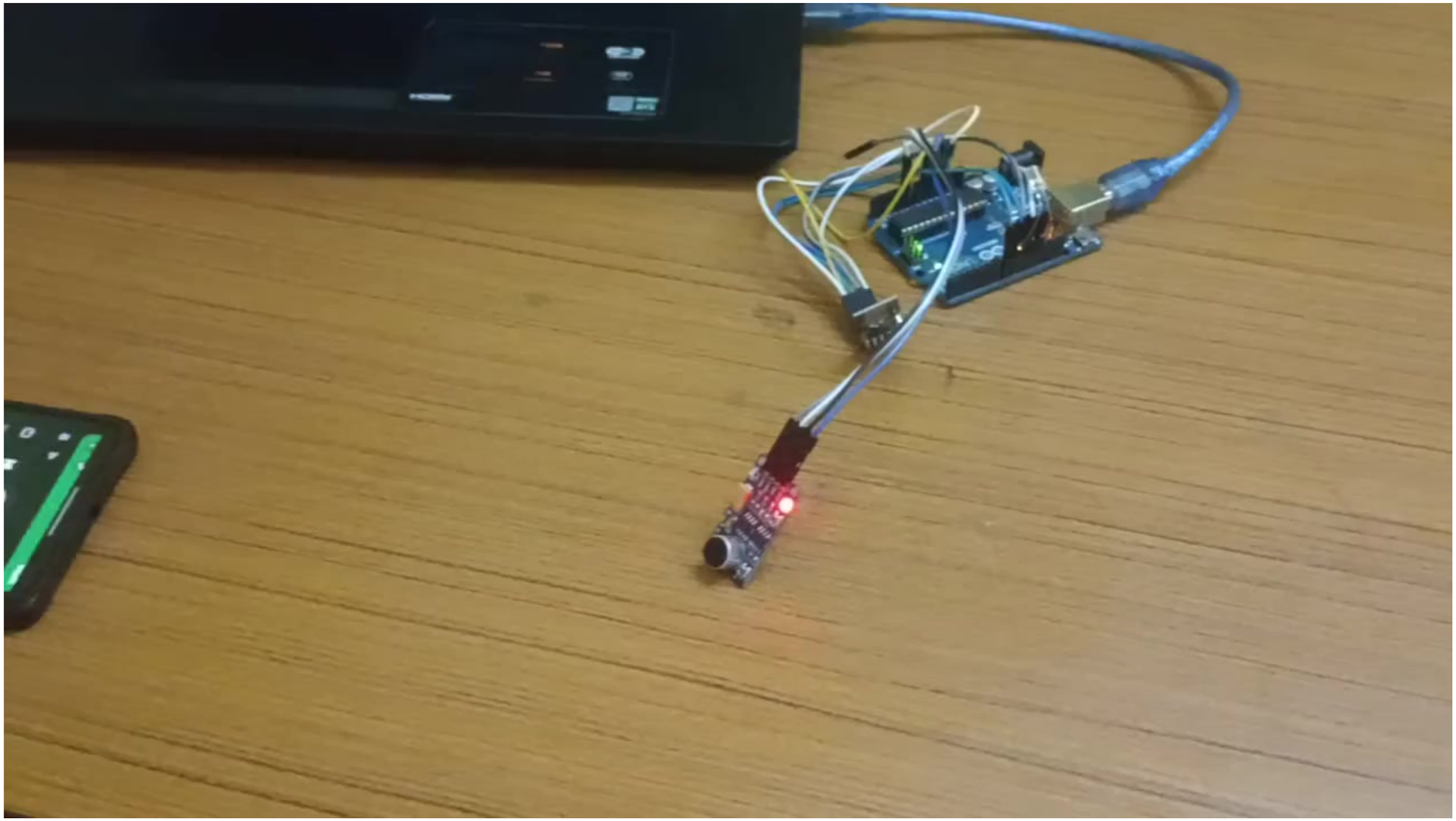
ALGORITHM WORKING DEMO:



INTELLIGENT NOISE SEGREGATION:

No impulsive input, Hence, No difference in behavior
the two signal runs parallel.

INTELLIGENT NOISE SEGREGATION DEMO:

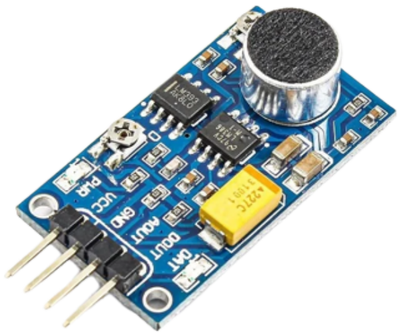


No Detection of Music or other Noises

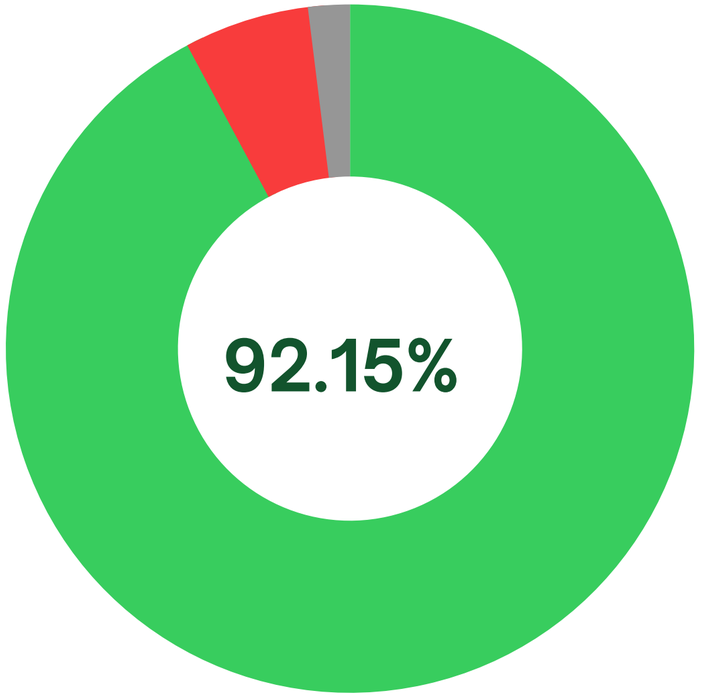
ALGORITHM TESTING:

Our Algorithm is tested on Indian traffic sound data

- Correct classification of 47 horns out of 51 horns
- Only 2 Misclassifications, where noise is erroneously detected as horn



- Mic sensitivity: 52dB
- Frequency range: 50Hz ~ 20KHz
- Power: 3.3V ~ 5.3V
- Onboard audio power amplifier LM386
- Audio signal gain up to 200

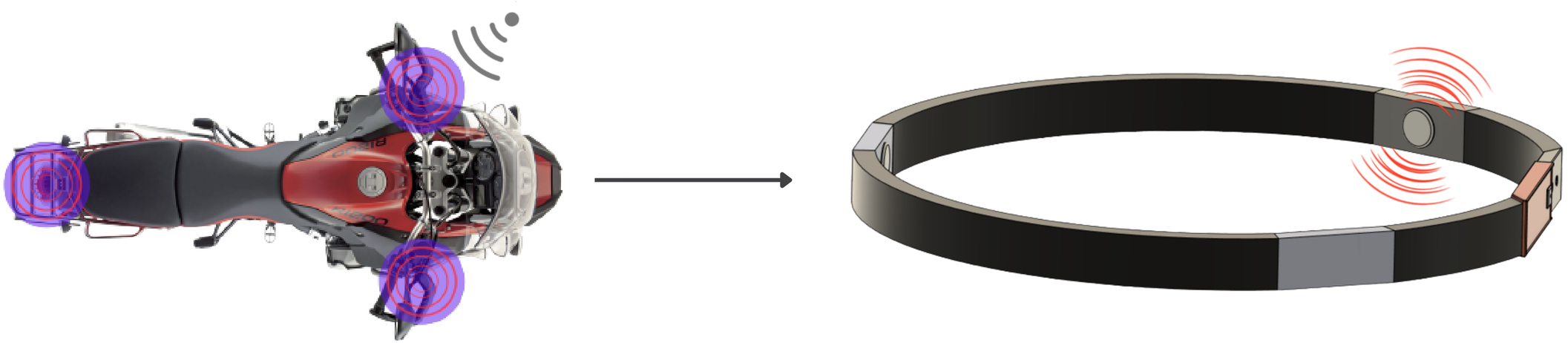


Accuracy

Test Data link :

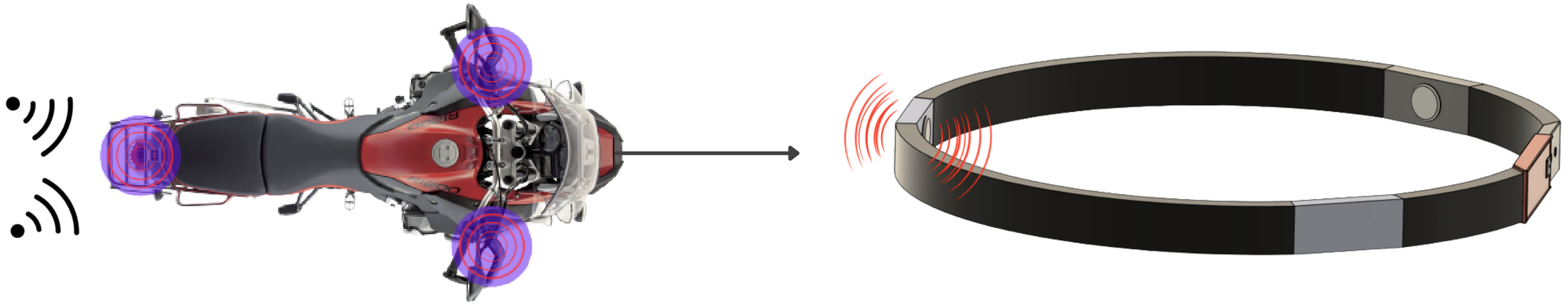
SALIENT FEATURES

SOUND LOCALIZATION AND ENHANCED RANGE



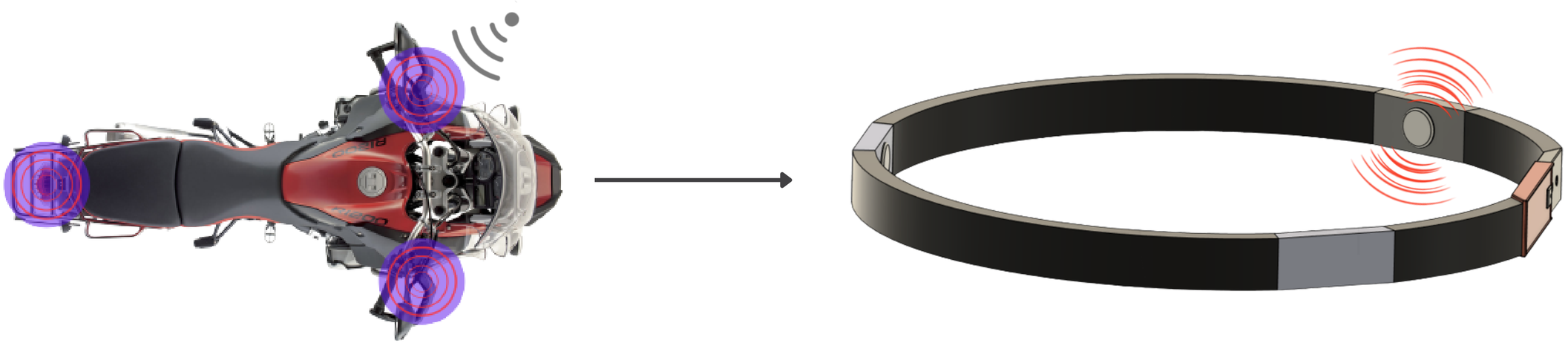
Vibrational Motors corresponding sound direction will be actuated

SOUND LOCALIZATION AND ENHANCED RANGE



Vibrational Motors corresponding sound direction will be actuated

SOUND LOCALIZATION AND ENHANCED RANGE



Vibrational Motors corresponding sound direction will be actuated

SOUND SHIELDING

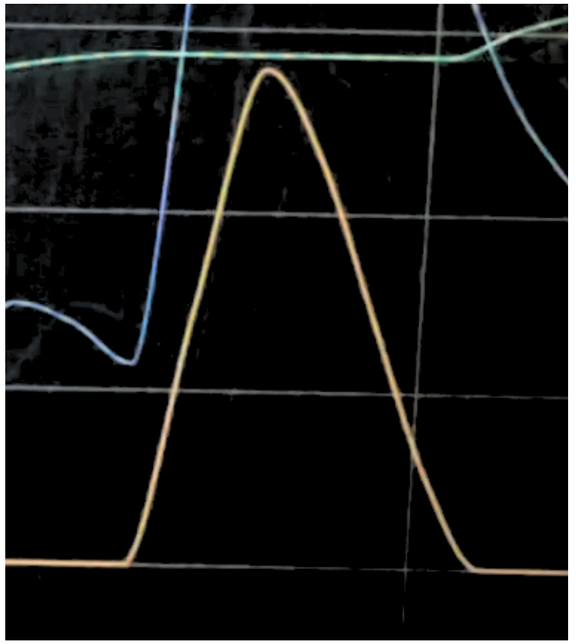
- Accurate sound detection from a specific direction
- Sound from any other direction will be absorbed by the form covering

ACOUSTIC MIRROR

Reflects sound coming from a specific direction into the microphone placed at the focus. Thus enhancing range.

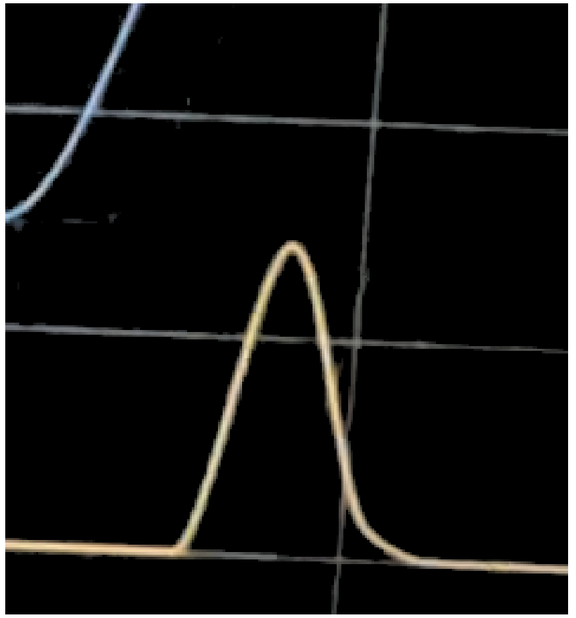
SOUND PROXIMITY

Nearby horn triggers relatively higher intensity vibrations.



Nearby horn

Distant horn triggers relatively Lower Intensity vibrations.

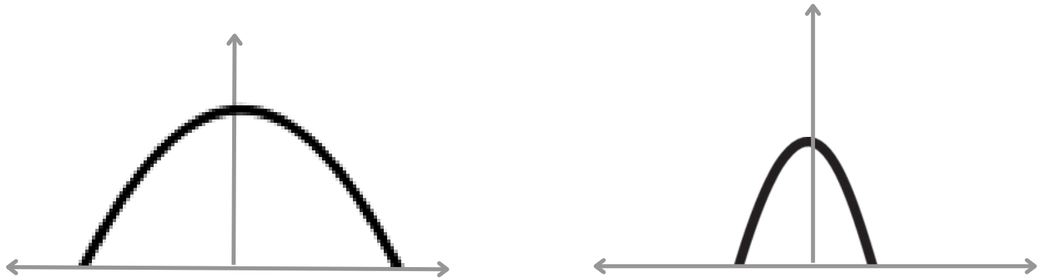


Distant horn

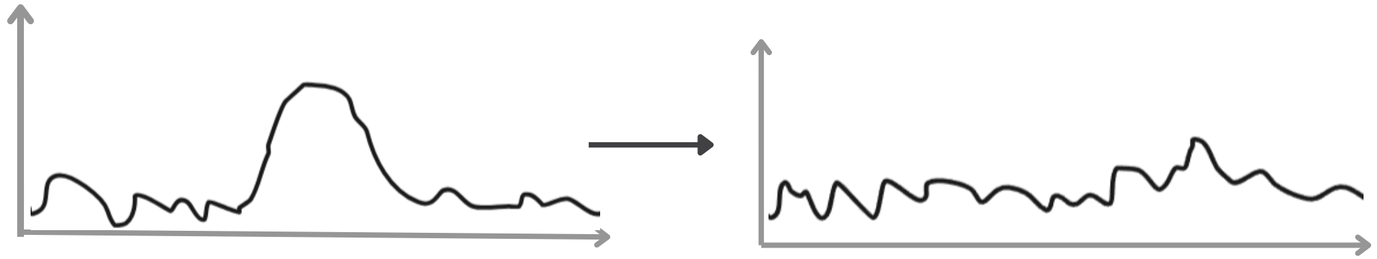
PROXIMITY AWARENESS!!

AVOIDS DETECTION OF OWN HORN

If our own horn sound is detected



Wave form will be properly scaled for all three sensors

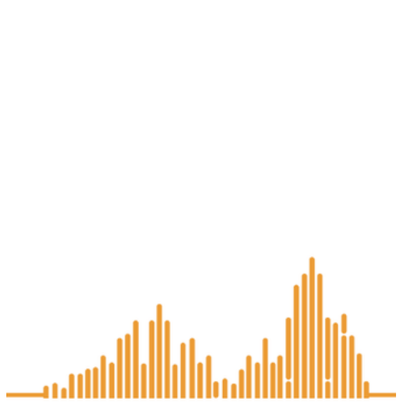


Detected sound will be subtracted from all the sensors

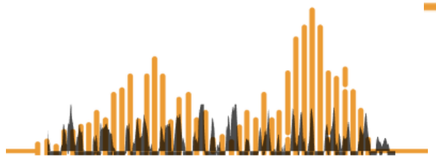
- Low sensitivity sound sensor has been installed in front of the Horn
- Sensor sensitivity has been adjusted to minimize environmental noise.

AVOIDS DETECTION OF OWN HORN DEMO

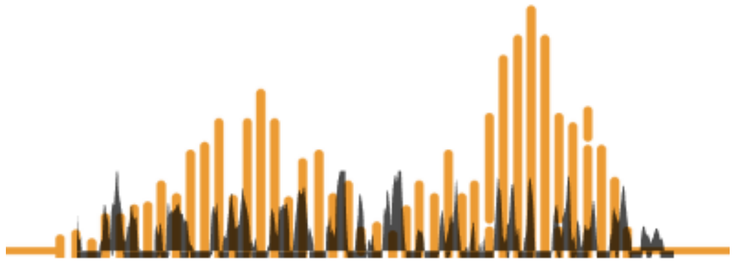
VIBRATION NOISE CANCELLATION

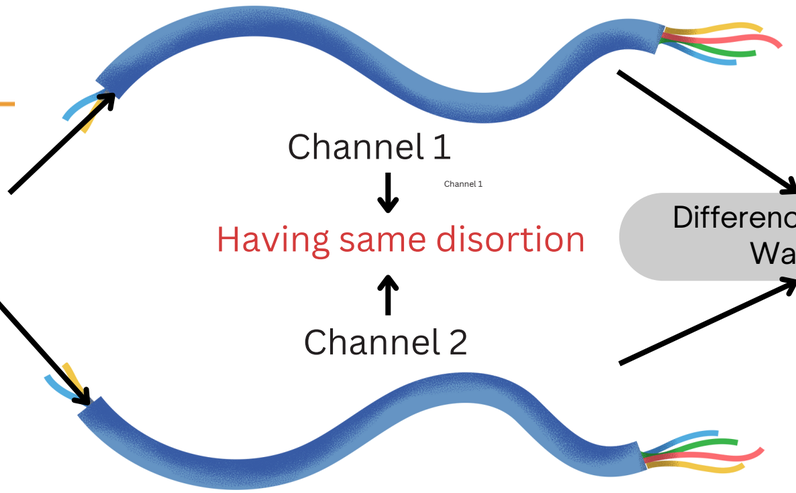


Waveform from the sensor



Bike vibrations adds distortions





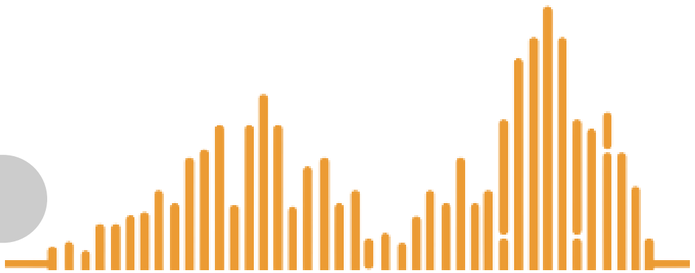
Channel 1

Channel 1

Having same disortion

Channel 2

Difference of Two Waves



Original Waveform

COST EFFECTIVENESS

Approximate cost

components	cost
Mlcroprocessor*2(Arduino/Nano)	1300
Sound Sensor (MAX9814)*3	800
Vibration Motors*3	300
nRF24LO1*2	180
casing & fabrication	400
Total	≃3000

Cost comparison with Hearing Aids:

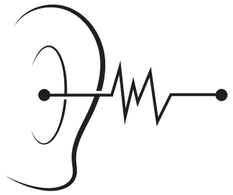
Our Product

Price - INR 3000

Mid-range hearing aids range from
INR 20,000 to 75,000 per Ear Machine.

Advanced hearing aids cost around
INR 50,000 to 2,00,000 per ear

Affordable in comparison to other expensive models and hearing aids present in market.



ADDITIONAL FEATURES

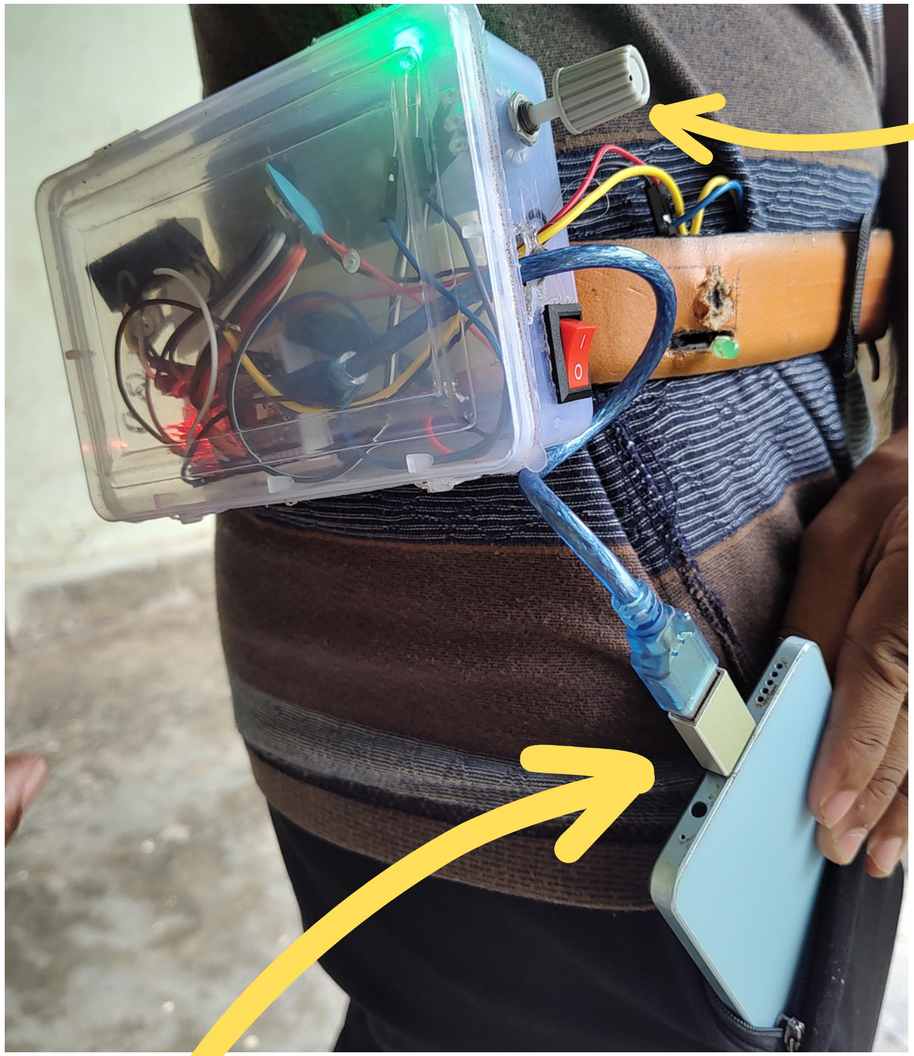
Alternate Sources for Power

- Using an OTG USB connector, our product can be powered by a powerbank or a mobile device.

- In emergency scenarios where the power source has dried up, this function can be useful.

Adjusting Knob

To cater to all types of clothing and comfort, user can adjust the maximum intensity of the vibration module using a knob.

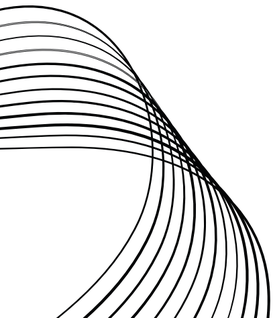


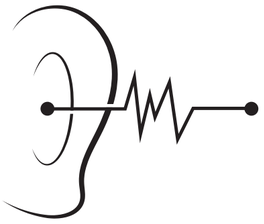
EMPOWER 2023

iitm research park
Bringing Unlike Minds Together

Thank You

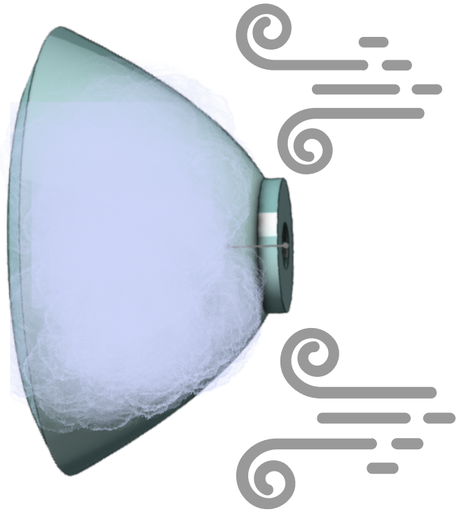
ADDITIONAL SLIDES





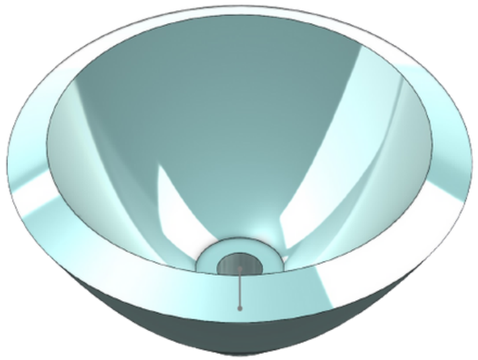
TACKLES WIND INFLUENCE ON SENSOR

- We will cover the sensor with foam windscreen.
- We will place a foam sheet covering over the sensor cup. (Foam is better at absorbing high frequencies).
- In addition, the cup itself would cover the sensor from the direct passage of wind.



WEATHER PROTECTION

- Utilize weather-resistant sturdy case for Arduino, safeguarding against rain, and dust.
- The acoustic mirrors will protect the sensors and inner circuitries from rain.



BATTERY LIFE

- Using 2500mAh rechargeable Li-ion baterry, we calculated 60 days of run in one battery life.

USER-FRIENDLY DESIGN

- **Customizable fit:** Adjustable belt size ensures tailored comfort.
- **Safety:** Ensures device integration doesn't hinder rider safety or attention on the road.