Safe Ride: Next Generation Car Safety Solution Using Arduino and Sensors

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Abstract-With car accidents continuing to be a leading cause of injuries and fatalities globally, there is an urgent need for innovative safety solutions. Safe Ride addresses this critical issue by developing an advanced vehicle safety system that integrates Arduino Mega and a suite of sensors to proactively prevent accidents and enhance overall road safety. Safe Ride offers an array of innovative features that work together to create a safer driving experience. The system includes automatic rain-triggered wipers and fog light activation to ensure optimal visibility in adverse weather conditions, thus reducing the risk of weather-related accidents. its advanced object identification technology, which detects and avoids obstacles in real-time, helping to prevent collisions. Additionally, the system incorporates an intelligent alcohol detection mechanism that prevents the vehicle from starting if the driver is impaired, addressing one of the most significant causes of car accidents. Safe Ride also enhances situational awareness with real-time monitoring of the vehicle's surroundings. It detects oncoming vehicle headlights and vehicles in blind spots, aiding in safer lane changes and reducing the likelihood of side-impact collisions. Parking safety is further improved with ultrasonic sensors that guide drivers into parking spaces with precision, reducing the risk of parking-related accidents. By leveraging the power of Arduino and sensor technology, Safe Ride represents a forward-thinking approach to reducing car accidents and improving overall vehicle safety.

I. INTRODUCTION

In the modern world, automobiles have become an indispensable part of daily life. However, with the increasing number of vehicles on the road, the risk of accidents and associated safety concerns have also risen. Ensuring the safety of drivers, passengers, and pedestrians has become a paramount issue that demands innovative solutions. The "Safe Ride" project aims to address these critical safety concerns by leveraging cutting-edge technology to enhance vehicle safety through the integration of Arduino and various sensors. This project presents a comprehensive and advanced vehicle safety system designed to mitigate risks and significantly reduce the likelihood of accidents. The core features of Safe Ride include the use of Arduino microcontrollers to interface with a variety of sensors that monitor and respond to different aspects of driving. The system offers automatic rain-sensing wipers and fog light activation to improve visibility in adverse weather conditions, object detection for collision prevention, and an alcohol detection mechanism to prevent impaired driving by rendering the vehicle inoperable if the driver is under the influence. Additionally, Safe Ride includes real-time monitoring of the vehicle's surroundings, such as detecting oncoming vehicle headlights and vehicles in blind spots, and providing adaptive responses for safer driving. Ultrasonic sensors assist in precise and safe parking manoeuvres, making parking simpler and safer for drivers. Furthermore, the Safe Ride system is designed with additional accessories such as motor drivers, Bluetooth modules, WIFI modules, and more, which collectively contribute to a robust and comprehensive safety solution.

1.1 Traffic Survey.

Road accidents in India represent a significant public health and safety challenge. According to the "Road Accidents in India 2020" report, the year recorded a staggering 3,66,138 road accidents, resulting in the tragic loss of 1,31,714 lives and injuries to 3,48,279 individuals. These figures underline the critical need for enhanced road safety measures, as road accidents remain one of the leading causes of death, disability, and hospitalization in the country. The most affected

age group, 18-45 years, accounts for about 70% of the total accidental deaths, highlighting the impact on the productive segment of the population.

In 2021, India reported a total of 412,432 road accidents, which resulted in 153,972 fatalities and caused injuries to 384,448 individuals. The most affected age group was 18-45 years, constituting approximately 67% of the total deaths. Despite the government's ongoing efforts to enhance road safety, significant progress has been elusive. Road accidents are a multifaceted issue influenced by various factors, and the Ministry of Road Transport and Highways has adopted a comprehensive strategy focusing on education, engineering, enforcement, and emergency care to address the problem.

Road accidents have been the leading cause of deaths worldwide with the last three decades seeing a substantial increase in this regard. The WHO's World Report on Road Traffic Injury Prevention lists Road Accidents as the third leading contributor to the global burden of disease, up from ninth position in 19901. India's contribution in this regard is amongst the highest in the world with the country accounting for the second highest number of road accidents globally and the highest number of deaths. A total of 1,51,113 people were killed in India in 4,80,652 road accidents as against China whose figures of 63,093 deaths from 2,12,846 place it a distant second.

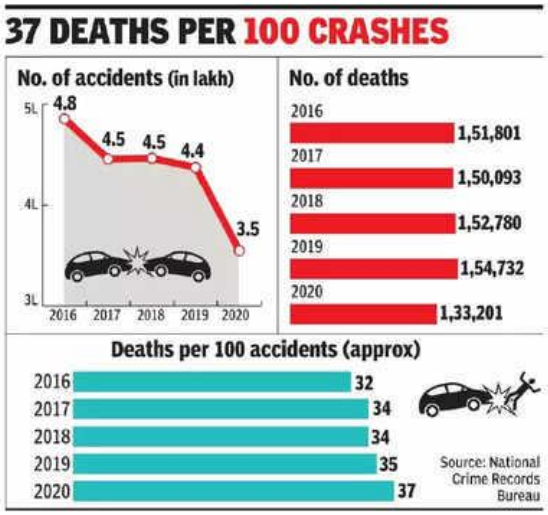


Figure 1.1.1 the strategic graph of deaths in India by Times of India report

In 2019, India experienced a total of 449,002 road accidents, resulting in 151,113 fatalities and 451,361 injuries. Despite government efforts and the enactment of the Motor Vehicle Amendment Act 2019, which aimed to enhance road safety and included significant penalties for traffic violations, road accidents remain a leading cause of death and injury. National Highways, accounting for only 2.03% of the total road network, disproportionately contributed to 35.7% of the deaths. Over speeding was identified as the primary cause of fatalities, responsible for 67% of deaths, followed by driving on the wrong side. The working age group of 18-60 years constituted 84% of the total road accident deaths.

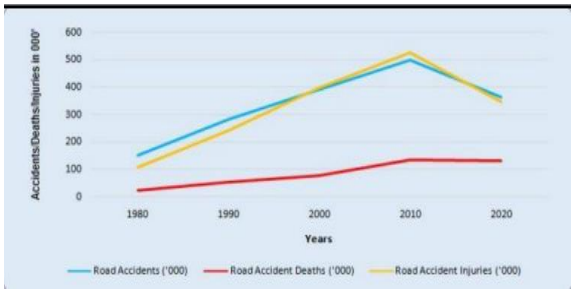


Figure 1.1.2 the graph of overall case of accidents from past 50 years

1.2 AIM

The Aim for the "Safe Ride" project stems from the need to address the rising safety concerns associated with the increasing number of vehicles on the road. With automobiles becoming an integral part of daily life, the risk of accidents has grown significantly. The project's aim is to enhance vehicle safety by integrating advanced technologies like Arduino and various sensors to create a comprehensive safety system. This system seeks to reduce the likelihood of accidents by offering features such as automatic rain-sensing wipers, object detection for collision prevention, alcohol detection to prevent impaired driving, and real-time monitoring of the vehicle's surroundings.

1.3 LITERATURE REVIEW

The literature survey for the "Safe Ride" project highlights the increasing significance of integrating advanced technological solutions to enhance vehicle safety in response to the escalating number of road accidents. Previous studies have demonstrated the effectiveness of using microcontroller-based systems, such as Arduino, to implement safety features in vehicles. These systems often employ various sensors for real-time data collection and processing to improve

driver awareness and response times. The integration of alcohol detection, obstacle detection, and weather-responsive features has been explored in numerous research efforts to address specific safety concerns. Existing literature emphasizes the need for comprehensive and cost-effective solutions that can be easily adapted to different vehicle models, underscoring the potential for microcontroller-based systems to revolutionize car safety. The "Safe Ride" project builds upon these foundations by proposing a multifaceted safety system that leverages current technological advancements to offer a more holistic approach to vehicular safety.

1.4 OBJECTIVE

The following objectives of the proposed project are set:

- Real-time weather response with automatic hazard lights activation during rain.
- Fog light activation for optimal visibility in adverse weather conditions.
- Object detection capabilities enable swift avoidance of obstacles on the road, enhancing collision prevention.
- Alcohol detection to prevent impaired driving, ensuring the vehicle remains inoperable if the driver is under the influence.
- Detection of oncoming vehicles headlights for adaptive response, as well as sensing vehicles in the blind spots on both sides.
- Parking maneuvers are simplified with the inclusion of ultrasonic sensors, aiding drivers in precise and safe parking.
- Manual and sensor mode
- Automatic falling of volume when any ambulance sound is detected.
- Recording all this data in the serial Bluetooth terminal APK automatically.
- Falling of sensors like if any hole or any down next to the car automatically stopping of the car.

II. PROPOSED SYSTEM

We group members are aiming to a build a solution for the problem is to develop a comprehensive safety solution that addresses key concerns such as accident prevention, driver alertness, and passenger well-being. The proposed system, titled "Safe Ride: Next Generation Car Safety Solution Using Arduino and Sensor," is an innovative project aimed at enhancing vehicle safety through the integration of Arduino microcontrollers and advanced sensor technology. The project includes selecting appropriate sensors and Arduino components, designing the hardware setup, writing code to read and process sensor data, and implementing decision-making logic to trigger safety actions or alerts.

2.1 BLOCK DIAGRAMS

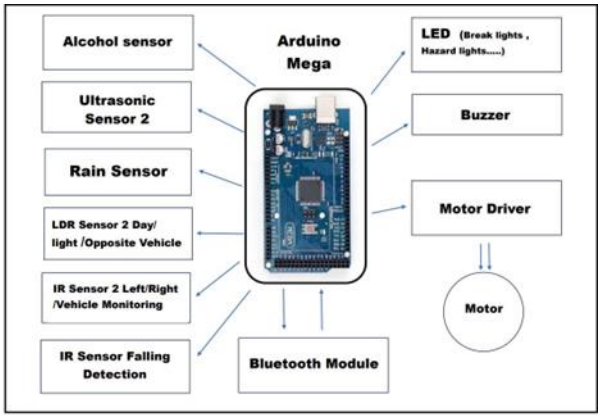


Figure 2.1.1 Block Diagram of Multipurpose car safety solutions

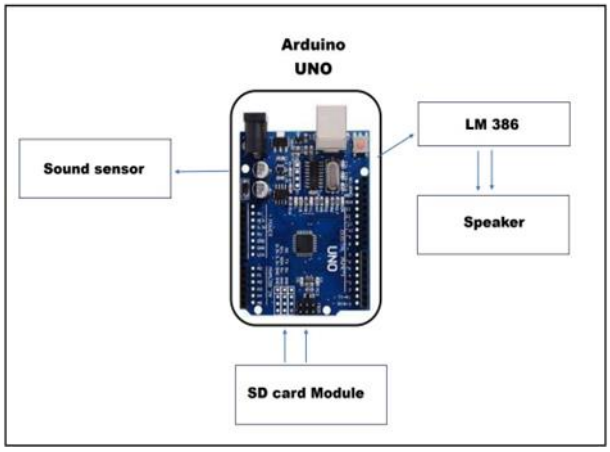
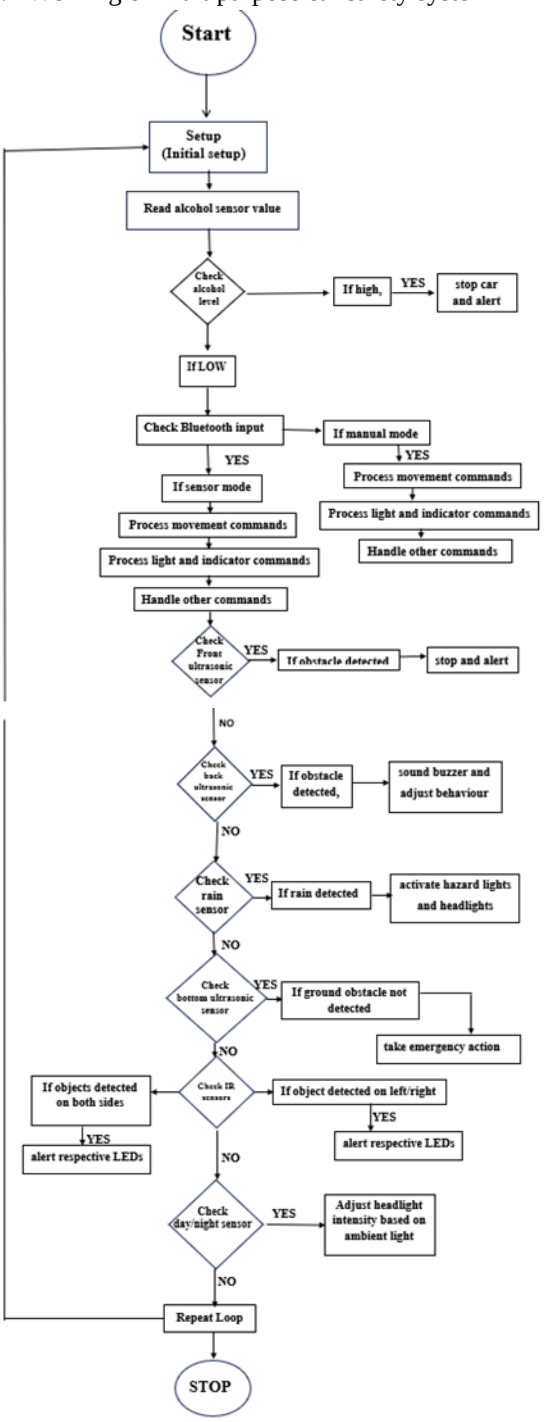


Figure 2.1.2 Block Diagram of the Emergency sound control

2.2 Prototype working

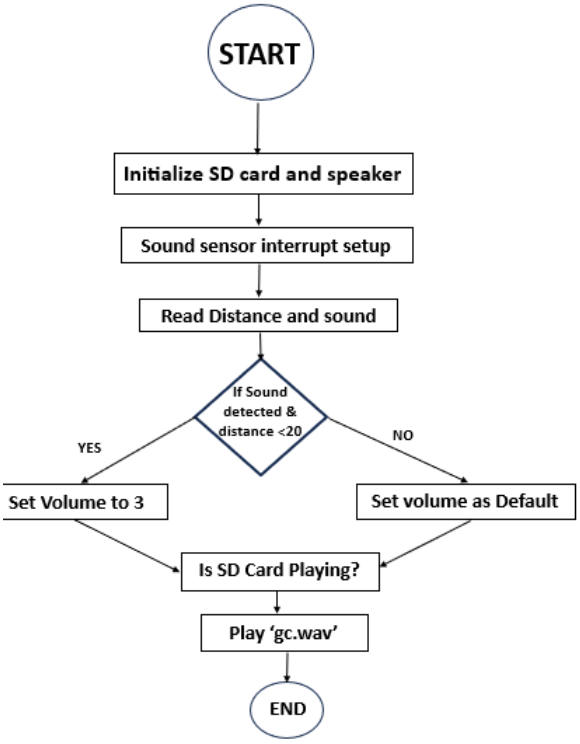
The prototype for the multipurpose car safety solution demonstrates the integration of various sensors and components to enhance vehicle safety. The system is built using an Arduino microcontroller, which serves as the central hub for processing data and controlling the safety features.

2.2.1 Working of Multipurpose car safety system



- Initializes serial communication for system and Bluetooth.
- Sets up pin modes for motor control, LED indicators, sensors, and other peripherals.
- Enters the main loop where the program continuously operates.
- Begins by reading the alcohol sensor value to monitor alcohol levels.
- Determines if the alcohol level exceeds a threshold (700 in this case).
- If alcohol level is high, Stops the robot's movement. Sends an alert message over Bluetooth indicating alcohol detection.
- Checks for incoming commands from Bluetooth:
  - **Sensor Mode**, Processes commands for movement (forward, backward, left, right, stop). Controls hazard lights, headlights (high/low/off), and buzzer.
  - **Manual Mode**, Processes similar movement and control commands based on manual input. Executes actions accordingly, including light and buzzer controls.
- **Front Sensor**, Monitors distance using an ultrasonic sensor. If an obstacle is detected within 20 cm, activates emergency stop and alerts over Bluetooth.
- **Back Sensor**, similar monitoring for obstacles behind the robot. Activates buzzer and adjusts behaviour based on proximity to obstacles.
- Determines if rain is detected using a rain sensor input.
- If rain is detected ,Activates hazard lights to alert surroundings. Turns on headlights for improved visibility in low-light conditions.
- Monitors proximity to ground using a bottom-mounted ultrasonic sensor.
- If a ground obstacle is detected initiates emergency braking and adjusts behaviour to avoid collision and Activates hazard lights as a precautionary measure.
  - Detects objects or vehicles on the left or right sides of the robot.
  - Activates respective LED indicators to warn of nearby obstacles.
  - Depending on the side(s) with detected obstacles, adjusts robot behaviour and alerts over serial communication.
- Monitors ambient light conditions using a day/night sensor.
- Adjusts headlight intensity accordingly, Lowers intensity during daylight or well-lit conditions. Increases intensity during low-light or nighttime conditions for better visibility.

2.2.2 Working of Emergency Sound Control system



1) Initialize SD card and Speaker:-

Setup and initialize the SD card and speaker components for the system.

2) Sound Sensor Interrupt Setup:-

Configure the sound sensor to generate interrupts when sound is detected.

3) Read Distance and Sound:-

Continuously monitor and read the distance (using a distance sensor) and sound levels (using the sound sensor).

4) Sound Detected & Distance < 20?

- Check if a sound is detected and if the distance is less than 20 units (could be cm or any other unit depending on the sensor).
- If both conditions are met, proceed to set the volume to 6.
- If the conditions are not met, set the volume to 3.

5) Set Volume to 3 or Set Volume to 6:-

Based on the previous condition, set the volume to 3 or 6.

6) Is SD Card Playing?

- Check if the SD card is currently playing any audio file.
- If the SD card is not playing, proceed to play the specified audio file (gc.wav).

7) Play 'gc.wav'

Play the audio file gc.wav from the SD card.

8) End

2.3 CIRCUIT DIAGRAM

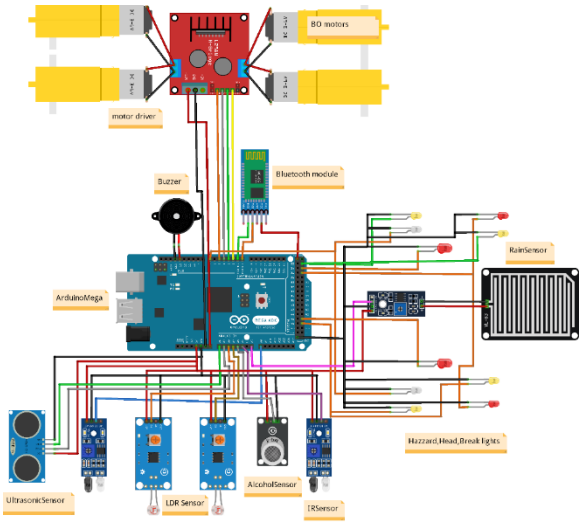


Figure 2.2.3 Circuit Diagram of Multipurpose car safety solution system solutions

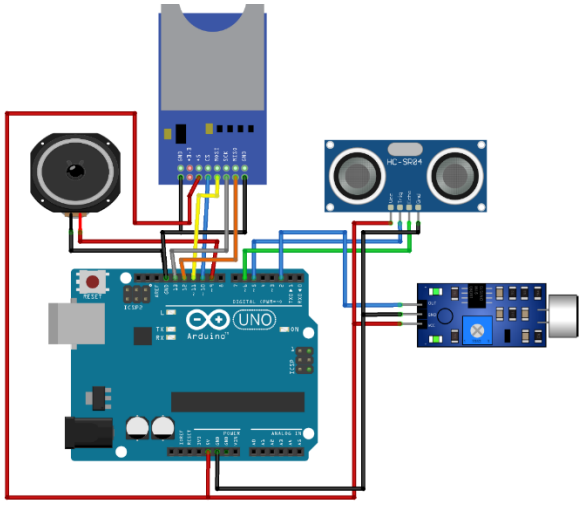


Figure 2.2.4 Circuit Diagram of Emergency Sound Control system

III COMPONENTS

3.1 MICROCONTROLLERS [Arduino mega & UNO]

A microcontroller is a compact integrated circuit designed to execute specific tasks within electronic devices. The microcontroller board like "Arduino Mega" depends on the ATmega2560 microcontroller. It includes digital input/output pins-54, where 16 pins are analog inputs, 14 are used like PWM outputs

hardware serial ports (UARTs) – 4, a crystal oscillator-16 MHz, an ICSP header, a power jack, a USB connection, as well as an RST button. This board mainly includes everything which is essential for supporting the microcontroller. So, the power supply of this board can be done by connecting it to a PC using a USB cable, or battery or an AC-DC adapter. This board can be protected from the unexpected electrical discharge by placing a base plate.

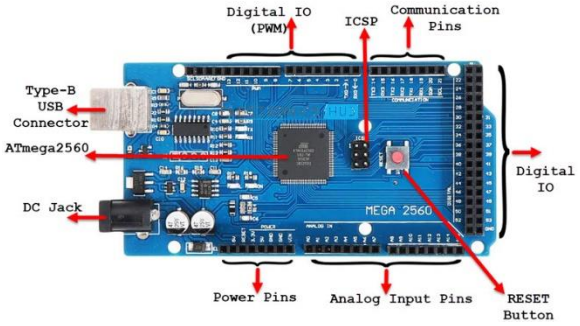


Figure 3.1.1 The schematic diagram of Arduino Mega Board

The Arduino Uno is a widely-used microcontroller board based on the ATmega328P, featuring 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header, and a reset button. It is designed to provide a simple and accessible platform for beginners and professionals alike, enabling the development of interactive projects.

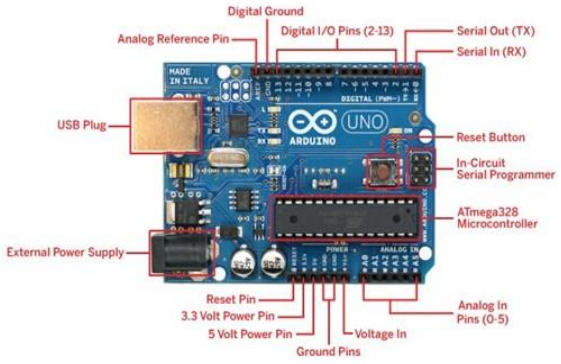


Figure 3.1.2 The schematic diagram of the Microcontroller Arduino UNO board

3.2 SENSORS

3.2.1 ULTRASONIC SENSOR

An ultrasonic sensor is a device that measures distance by using ultrasonic waves. It works by emitting a sound wave at a frequency above the range of human hearing and then waiting for the sound to be reflected back.

Figure 3.2.1 the ultrasonic senior

3.2.2 ALCOHOL SENSOR

This module is made using Alcohol Gas Sensor MQ3. It is a low cost semiconductor sensor which can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. The sensitive material used for this sensor is SnO2, whose conductivity is lower in clean air. It's conductivity increases as the concentration of alcohol gases increases. It has high sensitivity to alcohol and has a good resistance to disturbances due to smoke, vapor and gasoline. This module provides both digital and analog outputs. MQ3 alcohol sensor module can be easily interfaced with Microcontrollers, Arduino Boards, Raspberry Pi etc

Figure 3.2.2 the Alcohol senior

3.2.3 LDR SENSOR

LDR or Light Dependent Resistor is one type of variable resistor. It is also known as a photoresistor. The Light Dependent Resistor (LDR) works on the principle of "Photo Conductivity". The LDR resistance is change according to the light intensity falls on the LDR. When light intensity increases on the LDR surface, then the LDR resistance will decrease and the element conductivity will increase. When light intensity decreases on the LDR surface,

then the LDR resistance will increase and the element conductivity will decrease.

Figure 3.232 the LDR sensor

3.2.4 IR SENSOR

Figure 3.2.4 the IR sensor

The working principle of an IR sensor is fascinating. These sensors detect infrared radiation emitted by objects in their vicinity. When an object emits heat, it generates infrared radiation that the sensor can pick up. This detection process allows the sensor to identify the presence or absence of an object based on its heat signature.

3.2.5 RAIN SENSOR

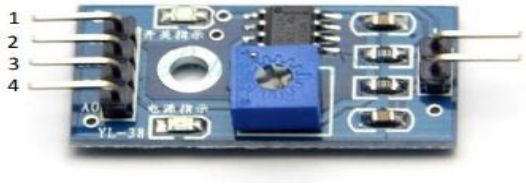


Figure 3.2.5 the Rain sensor

A rain sensor is one kind of switching device which is used to detect the rainfall. It works like a switch and the working principle of this sensor is, whenever there is rain, the switch will be normally closed. This module is similar to the LM393 IC because it includes the electronic module as well as a PCB. Here PCB is used to collect the raindrops. When the rain falls on the board, then it creates a parallel resistance path to calculate through the operational amplifier.

3.2.6 SOUND SENSOR

A sound sensor is a simple, easy-to-use, and low-cost device that is used to detect sound waves traveling through the air. Not only this but it can also measure its intensity and most importantly it can convert it to an electrical signal which we can read through a microcontroller.

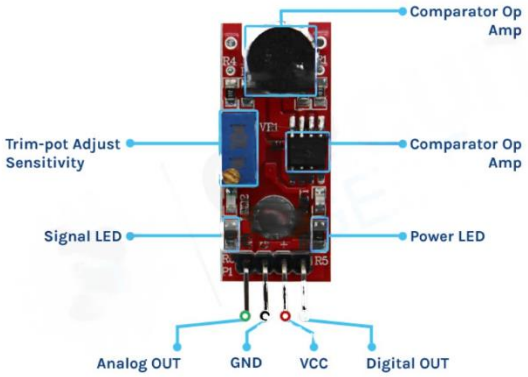


Figure 3.2.6 the Sound sensor

IV. PROTOTYPE

Figure 4.1.1 outside view of prototype

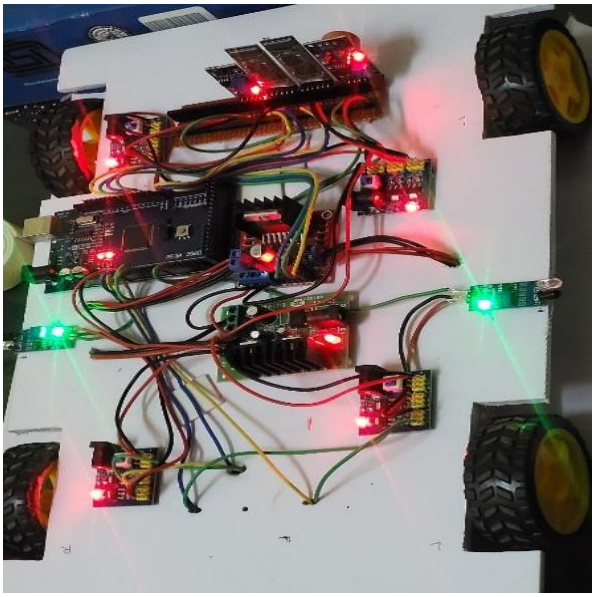


Figure 4.1.2 inside view of prototype

V. RESULT

5.1 Real-time weather response with automatic hazard lights activation during rain using rain sensor

Figure 5.1.1 shows the Rain Sensor and the weather response by switching automatic head lights

5.2 Object Detection Using Ultrasonic Sensor

Figure 5.2.1 shows the Ultra sonic Sensor for front object detection

Figure 5.2.2 shows the Data of front Distance detected by ultrasonic sensor

5.3 Alcohol Detection Using Alcohol Sensor

Figure 5.3.1 shows the alcohol testing

5.4 Dim & Dip Of Headlights Using Ultrasonic Sensors.

Figure 5.4.1 shows the dim and dip of headlights

5.5. Falling Detection Using Bottom Ultrasonic Sensor

Figure 5.5.1 shows that falling detection

5.6. Sensing Vehicles In The Blind Spots On Both Sides Using IR Sensor

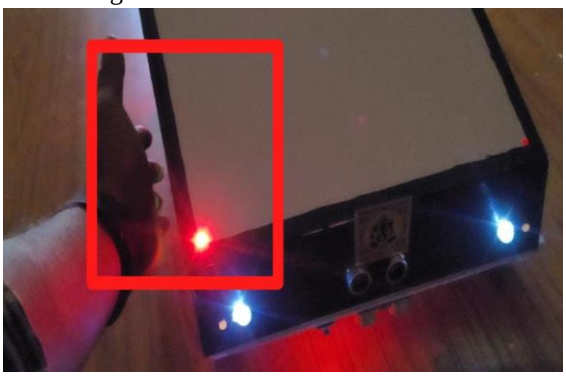


Figure 5.6.1 shows that result of I R sensor in the blind spots

5.7. Parking Maneuvers Using Back Ultrasonic Sensor

Figure 5.7.1 back ultrasonic senor in the basic set up

5.8. Day And Night Monitoring Using LDR Sensor

Figure 5.8.1 day and night sensing using LDR sensor

5.9. Recording All Sensor Data Using Serial Bluetooth Terminal APK And Monitoring Two Modes {Serial Mode, Manual Mode}

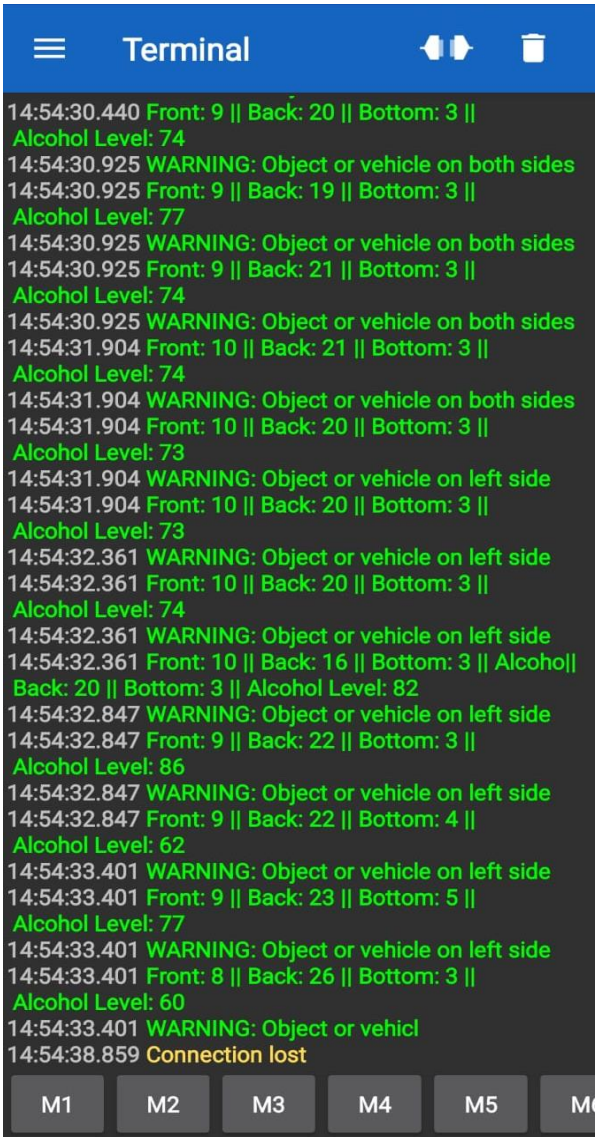


Figure 5.9.1 the serial Bluetooth terminal in the sensor mode

Figure 5.9.2 the serial Bluetooth terminal in the manual mode

VI. FUTURE SCOPE

- Integration with Advanced AI: Incorporating advanced AI algorithms to improve real-time decision-making and predictive analytics.
- Enhanced Connectivity: Leveraging 5G technology for faster data transmission and improved connectivity with other vehicles and infrastructure.
- Expanded Sensor Network: Adding more sensors to cover additional safety aspects such as tire pressure monitoring, road condition sensing, and pedestrian detection.
- Global Positioning System (GPS): Integrating GPS for real-time location tracking and navigation assistance.

- Collaboration with Automotive Manufacturers: Partnering with automotive manufacturers to implement the system in production vehicles.
- User Interface Enhancements: Developing more intuitive and user-friendly interfaces for driver interaction and system monitoring.
- Regulatory Compliance: Ensuring the system meets all regulatory standards and certifications for automotive safety systems.

VII. CONCLUSION

The "Safe Ride: Next Generation Car Safety" project represents a significant advancement in vehicle safety technology. By integrating Arduino microcontrollers with various sensors, the project offers a comprehensive safety solution that addresses multiple aspects of road safety. The flexibility, cost-effectiveness, and potential for customization make it a viable option for enhancing vehicle safety across different models and user requirements. This project not only aims to prevent accidents but also ensures driver and passenger well-being through continuous monitoring and proactive safety measures.

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