INDUSTRIAL ORIENTED MINI PROJECT

Report

On

INTOXICHECK ALERT: IOT-BASED REAL-TIME ALCOHOL SENSOR SYSTEM

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

In

INFORMATION TECHNOLOGY

By

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CERTIFICATE

This is to certify that the **Industrial Oriented Mini Project** entitled **INTOXICHECK ALERT: IOT-BASED REAL-TIME ALCOHOL SENSOR SYSTEM** submitted by **Katepally Srikanth (22261A1234), V. Bindu Sri(22261A1261)** in partial fulfillment of the requirements for the Award of the Degree of Bachelor of Technology in Information Technology as specialization is a record of the bonafide work carried out under the supervision of **Mrs. Ch. Lakshmi Kumari**, and this has not been submitted to any other University or Institute for the award of any degree or diploma.

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DECLARATION

We hear by declare that the **INDUSTRIAL ORIENTED MINI PROJECT** entitled **INTOXICHECK ALERT: IOT-BASED REAL-TIME ALCOHOL SENSOR SYSTEM** is an original and bonafide work carried out by us as a part of fulfilment of Bachelor of Technology in Information Technology, Mahatma Gandhi Institute of Technology, Hyderabad, under the guidance of **Mrs. Ch. Lakshmi Kumari, Assistant Professor**, Department of IT, MGIT.

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ABSTRACT

Drunk driving continues to be a significant contributor to road accidents worldwide, posing serious risks to both drivers and pedestrians. Traditional alcohol detection methods are either manual, reactive, or lack real-time warning systems. There is a pressing need for an automated, cost-effective solution that can detect alcohol presence immediately and initiate preventive measures within the vehicle.

This project proposes an alcohol detection and alert system using an MQ-3 gas sensor interfaced with an Arduino Uno microcontroller. The system monitors the driver's breath upon vehicle entry and checks if the alcohol concentration exceeds a predefined threshold. If alcohol is detected, a sequence of alerts is activated — including a buzzer, blinking LEDs, and a seat-mounted vibration motor — to warn the driver and surrounding individuals. The detected alcohol levels are also displayed via the Serial Monitor for real-time observation. The system provides a low-cost and scalable solution to enhance road safety through early detection and physical warning signals. It can be embedded into vehicle dashboards and used in both personal and commercial transport settings. Future improvements may include features like GSM/GPS-based emergency notifications, engine-locking mechanisms, and cloud-based data tracking for smarter, connected safety systems.

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1. INTRODUCTION

1.1 MOTIVATION

Drunk driving remains a major cause of road accidents and fatalities across the globe. Despite strict laws and awareness campaigns, intoxicated driving continues to endanger not only the lives of the drivers but also of innocent passengers and pedestrians. Traditional alcohol detection methods, such as police breathalyzer tests or manual checks, are reactive in nature and often occur only after the vehicle is already in motion — making them ineffective in preventing incidents in real time.

This project is motivated by the urgent need for a proactive, embedded system that can detect alcohol at the point of vehicle entry and initiate immediate preventive measures. By combining low-cost sensors with simple yet effective output devices like buzzers, LEDs, and vibration motors, this system aims to act as an in-vehicle safety assistant. It promotes responsible driving habits and provides real-time alerts to discourage drunk driving before the vehicle is operated.

The use of Arduino-based technology makes this solution affordable and easily adaptable for widespread use, especially in regions where advanced vehicle systems are not common. This motivation stems from the goal of reducing preventable accidents through accessible technology.

1.2 PROBLEM STATEMENT

Road safety is a growing concern, with drunk driving continuing to be one of the primary causes of traffic accidents and fatalities worldwide. Despite public awareness efforts and legal restrictions, a significant number of drivers still operate vehicles under the influence of alcohol. These actions not only endanger the lives of the drivers but also pose a serious threat to pedestrians and other road users.

Traditional alcohol detection methods, such as handheld breathalyzers or police checks, are mostly reactive and require human intervention. These systems are often implemented after the vehicle is already in motion, limiting their effectiveness in preventing accidents.

Moreover, many existing in-vehicle systems are either expensive, easy to bypass, or lack any meaningful real-time monitoring or driver feedback.

There is a pressing need for a low-cost, embedded solution that can detect alcohol automatically when the driver enters the vehicle and take immediate action before the car is started. Such a system should be capable of detecting alcohol in a driver’s breath, triggering alerts through multiple channels (audio, visual, and physical), and ideally preventing the operation of the vehicle without requiring manual input or external enforcement.

This project aims to address that gap by developing an alcohol detection and alert system using an MQ-3 sensor and Arduino Uno. The system monitors the alcohol level in the driver's breath and activates warning mechanisms such as a buzzer, LED indicators, and a vibration motor when intoxication is detected. This setup ensures that timely warnings are issued, discouraging drunk driving and enhancing road safety through a simple, scalable, and proactive solution.

1.3 EXISTING SYSTEM

In recent years, various alcohol detection systems have been developed to minimize drunk driving incidents. The most commonly used method is the manual breathalyzer test, conducted by traffic police to check a driver’s blood alcohol content (BAC). These handheld devices are effective in detecting alcohol but rely on human enforcement and are only used after the vehicle is already in motion or when suspicion arises.

Some advanced vehicles have built-in alcohol detection mechanisms, such as interlock devices that require the driver to blow into a sensor before the engine can start. While effective, these systems are typically costly and not widely adopted, especially in low- to middle-income regions. Moreover, such systems usually lack real-time alerting features and are vulnerable to circumvention using tricks like having someone else blow into the sensor.

Other research-based systems have explored using IoT-enabled detection or infrared absorption techniques for alcohol sensing. While these offer improved accuracy and remote monitoring capabilities, they often require complex hardware, continuous internet access, and more power, making them less practical for simple embedded use. Most existing systems either focus solely on detection or require significant infrastructure, leaving a gap for an affordable, all-in-one alerting system like the one proposed in this project

1.3.1 Limitations

- **Limited Detection Range :**
  The MQ-3 sensor can only detect alcohol effectively within 2–5 cm. If the driver does not exhale directly toward the sensor, detection may fail. This limits reliability in real-world use. Airflow and cabin ventilation can also dilute vapors and affect accuracy.

- **No Engine Locking Mechanism :**
  The system issues alerts but does not prevent the vehicle from starting. Without engine locking, an intoxicated driver can still operate the vehicle. This reduces the system's preventive impact and makes it more advisory than enforceable.

1.4 PROPOSED SYSTEM

The proposed system is a smart alcohol detection and alert mechanism integrated with a vehicle's interior, designed to proactively monitor and discourage drunk driving. It utilizes an MQ-3 alcohol sensor connected to an Arduino Uno microcontroller to detect the presence of alcohol in the driver's breath when they enter the vehicle.

If the sensor detects alcohol above a predefined threshold, the system immediately triggers a series of alerts — including a buzzer, blinking LEDs, and a seat vibration motor — to warn the driver and surrounding individuals. The detected alcohol level is also displayed in real-time on the Serial Monitor, providing visual feedback to the user or observer.

The system is designed to operate in a sequential manner, where each alert is activated step-by-step for maximum effectiveness and driver awareness. The use of physical (vibration), auditory (buzzer), and visual (LED) alerts ensures that the warning reaches the driver in multiple ways, reducing the risk of being ignored. This modular and flexible setup allows for easy customization or expansion based on different use cases or future requirements.

This solution is cost-effective, easy to implement, and suitable for integration into both personal and public vehicles. It helps reduce road accidents by issuing early warnings and promoting responsible behavior before the vehicle is even in motion. The system can be further enhanced with features like engine locking, IoT alerts, or emergency SMS notifications in future iterations.

1.4.1 ADVANTAGES

- **Real-Time Detection and Alerts:** The system continuously monitors the driver's breath and provides immediate alerts when alcohol levels exceed a predefined threshold, ensuring quick intervention and enhancing road safety.
- **Proactive Drunk-Driving Prevention:** Unlike traditional breathalyzer tests that are reactive, this system provides ongoing monitoring, preventing drunk driving before an accident occurs, which can save lives.
- **Cost-Effective Solution:** The use of an MQ-3 sensor and low-cost components makes the system affordable, which allows for widespread adoption without significant financial burden.
- **IoT Integration**: The system can be connected to the internet for additional features like real-time data collection, remote monitoring, and future upgrades, enhancing its flexibility and scalability.
- **Physical and Visual Alerts:** By using a buzzer, LED indicators, and a vibrating seat motor, the system ensures that the driver is made aware of their intoxicated state through multiple sensory alerts, increasing the chance of timely action.
- User-Friendly: The system is simple to operate and does not require any complex user input, making it easy for drivers to use without distractions.
- **Scalability and Customization:** The system can be integrated into a variety of vehicles, from personal cars to commercial fleets, and can be customized for different thresholds, making it adaptable to different needs.
- **Enhanced Driver Awareness:** By providing continuous feedback on alcohol levels, the system encourages responsible driving habits and reinforces awareness about the dangers of drunk driving.
- **Low Maintenance:** The system uses durable, low-maintenance components, ensuring long-term reliability and reducing the need for frequent repairs or recalibration.
- **Safety for All Road Users**: By preventing drunk driving, the system not only protects the driver but also ensures the safety of other road users, making roads safer for everyone.

1.5 OBJECTIVES

- Create a cost-effective alcohol detection system using the MQ-3 sensor to monitor the driver's breath continuously.
- Detect alcohol levels in real-time and alert the driver if the alcohol content exceeds a set limit.
- Provide multiple alerts including a buzzer, LED lights, and a vibrating seat to warn the driver.
- Ensure accurate and reliable sensor performance under different conditions.
- Prevent drunk driving accidents by offering a proactive warning system before driving behavior becomes dangerous.
- Make the system easy to install and use in different types of vehicles.
- Enable remote monitoring and data collection using IoT for better tracking and analysis.
- Design the system to require minimal maintenance for long-term use.
- Promote responsible driving by giving continuous feedback on the driver’s alcohol levels.
- Improve road safety for both drivers and other people on the road by preventing drunk driving.

1.6 HARDWARE AND SOFTWARE REQUIREMENTS

1.6.1 Software Requirements

1. **ArduinoIDE:**
   The Arduino IDE is the primary development environment used for programming the Arduino microcontroller. It supports Windows, macOS, and Linux, providing tools for writing, testing, and uploading code to the microcontroller.

2. **EmbeddedC:**
   The system is programmed using Embedded C, a C-based language that is suitable for developing firmware on microcontrollers. This language is efficient and optimized for

handling hardware-level tasks like reading sensor data and controlling outputs.

3. **MQ-3SensorLibrary:**
   The MQ-3 sensor library simplifies the process of interfacing with the MQ-3 alcohol sensor. It's compatible with the Arduino IDE and can be easily installed through the library manager, allowing developers to quickly integrate alcohol detection functionality

1.6.2Hardware Requirements

1. **MQ-3AlcoholSensor:**
   The MQ-3 alcohol sensor detects alcohol levels in the driver's breath. It operates at 5V and provides both analog and digital outputs. The sensor works effectively in temperatures ranging from -20°C to 50°C, with high sensitivity to alcohol vapors, making it suitable for real-time breath monitoring.
2. **Microcontroller(Arduino):**
   The Arduino microcontroller acts as the brain of the system. It processes data from the MQ-3 sensor and triggers the necessary alerts. Using an Arduino Uno or similar model, the microcontroller operates at 5V with a clock speed of 16 MHz and supports both digital and analog I/O pins for versatile control.
3. **VibratingMotor:**
   The vibrating motor provides a physical alert to the driver when alcohol is detected. Powered by 5V, it draws around 100mA of current and can offer continuous or pulse-like vibration to grab the driver's attention effectively.
4. **Buzzer:**
   The buzzer emits a sound alert when alcohol is detected, helping warn the driver audibly. The 5V-powered buzzer typically outputs a sound level of 85dB or higher, ensuring it's loud enough to be heard in various environments.
5. **LEDSystem:**
   The LED system visually alerts the driver and others in the vicinity of the vehicle when alcohol is detected. Using RGB LEDs for different colors, the system operates at 5V with a power consumption of around 20mA per LED.

6. **Breadboard:**

   A breadboard is used for prototyping the circuit without soldering. It’s a full-size breadboard, with approximately 830 tie points, allowing easy connection of all components during testing and development.

7. **ConnectingWires:**

   Connecting wires (typically 22 AWG) are used to link all the components together. These jumper wires are flexible and come in various lengths (typically 20-30 cm), ensuring that components are easily connected on the breadboard.

8. **Resistors&Capacitors:**

   Resistors and capacitors are used to stabilize the circuit and manage current flow where necessary. Common resistor values include 10kΩ for pull-up/pull-down configurations, while capacitors (0.1µF) help filter noise in the circuit for reliable operation.

2. LITERATURE SURVEY

L. M. Barba-Maza and C. Sánchez-López (2016) proposed a breathalyzer system for drivers using sensor-based alcohol detection through breath samples. The system aims to offer a simple and efficient method to identify alcohol levels in real time. The main strength of this work lies in its accurate detection capability using a reliable sensing mechanism. However, the system lacks real-time alert functionalities such as alarms or LED notifications and does not support IoT-based connectivity for remote monitoring. This limits its practical use in smart transportation environments, where immediate alerts and communication are critical for safety.[1]

F. Uzairue et al. (2018) presented an IoT-enabled alcohol detection system integrated with smart city infrastructure to improve road safety through real-time monitoring and remote data access. The system leverages internet-connected sensors to detect alcohol presence and transmit alerts to relevant authorities or control centers. Its key strength lies in the integration with IoT, allowing for centralized surveillance and potential automation of safety responses. However, the solution heavily depends on stable internet connectivity and supporting infrastructure, which may not be feasible in all regions. The authors emphasize the necessity of conducting broader real-world deployments to evaluate the system's scalability and effectiveness.[2]

F. Rahmad et al. (2019) explored the use of the MQ-303A sensor for detecting alcohol levels in drivers' breath, emphasizing its reliability and accuracy for basic detection tasks. The study showcases the sensor's effectiveness in identifying alcohol presence, highlighting its strength as a dependable hardware component. However, the system does not include proactive safety measures such as buzzer alerts, LED signals, or automated vehicle locking mechanisms. Additionally, the absence of communication or emergency alert features limits its applicability in real-world driving environments, indicating the need for further development in integrated safety and response systems.[3]

Tamoghna Sarkar and Sukriti Shaw (2020) developed an IoT-based intelligent alcohol detection system aimed at preventing drunk driving by enabling smart interactions between sensors and vehicle systems. The system uses modern IoT tools to monitor alcohol levels and trigger preventive actions, making it a forward-thinking approach to enhancing road safety. Its use of intelligent technologies allows for more proactive measures against intoxicated driving. However, the system may face potential delays in response time and lacks integration with emergency support services. The study suggests the need for improved responsiveness and automated intervention capabilities in critical situations.[4]

M. Hariharan et al. (2024) proposed a real-time alcohol detection system using the ESP8266 Wi-Fi module, designed to monitor driver sobriety and lock the vehicle engine if alcohol is detected. The system offers continuous IoT-based monitoring and instant safety intervention, providing real-time alerts and preventing the vehicle from being started by an intoxicated driver. Its key strength lies in the integration of engine control for proactive safety enforcement. However, the system relies heavily on stable internet connectivity, which may limit its use in areas with poor network coverage. Additionally, the lack of testing across different vehicle types indicates a need for broader validation and compatibility improvements.[5]

Table 2.1 Literature Survey of Alcohol Detection and Prevention Systems

Ref	Author(s), Year of publication	Journal / Conference	Method / Approach	Merits	Demerits	Research Gaps
[1]	L. M. Barba-Maza, C. Sánchez-López (2016)	Development of a Breathalyzer for Drivers, IEEE ROPEC 2016	Sensor-based breathalyzer for alcohol detection	Accurate detection using reliable sensors	No real-time alert or communication system	No IoT or smart monitoring integration
[2]	F. Uzairue et al. (2018)	IoT-Enabled Alcohol Detection Integrated with Smart City Infrastructure, Springer LNCS ICCSA 2018	Alcohol detection with IoT and smart city integration	Enables remote access and data transmission	Depends on internet availability and infrastructure	Requires large-scale real-world deployment
[3]	F. Rahmad et al. (2019)	Application of MQ-303A Sensor for Alcohol Detection in Drivers, IEEE CITSM 2019	MQ-303A sensor-based alcohol detection	Reliable sensor performance	No alerts or emergency response features	No automatic safety/control integration
[4]	Tamoghna Sarkar, Sukriti Shaw (2020)	IoT-Based Intelligent Alcohol Detection System for Vehicles, ACM BDIoT 2020	IoT-enabled alcohol detection and vehicle alerting	Intelligent detection and preventive technology	Lacks emergency integration and may have response delays	Needs better responsiveness and smart intervention

[5]	M. Hariharan et al. (2024)	Realtime Alcohol Detection with ESP8266 for Engine Locking, IEEE ICSCNA 2024	ESP8266-based real-time alcohol detection with engine lock	Real-time alert and vehicle control	Internet-dependent; limited testing across vehicle types	Requires broader compatibility testing

3. ANALYSIS AND DESIGN

The IntoxiCheck Alert system is designed to proactively address the issue of drunk driving by using real-time alcohol detection. Traditional methods like manual breathalyzer checks are limited, reactive, and depend on human presence. This system uses an MQ-3 alcohol sensor connected to an Arduino microcontroller to detect alcohol levels in the driver's breath upon entry into the vehicle. If alcohol is detected above a predefined threshold, alerts are triggered immediately.

These include a buzzer for sound, a seat vibration motor for physical feedback, and LEDs for visual warning. The integration of IoT also allows real-time data to be sent to family or authorities for quick response.

The system is divided into two core modules: Alcohol Detection and Alert System. The detection module uses the MQ-3 sensor to capture alcohol levels and passes the data to the Arduino for processing. If the reading exceeds the threshold, the alert system activates a buzzer, LEDs, and vibration motor. The logic is programmed in Embedded C using the Arduino IDE, and the system runs in a continuous loop to monitor the driver's breath in real time. The output is also displayed on the serial monitor for live tracking. This design ensures quick intervention before the vehicle is in motion, preventing accidents.

From a design perspective, the system follows a simple yet efficient architecture where all components are controlled by the Arduino board. UML diagrams such as use case, class, sequence, and activity diagrams provide a clear understanding of system flow and interactions. The use case diagram identifies user roles and system functions, while the activity diagram explains how the system responds when alcohol is detected. The architecture is modular and low-cost, making it suitable for integration into various vehicle types. Future improvements could include engine locking, mobile alerts, and health monitoring to enhance safety further.

3.1 MODULES

1. **Alcohol Detection Module :**

- Functions:

  Continuously monitors the driver’s breath using the MQ-3 alcohol sensor to detect the presence and concentration of alcohol. It initiates the alert system if the alcohol level crosses a predefined safety threshold. The sensor sends both analog and digital signals to the microcontroller for processing.

- Input:

  Driver’s breath containing alcohol vapors, read through the MQ-3 sensor (analog and digital signals).

- Output:

  Sensor readings indicating alcohol concentration, used to determine whether the driver is intoxicated. If alcohol is detected, control is passed to the Alert Module.

2. **Alert System Module :**

- Functions:

  Activates real-time warning mechanisms when alcohol is detected. This includes sounding a buzzer, turning on LED indicators, and triggering a seat vibration motor to ensure the driver is immediately alerted through audio, visual, and physical cues.

- Input:

  Signal from the Alcohol Detection Module indicating that alcohol levels have exceeded the threshold.

- Output:

  Multi-modal alerts — buzzer sound, blinking LEDs, and seat vibration — to warn both the driver and nearby individuals.

3.2 ARCHITECTURE

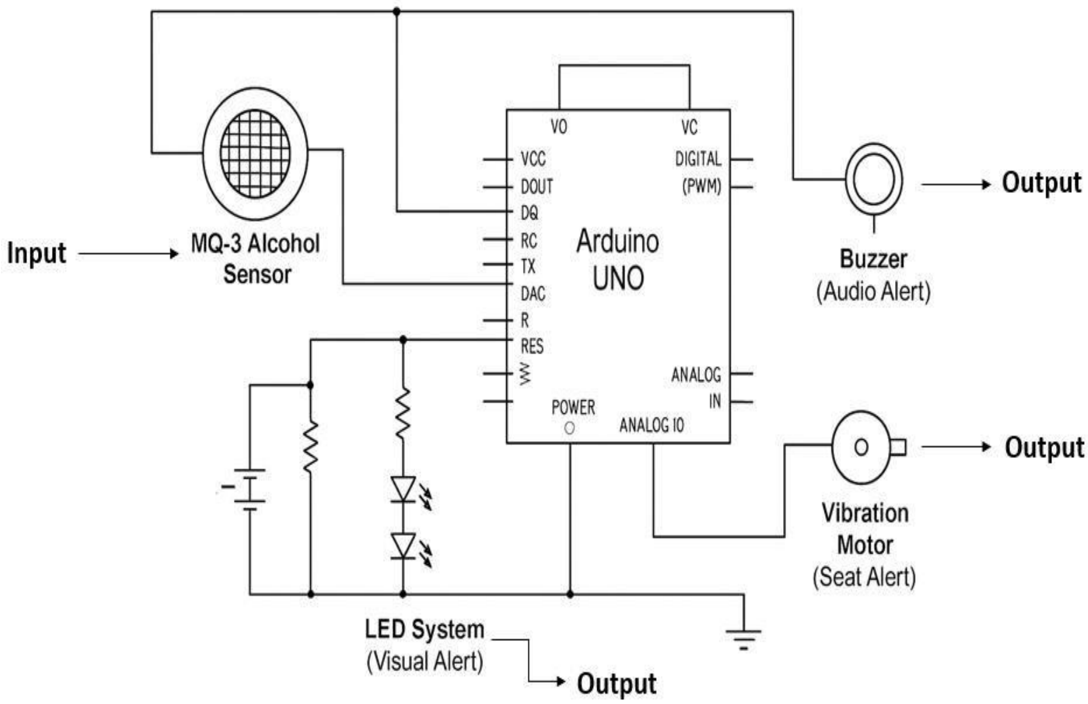

Fig. 3.2.1 Architecture of Alcohol Detection and Prevention Systems

The architecture of the system, as shown in Fig. 3.2.1, is designed to detect alcohol presence in a driver's breath and trigger appropriate safety alerts. The system begins with the **MQ-3 Alcohol Sensor**, which acts as the primary input module. This sensor detects alcohol concentration in the air near the driver, particularly upon vehicle entry, and sends both analog and digital signals corresponding to the detected levels.

These signals are then sent to the **Arduino UNO**, which functions as the decision-making unit of the system. The Arduino processes the incoming data from the sensor, compares the values against a predefined threshold, and determines whether the driver is intoxicated. If alcohol is detected above the safe limit, the Arduino initiates a sequence of alert actions.

Based on the detection outcome, the system activates the **Buzzer** to provide an immediate auditory alert to the driver. Simultaneously, the **LED Blinks** module is triggered to visually notify nearby pedestrians or passengers. Additionally, the system controls a **Vibration Motor**, which is placed under the driver's seat to deliver a physical alert through vibrations. These three components work

together to ensure that the driver is immediately made aware of the detection, and that surrounding individuals are alerted.

Alongside these safety responses, the **Serial Monitor** (a feature of the Arduino IDE) displays real-time data, including the analog sensor values, digital detection status, and estimated alcohol levels such as "Low", "Moderate", or "High". This serves as a live monitoring tool during testing and development, enabling visibility into the system's performance.

To ensure sequential execution of alerts, the Arduino code is designed to trigger the **buzzer first**, followed by the **LED blinking pattern**, and finally the **vibration motor**. This staggered response sequence increases the chances of the driver noticing the alerts while minimizing sensory overload. Each output device is connected to a designated GPIO pin on the Arduino and is powered via the onboard 5V output, making the circuit both efficient and compact. The entire system operates in a loop, continuously monitoring for alcohol presence as long as the vehicle is powered on.

Overall, this architecture ensures timely detection of alcohol consumption and delivers multi-modal feedback to prevent potential drunk driving incidents. The modular design allows for future enhancements such as engine lock integration or emergency SMS alerts

3.3 UML DIAGRAMS

3.3.1 USE CASE DIAGRAMS

A use case diagram is a visual representation that depicts the interactions between various actors and a system, capturing the ways in which users or external entities interact with the system to achieve specific goals. It is an essential tool in system analysis and design, often used in software engineering and business analysis. In a use case diagram, actors are entities external to the system that interact with it, and use cases are specific functionalities or features provided by the system as seen in Fig. 3.3.1.1. These interactions are represented by lines connecting actors to use cases. The diagram helps to illustrate the scope and functionality of a system, providing a high-level view of how users or external entities will interact with it.

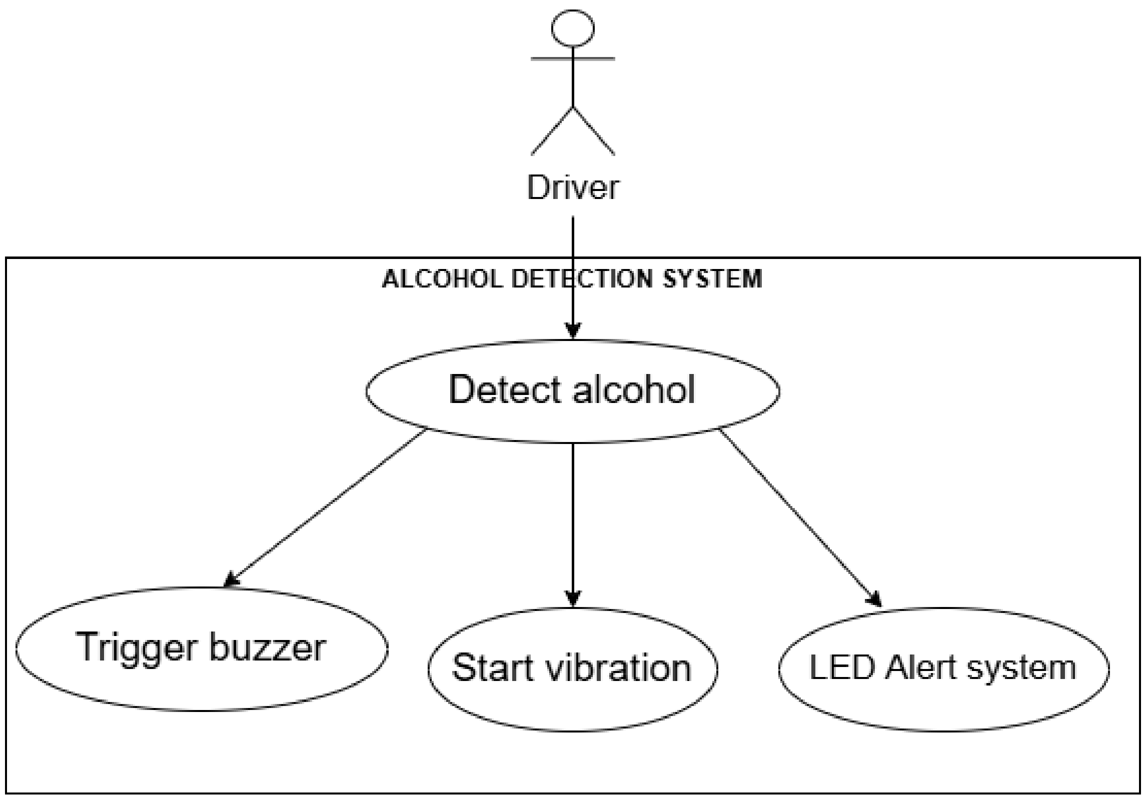

Fig. 3.3.1.1 Use Case Diagram

Actors:

1. **Driver:**
   The individual who enters the vehicle and is automatically monitored for alcohol presence by the system. The driver indirectly interacts with the system through breath detection and receives alerts if intoxicated.
2. **Alcohol Detection System (Arduino-based):**
   The embedded system that detects alcohol levels using the MQ-3 sensor and triggers appropriate alert mechanisms (buzzer, LEDs, vibration motor) based on sensor data.

Use Cases:

1. **Alcohol Detection:**
   The system continuously checks the alcohol level in the driver's breath using the MQ-3 sensor upon entry into the vehicle.
2. **Trigger Buzzer Alert:**
   When alcohol is detected above a set threshold, the system activates a buzzer to produce a loud warning sound to alert the driver.
3. **LED Alert to Surroundings:**
   Blinking LEDs are activated outside the vehicle to alert nearby people or authorities that a potentially intoxicated driver is attempting to drive.
4. **Activate Seat Vibration Motor:**
   The system turns on a vibration motor embedded in the seat to physically alert or disturb the driver, especially useful if the driver is drowsy or ignoring other alerts.
5. **Display Alcohol Level on Serial Monitor:**
   The real-time analog reading of alcohol concentration is displayed on the Arduino Serial Monitor for monitoring and logging purposes.

3.3.2 CLASS DIAGRAM

A class diagram is a visual representation that models the static structure of a system, showcasing the system's classes, their attributes, methods (operations), and the relationships between them as seen in Fig. 3.3.2.1. It is a key tool in object-oriented design and is commonly used in software engineering to define the blueprint of a system.

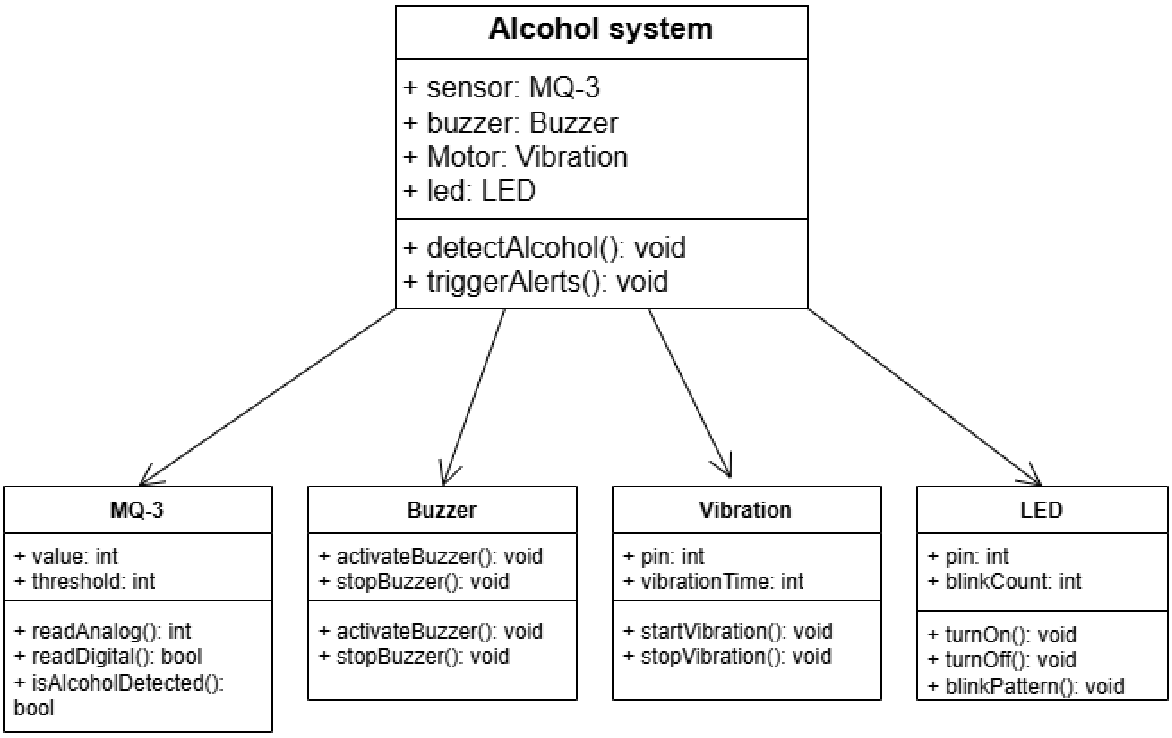

Fig. 3.3.2.1 Class Diagram

Relationships:

1. **AlcoholSystem → MQ3**

- The AlcoholSystem class uses the MQ3 sensor class to detect the presence of alcohol in the driver's breath.
- It accesses the sensor data to determine whether to trigger alert actions.

2. **AlcoholSystem → Buzzer**

- When alcohol is detected, the AlcoholSystem triggers the Buzzer class to activate an audible alert.
- The buzzer provides immediate feedback to the driver.

3. **AlcoholSystem → Vibration**

- The AlcoholSystem class interacts with the Vibration class to activate a vibration motor.
- This physical feedback ensures that the driver is alerted even if they miss visual or sound warnings.

4. **AlcoholSystem → LED**

- The LED class is used to blink external lights when alcohol is detected.
- This helps alert nearby individuals or authorities visually about a potential drunk-driving situation.

System Flow:

1. Detection Phase:

- The AlcoholSystem initiates the detectAlcohol() function, which reads data from the MQ3 sensor.
- If the alcohol level exceeds a certain threshold, it proceeds to the alert phase.

2. **Alert Triggering:**

- Upon detection, the system executes triggerAlerts().
- This function activates the Buzzer, Vibration, and LED components sequentially to issue multi-modal alerts.

3. **Component Coordination:**

- Each component class (Buzzer, Vibration, LED) operates independently but is called by the central AlcoholSystem class.
- This ensures modularity, where each alert component can be updated or replaced without affecting the entire system.

3.3.3 ACTIVITY DIAGRAM FOR ALCOHOL DETECTION AND ALERT SYSTEM

The activity diagram illustrates the flow of actions within the alcohol detection system embedded in a vehicle. When the driver enters the car, the system automatically begins monitoring the alcohol level using the MQ-3 gas sensor. If the detected alcohol content is above a predefined safety threshold, a series of alerts is triggered to warn the driver and surrounding individuals. These alerts include a buzzer sound, blinking LED lights, and activation of a seat vibration motor. If no alcohol is detected, the system allows normal driving without interruption. This proactive workflow ensures that multiple alert methods are employed to prevent intoxicated driving, enhancing vehicle safety through a low-cost, real-time embedded solution.

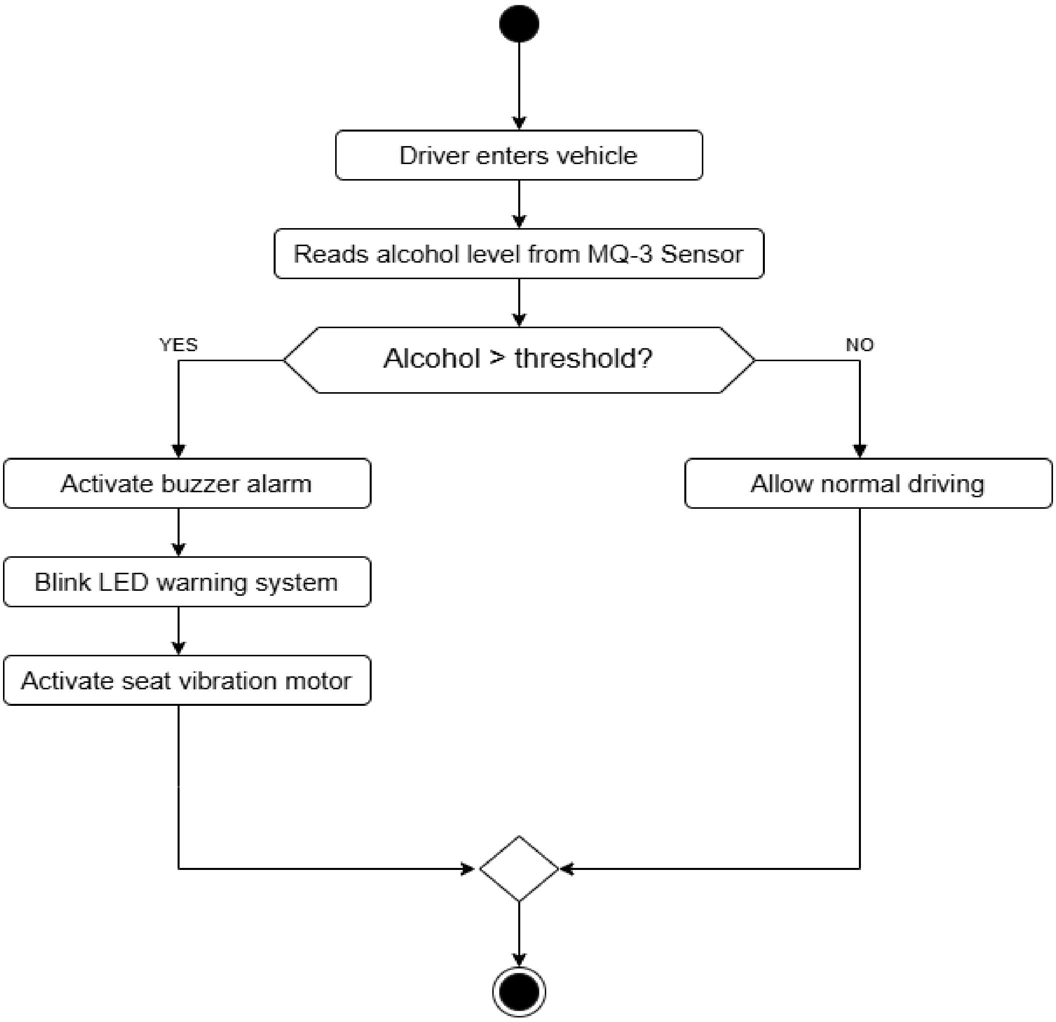

Fig. 3.3.3.1 Activity Diagram

Flow Explanation:

1. Driver Enters Vehicle

- The system is initialized as soon as the driver is seated or the vehicle is accessed.

2. Read Alcohol Level from MQ-3 Sensor

- The sensor begins analyzing the alcohol concentration inthe surrounding air,primarily the driver's breath.

3. Check Threshold

- The system compares the current sensor reading against a predefined alcohol limit.

4. If Alcohol is Detected (above threshold):

a. Activate Buzzer Alarm: A loud buzzer sounds inside the vehicle to alert the driver.
b. Blink LED Warning System: External LEDs blink in a noticeable pattern to warn others

near the vehicle.
c. Activate Seat Vibration Motor: Provides tactile feedback to the driver, ensuring they're physically alerted.

5. If No Alcohol is Detected:

- The driver is considered sober, and the system allows standard vehicle operation without triggering any alerts.

6. System Reset

- After executing the alerts (if any), the system returns to the initial state, ready for another detection cycle upon new driver entry or vehicle restart.

3.3.4 SEQUENCE DIAGRAM

A sequence diagram illustrates the flow of interactions between actors and system components over time as seen in Fig. 3.3.4.1, emphasizing the order in which messages are exchanged to achieve specific functionalities. Actors represent external entities that interact with the system, while lifelines depict the system components involved in the process. Messages are shown as arrows, indicating the flow of information or actions between these elements. By providing a step-by-step view of workflows, sequence diagrams help in understanding and designing the dynamic behaviour of a system.

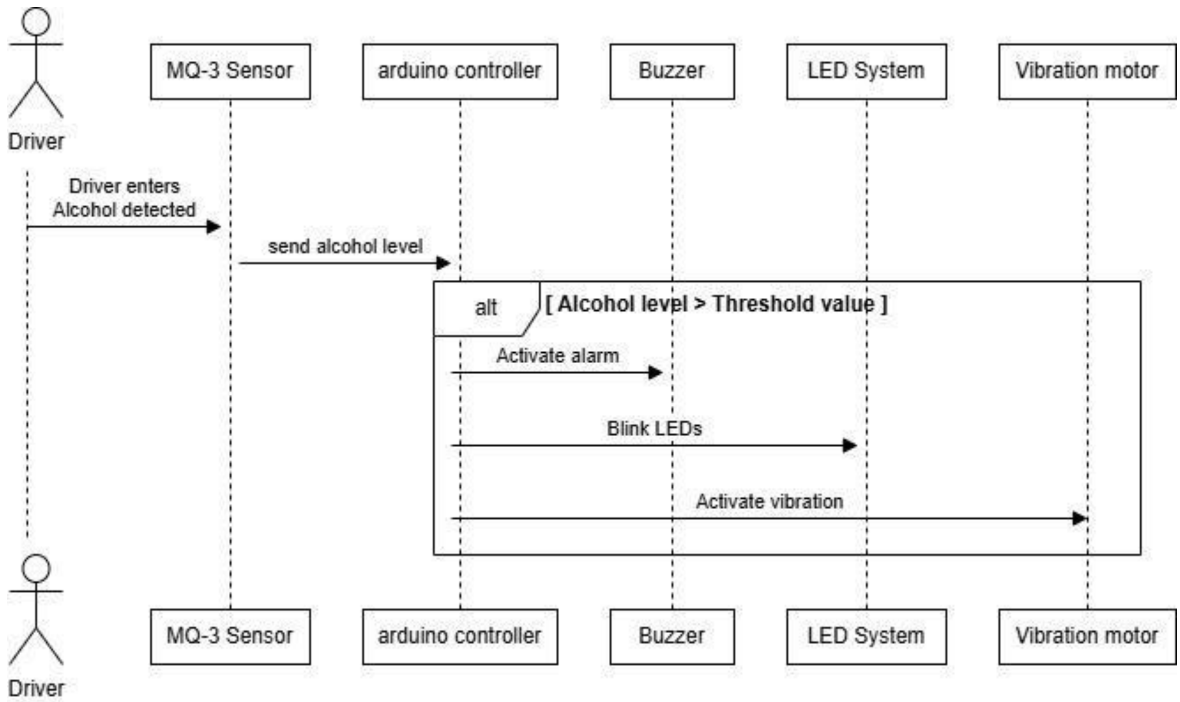

Fig. 3.3.4.1 Sequence Diagram

Key Interactions and Relationships :

1. Driver and MQ-3 Sensor:

- Breath Detection: When the driver enters the vehicle, the MQ-3 sensor automatically detects alcohol in their breath.
- Alcohol Level Sensing: The sensor reads the concentration of alcohol and sends the data to the Arduino controller for evaluation.

2. MQ-3 Sensor and Arduino Controller:

- Sensor Data Transfer: The sensor sends analog and digital signals representing the alcohol level.
- Threshold Comparison: The Arduino processes this input and checks whether the alcohol level exceeds the safe threshold.

3. Arduino Controller and Output Devices:

- Buzzer Activation: If alcohol is detected, the Arduino activates the buzzer to generate an audible alert for the driver.
- LED System Alert: Simultaneously, the Arduino triggers blinking LEDs outside

vehicle to visually warn others nearby.

- Vibration Motor Response: The seat's vibration motor is also activated to physically alert the driver.

4. Arduino Controller and Serial Monitor:
   - Alcohol Level Display: The detected alcohol values are sent to the Serial Monitor for real-time visualization and data tracking.

5. Driver and System Loop:
   - No Alcohol Detected: If the alcohol level is below the threshold, the Arduino allows normal driving without triggering any alerts.
   - System Reset: After alerting, the system resets and waits for the next cycle (new entry or breath detection).

3.3.5 COMPONENT DIAGRAM

A Component Diagram is a type of structural diagram used in software engineering to represent the components of a system and how they interact or depend on each other. It shows how the components (which could be software modules, subsystems, or other significant parts) are organized and connected within a system. In this diagram, each component encapsulates a set of related functionalities and interfaces as shown in Fig. 3.3.5.1.

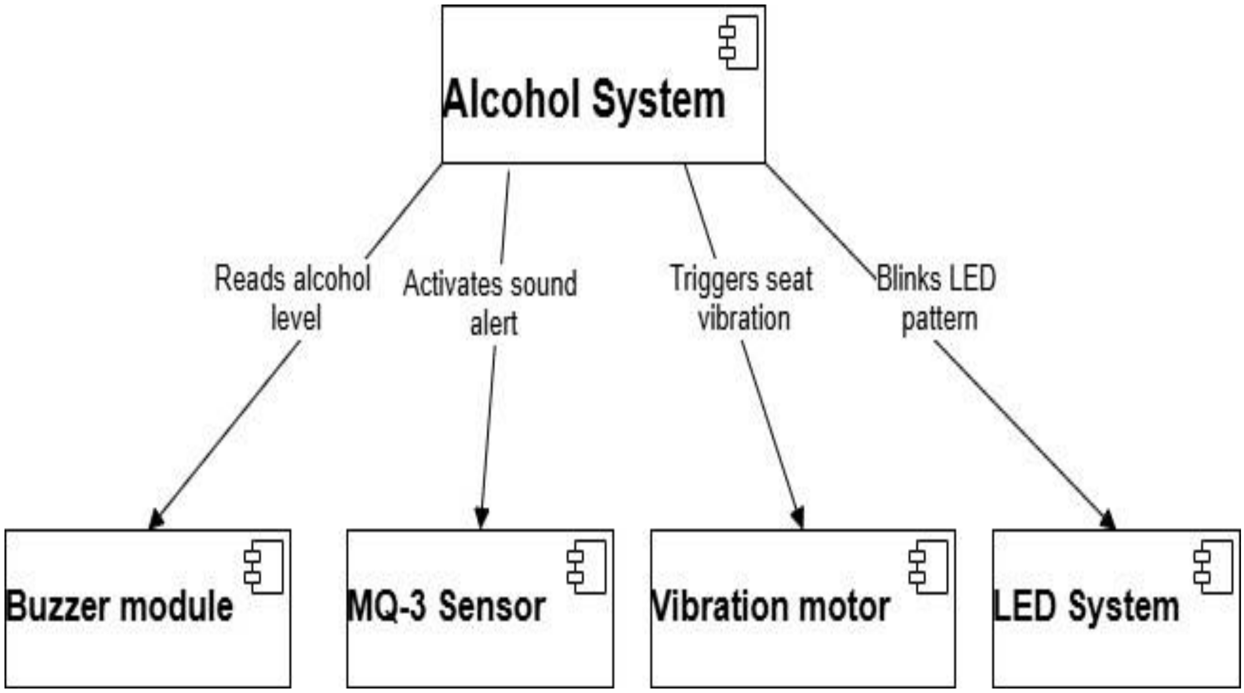

Fig. 3.3.5.1 Component Diagram

Main Components:

1. **MQ-3 Sensor**
    - Description: This gas sensor detects the presence of alcohol in the driver's breath. It provides both analog and digital outputs to indicate alcohol concentration.
2. **Arduino UNO**
    - Description: The central microcontroller that receives input from the MQ-3 sensor, processes the data, and triggers the appropriate alert mechanisms based on the alcohol level.
3. **Buzzer**
    - Description: An audio output component activated by the Arduino to alert the driver when alcohol is detected above the threshold.
4. **LED System**
    - Description: A set of LEDs that blink in a warning pattern to visually alert nearby people or authorities that the driver may be intoxicated.
5. **Vibration Motor**
    - Description: A tactile feedback device placed on the seat to physically alert the driver when alcohol is detected.

3.3.6 DEPLOYMENT DIAGRAM

The Deployment Diagram illustrates the physical arrangement of hardware and software components in the Alcohol Detection Alert System. It shows how the MQ-3 alcohol sensor interacts with the Arduino UNO microcontroller, which processes the input and activates multiple output devices including a buzzer, LED system, vibration motor, and serial monitor.

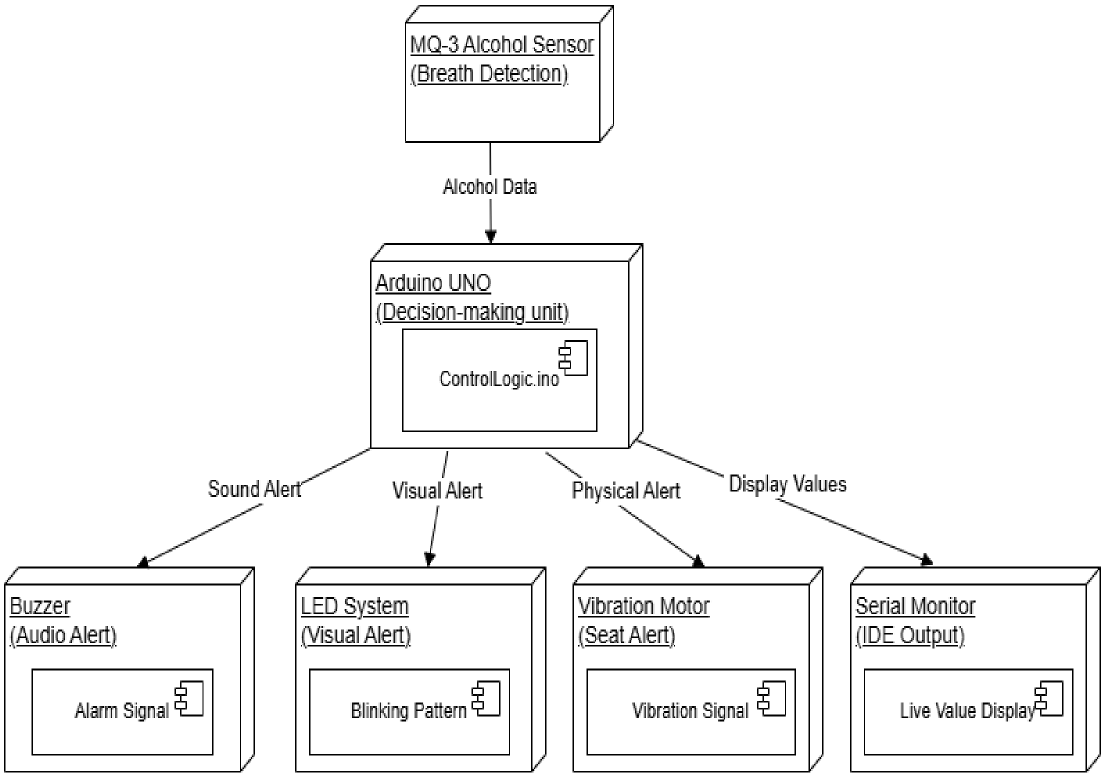

Fig. 3.3.6.1 Deployment Diagram

The deployment diagram shows how the components of the alcohol detection system are distributed across key hardware modules:

- **MQ-3 Alcohol Sensor**: Captures breath input from the driver and sends alcohol concentration data to the Arduino controller.
- **Arduino UNO (Microcontroller)**: Acts as the central processing unit, running the control logic to evaluate sensor data and trigger corresponding alerts.
- **Output Devices**: Includes a buzzer (sound alert), LED system (visual alert), vibration motor (physical seat alert), and serial monitor (digital IDE display) to respond appropriately when alcohol is detected.

  This setup ensures coordinated interaction between sensing, processing, and alerting units within a real-time embedded system for driver safety.

3.4 METHODOLOGY

Sensor Data Acquisition

- Live Input: The system reads real-time breath data using the MQ-3 alcohol sensor as soon as the driver enters the vehicle.
- Purpose: The analog and digital outputs from the sensor help determine the presence and concentration of alcohol in the driver's breath.
- Real-Time Monitoring: Values are continuously monitored and displayed on the Serial Monitor for debugging and testing purposes.

System Workflow Steps

- Sensor Initialization: On system startup, the Arduino initializes the MQ-3 sensor and output devices like buzzer, LEDs, and vibration motor.
- Data Reading: The sensor constantly sends analog values (alcohol concentration) and digital values (threshold flag) to the Arduino.
- Threshold Check: If the alcohol value crosses a predefined threshold, the system identifies it as intoxication.
- Alert Activation: If intoxication is detected, the system activates alerts sequentially—buzzer, LED blinking, and seat vibration.
- Safe Condition Handling: If no alcohol is detected, the vehicle operates normally with no alerts triggered.

Models Used

1. **Alcohol Detection Module**

- Description: This module processes real-time input from the MQ-3 sensor to detect the presence of alcohol.
- How it Works: It reads analog and digital values and compares them against the threshold to determine if an alert sequence should be triggered.
- Why it's Used: It ensures early and automatic identification of intoxication, without needing manual testing.

2. Alert Module

- Description: Manages all alert components such as buzzer, LEDs, and seat vibration motor.
- How it Works: When called, it sequentially activates all alerts:

a) The buzzer produces a loud sound.

b) LEDs blink in a specific pattern.

c) The vibration motor vibrates the seat to physically alert the driver.

- Why it's Used: Multi-sensory alerts ensure the driver is warned effectively, and nearby people are visually informed.

3. Arduino Processing Core

- Description: The central controller that manages sensor input, logic processing, and alert control.
- How it Works: Written in Arduino C/C++, the code uses conditional checks on sensor values and digitalWrite functions to trigger hardware responses.
- Why it's Used: Arduino Uno provides an open-source, low-cost, and flexible platform for real-time embedded system development.

4. CODE AND IMPLEMENTATION

4.1 CODE

```
#define sensorDigital 2
#define LED 3
#define buzzer 4
#define sensorAnalog A1

void setup() {
  pinMode(sensorDigital, INPUT);
  pinMode(LED, OUTPUT);
  pinMode(buzzer, OUTPUT);
  Serial.begin(9600);
}

void loop() {
  bool digital = digitalRead(sensorDigital);
  int analog = analogRead(sensorAnalog);

  Serial.print("Analog value: ");
  Serial.print(analog);
  Serial.print("\t");

  Serial.print("Digital value: ");
  Serial.print(digital);
  Serial.print("\t");

  // Estimate alcohol level category
  String alcoholLevel;
  if (analog < 200) {
    alcoholLevel = "Low";
  } else if (analog < 400) {
    alcoholLevel = "Moderate";
```

```
  } else {
    alcoholLevel = "High";
  }
  Serial.print("Estimated Alcohol Level: ");
  Serial.println(alcoholLevel);

  // Alert using LED and buzzer if alcohol detected
  if (digital == 0) {
    digitalWrite(LED, HIGH);
    digitalWrite(buzzer, HIGH);
  } else {
    digitalWrite(LED, LOW);
    digitalWrite(buzzer, LOW);
  }

  delay(1000); // Add delay for readability
}
```

4.2 IMPLEMENTATION

1. Project Directory Structure :

Create a directory folder as shown below and place relevant files inside it for organized development and testing:

```
AlcoholDetectionSystem/
│
├── alcohol_detection.ino        # Main Arduino program
├── components/
│   ├── buzzer_module.ino        # Controls buzzer alert
│   ├── led_module.ino           # Controls blinking LED pattern
│   ├── vibration_module.ino     # Controls seat vibration motor
│   └── alcohol_sensor_module.ino # Reads and processes MQ-3 sensor data
│
├── docs/
│   ├── report.pdf               # Project report and documentation
│   └── circuit_diagram.png      # Circuit diagram or Fritzing layout
│
├── images/
│   ├── prototype.jpg            # Picture of the working model
│   └── wiring_layout.jpg        # Breadboard or hardware layout
│
└── README.md                    # Project overview and setup instructions
```

2. Required Tools

1. **Arduino IDE**
   - Used for writing and uploading code to the Arduino Uno board.
     Download: https://www.arduino.cc/en/software
2. **Hardware Components**
   - Arduino UNO
   - MQ-3 Alcohol Sensor
   - Buzzer
   - LEDs
   - Vibration Motor
   - Jumper Wires, Breadboard, USB Cable

3. Setting Up Arduino IDE

1. Open the Arduino IDE and connect the Arduino Uno to your PC via USB.

2. Go to **Tools > Board > Arduino UNO**.
3. Go to **Tools > Port** and select the correct COM port.
4. Copy the alcohol_detection.ino code into the IDE.

4. Uploading the Code :

1. Verify the code using the ✅ button on the IDE.
2. Click the **Upload** button to transfer the code to the Arduino board.
3. Open the **Serial Monitor (Ctrl + Shift + M)** to observe real-time alcohol level readings from the sensor.

5. Sensor Threshold Calibration:

1. The alcohol detection threshold is defined in the code (e.g., analog value > 400).
2. You can adjust this value based on your testing environment for better accuracy.
3. Use test samples (alcohol swabs, hand sanitizers) to validate sensor behavior.

6. Testing Alerts

1. When the sensor detects alcohol above the threshold:

- The **buzzer** sounds.
- **LEDs** blink in a pattern.
- The **seat vibration motor** activates.

2. When no alcohol is detected, all components remain off.

5. TESTING

5.1 INTRODUCTION TO TESTING

The purpose of testing in this project is to verify the correct functionality of the **MQ-3 alcohol sensor system** integrated with an Arduino. The system is designed to detect the presence and concentration of alcohol in the surrounding air and respond accordingly with visual (LED) and audio (buzzer) alerts. Additionally, it logs the sensor data via the Serial Monitor for real-time monitoring and debugging.

Testing ensures that:

- The MQ-3 sensor accurately detects alcohol vapors.
- The analog readings correctly reflect varying alcohol concentrations (Low, Moderate, High).
- The digital output pin of the MQ-3 sensor reliably toggles based on alcohol threshold detection.
- The buzzer and LED respond only when alcohol is detected.
- The system outputs the correct values and status messages through the Serial Monitor.

Through a series of practical experiments using different sources of alcohol (e.g., hand sanitizer, spirit, or mouthwash), the system's responsiveness, stability, and reliability are evaluated. This helps to confirm that the alert mechanism works as expected under real-world conditions and provides a foundation for potential enhancements, such as data logging or mobile alerts.

5.2 TEST CASES:

Table 5.1 Test Cases of Alcohol Detection and Prevention Systems

Test Case ID	Test Case Name	Test Description	Expected Output	Actual Output	Remarks
TC_01	System Initialization	Power on the system and initialize all components	MQ-3 sensor and output modules initialize successfully	MQ-3 sensor and output modules initialize successfully	Pass
TC_02	Alcohol Detection	Exhale into the MQ-3 sensor with no alcohol	Sensor detects no alcohol; no alerts are triggered	Sensor detects no alcohol; no alerts are triggered	Pass
TC_03	Alcohol Detection	Exhale into the MQ-3 sensor with alcohol present	Sensor detects alcohol; alert sequence is activated	Sensor detects alcohol; alert sequence is activated	Pass
TC_04	Buzzer Alert	Trigger alert by exceeding alcohol threshold	Buzzer sounds continuously for defined duration	Buzzer sounds continuously for defined duration	Pass
TC_05	LED System	Trigger alert via sensor	LEDs blink in pattern to indicate detection	LEDs blink in pattern to indicate detection	Pass
TC_06	Vibration Motor	Trigger alert via sensor	Seat vibration motor activates for specified time	Seat vibration motor activates for specified time	Pass
TC_07	Serial Output	Observe output in Arduino Serial Monitor	Alcohol level readings display correctly in real time	Alcohol level readings display correctly in real time	Pass
TC_08	Threshold Accuracy	Test with borderline alcohol value	System correctly distinguishes between pass/fail threshold	System correctly distinguishes between pass/fail threshold	Pass

6. RESULTS

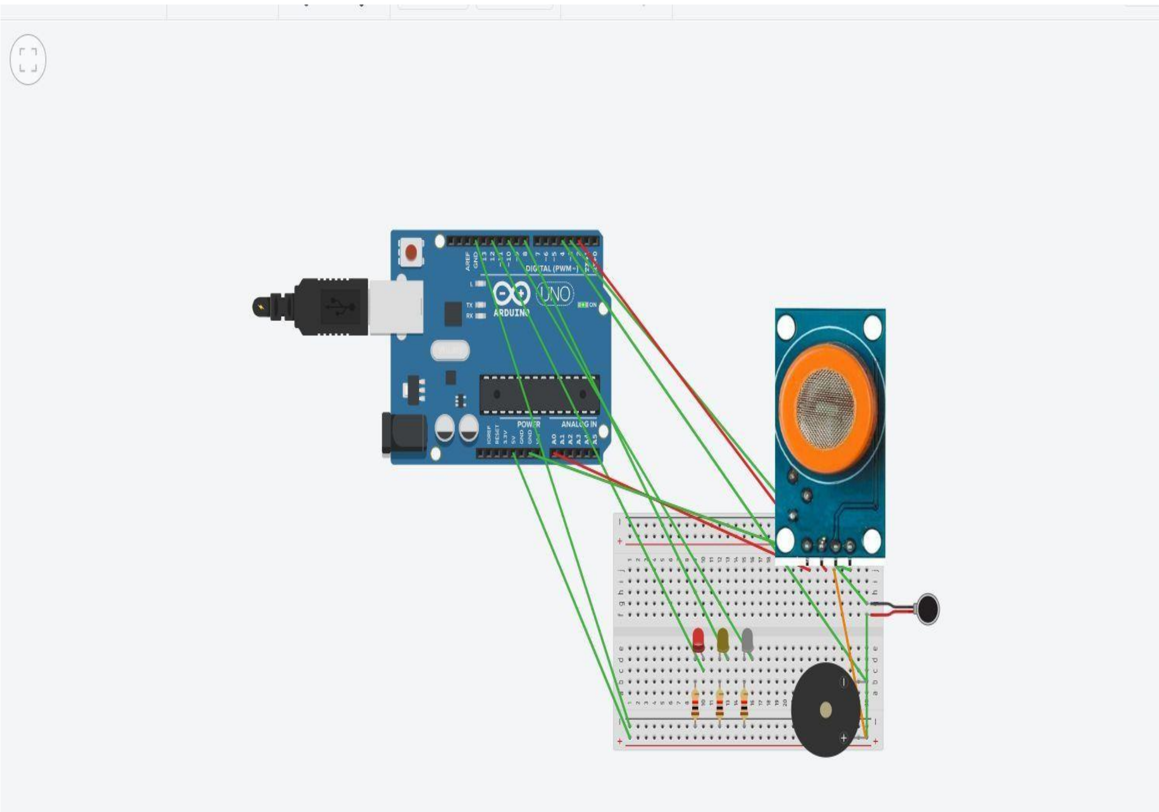

Fig. 6.1 Alcohol Detection System blinking red LED

Fig. 6.1 shows the hardware configuration of an alcohol detection system using an Arduino Uno. The system consists of an MQ-3 alcohol sensor connected to the Arduino to detect the presence of alcohol in the air. When alcohol is detected, the system triggers multiple outputs to alert the user and surrounding environment. These outputs include:

- A buzzer that emits a loud alarm sound to notify others in the vicinity.
- The RED LED used to indicate the severity or presence of alcohol detection.
- A vibration motor that provides tactile feedback through vibrations, which can be useful in silent or discreet alert scenarios.

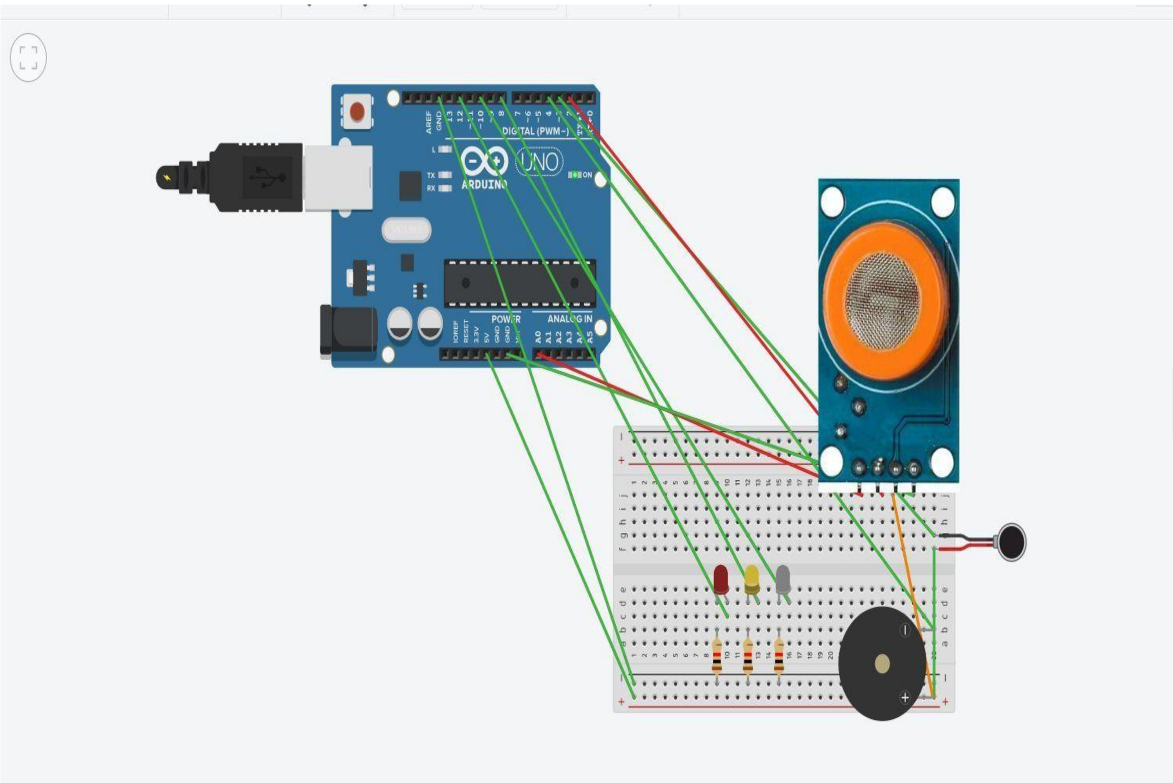

Fig. 6.2 Alcohol Detection System blinking yellow LED

Fig. 6.2 shows the hardware configuration of an alcohol detection system using an Arduino Uno. The system consists of an MQ-3 alcohol sensor connected to the Arduino to detect the presence of alcohol in the air. When alcohol is detected, the system triggers multiple outputs to alert the user and surrounding environment. These outputs include:

- A buzzer that emits a loud alarm sound to notify others in the vicinity.
- The YELLOW LED blinking in a pattern, used to indicate the severity or presence of alcohol detection.
- A vibration motor that provides tactile feedback through vibrations, which can be useful in silent or discreet alert scenarios.

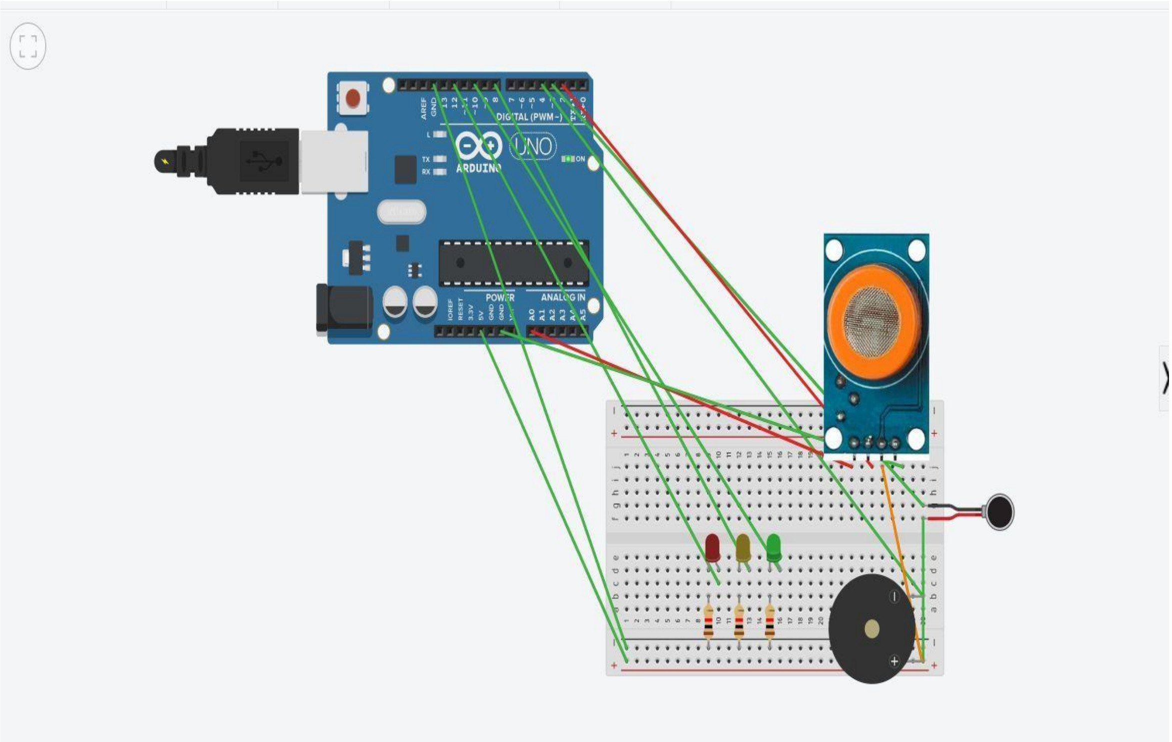

Fig. 6.3 Alcohol Detection System blinking green LED

Fig. 6.3 shows the hardware configuration of an alcohol detection system using an Arduino Uno. The system consists of an MQ-3 alcohol sensor connected to the Arduino to detect the presence of alcohol in the air. When alcohol is detected, the system triggers multiple outputs to alert the user and surrounding environment. These outputs include:

- A buzzer that emits a loud alarm sound to notify others in the vicinity.
- The GREEN LED blinking in a pattern, used to indicate the severity or presence of alcohol detection.
- A vibration motor that provides tactile feedback through vibrations, which can be useful in silent or discreet alert scenarios.

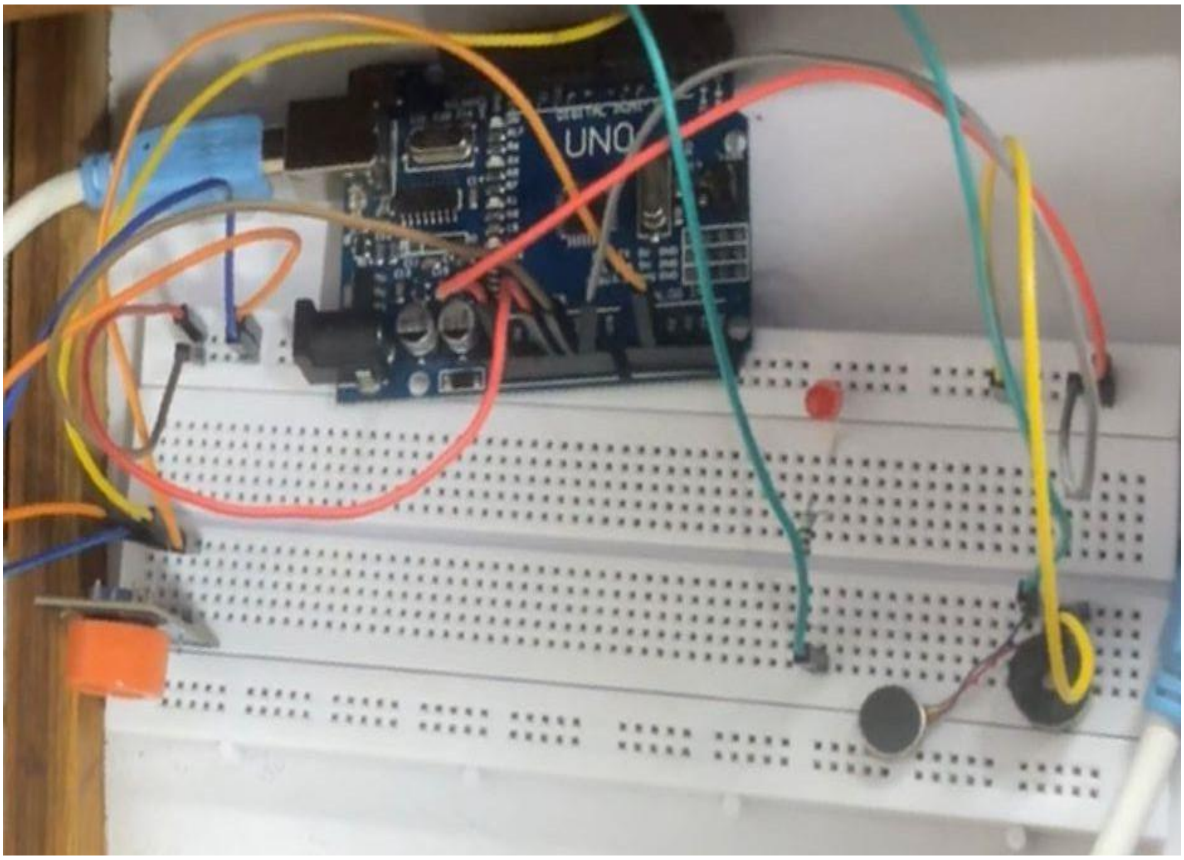

Fig. 6.3 Alcohol Detection System with all components

Fig. 6.3 illustrates the hardware setup of an alcohol detection system, which connects all components to a breadboard and an Arduino Uno. The system consists of an MQ-3 alcohol sensor connected to the Arduino to detect the presence of alcohol in the air. When alcohol is detected, the system triggers multiple outputs to alert the user and the surrounding environment. These outputs include:

- A buzzer that emits a loud alarm sound to notify others in the vicinity.
- The LEDs blinking in a pattern, used to indicate the severity or presence of alcohol detection.
- A vibration motor that provides tactile feedback through vibrations, which can be useful in silent or discreet alert scenarios.

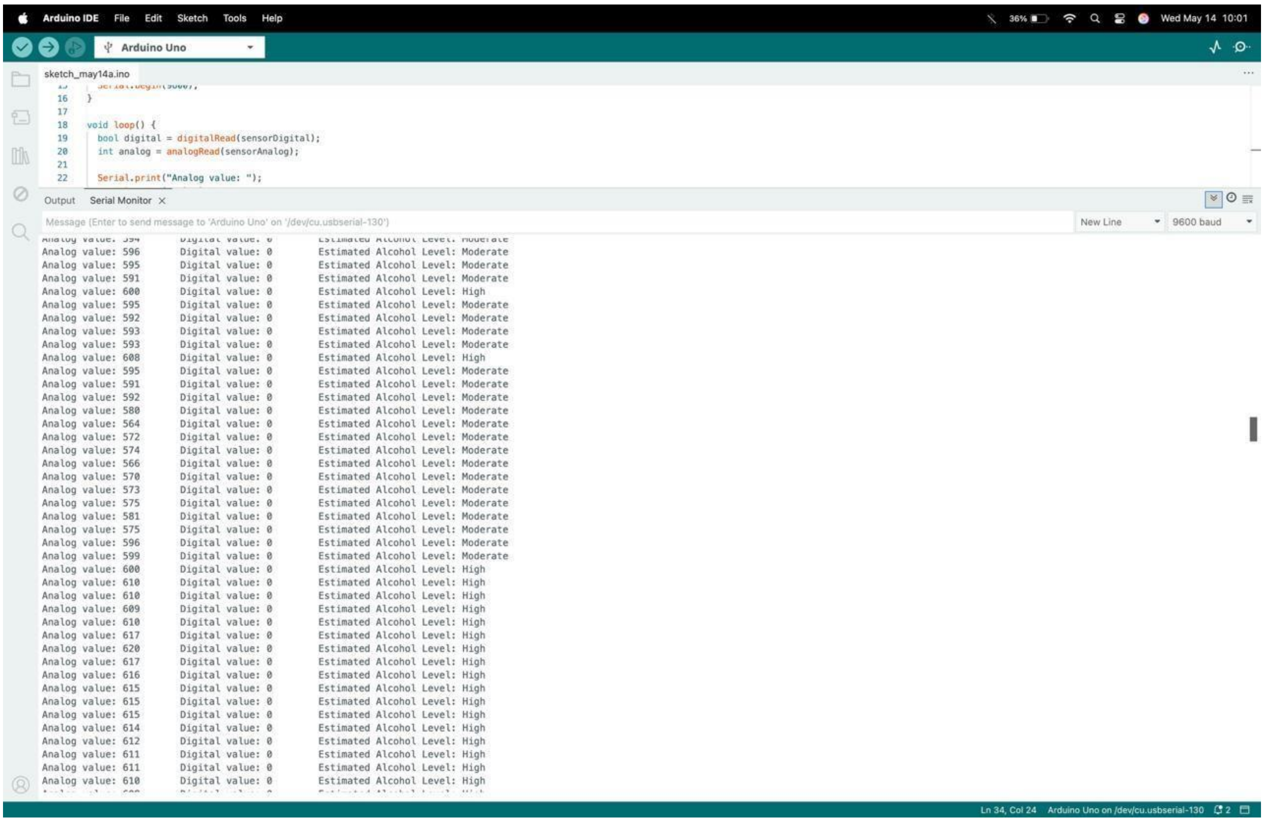

Fig. 6.4 Serial Monitor Output

Fig. 6.3 displays the Serial Monitor output of the Arduino IDE while the alcohol detection system is running. It continuously prints real-time data, including:

- Analog values from the MQ-3 sensor.
- Digital readings (0 or 1) to indicate alcohol presence.
- An estimated alcohol level categorized as “None,” “Moderate,” or “High” based on sensor thresholds.

As shown in the output, the system dynamically updates alcohol levels, demonstrating proper sensor calibration and data processing. This feedback loop helps validate the system’s real-time responsiveness and provides transparency in sensor readings.

7. CONCLUSION AND FUTURE ENHANCEMENTS

7.1 CONCLUSION

This project successfully demonstrates a functional alcohol detection and alert system using the MQ-3 gas sensor and an Arduino UNO. The MQ-3 sensor is sensitive to alcohol vapors and is capable of detecting even low concentrations from the breath of a driver. When alcohol is detected, the system provides immediate alerts using an LED and a buzzer, ensuring quick and clear notification.

The system continuously monitors both analog and digital outputs from the sensor to estimate the alcohol level and differentiate between low, moderate, and high concentrations. All readings are displayed through the Serial Monitor, making it suitable for data logging and calibration.

This design is:

- Low-cost and uses easily available components.
- Portable, with the potential to run on battery power.
- Scalable, allowing further integration with GSM modules, IoT platforms, or vehicle control units.

By embedding this system in vehicle dashboards, it can serve as a real-time driver alcohol detection mechanism, potentially preventing drunk driving incidents and thereby enhancing road safety.

7.2 FUTURE ENHANCEMENTS

- **Engine Locking Mechanism**: Implement a system that automatically disables the ignition if the driver is intoxicated.
- **Mobile App Support**: Develop a companion mobile app for remote alerts, system monitoring, and logs.
- **Hydration & Health Monitoring**: Add sensors to detect hydration levels or monitor pulse rate to assess driver health conditions.
- **Voice Assistant Notification**: Integrate voice alert systems to warn the driver through speaker systems

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