ALCOHOL DETECTION SYSTEM MQ-3 SENSOR AND ARDUINO

Table of Contents

1. Introduction

Safety on roads is among the most serious issues in contemporary transport systems. Out of all the causes of accidents, drunk driving is a prominent one, causing serious injuries, loss of lives, and property damage annually. Alcohol diminishes an individual's judgment ability, slows down reaction, and impairs coordination, making driving while intoxicated extremely risky.

To solve this problem, preventive methods based on technology are becoming increasingly significant. One of them is the creation of a microcontroller-based alcohol detection system that detects the alcohol in the surrounding environment or in a driver's breath and takes action according to that. Such systems can act as an early warning system or a safety system to prevent accidents due to drunk driving.

In the present project, an Arduino Uno-based alcohol detection system is designed and implemented. The system employs a proper gas sensor to sense alcohol vapors and analyze the data received for further processing. The software and hardware modules are properly integrated to achieve a consistent detection and ensure efficient operation.

The project prioritizes precision, affordability, and simplicity with the objective of developing a model that can be used in actual applications in the future like vehicles, workplaces, or public safety settings. The intended design is to show how embedded systems can make a positive contribution to automated safety surveillance and prevention of alcohol-related accidents

2. Aim

The objective of this project is to develop and design a microcontroller-based alcohol detector system utilizing the Arduino Uno and MQ-3 sensor that will detect alcohol vapours in the surrounding environment or in a driver's Breath .The system is attempting to offer an inexpensive, small, yet reliable solution that can detect alcohol concentration and produce proper alerts.
It is also intended to show how embedded systems can be used to improve road safety and minimize accidents due to drunk driving by detecting it early and alerting the driver accordingly.

3. Objectives

a. To interface the **MQ-3 alcohol sensor** with the **Arduino Uno** microcontroller for reliable alcohol vapor detection.
b. To measure alcohol vapor concentration and classify it into **Safe**, **Warning**, and **Danger** levels based on sensor readings.
c. To provide **real-time visual and audio alerts** using **Green, Yellow, and Red LEDs** along with a **buzzer** to indicate different alcohol levels.
d. To design a **user-friendly, low-cost, and portable system** that can be easily integrated into vehicles for safety applications.
e. To introduce an **innovative calibration process** and a **three-level indication mechanism**, ensuring improved accuracy, adaptability, and practical usability of the system.

4. Components Required

- Arduino Uno (1x)
- MQ-3 Alcohol Sensor Module (1x)
- LEDs: Green, Yellow, Red (1 each)
- Resistors: 220 Ω (3x for LEDs)
- Buzzer (1x)
- Switch (1x)
- Jumper wires
- Breadboard

USB cable for programming and power

5. MQ-3 Sensor Module Components

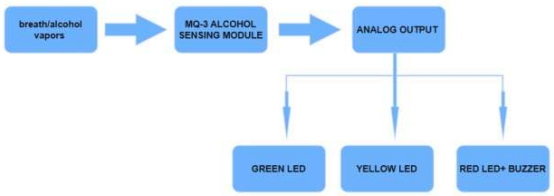
The MQ-3 alcohol sensor module is composed of several key elements that work together to detect alcohol vapors accurately.

1. **Gas Sensor Element (SnO_2 + Heater):**
    - The core sensing component is made of **Tin Dioxide (SnO_2)**. ○ Its **electrical resistance changes** when exposed to alcohol vapors.
    - A small **heater coil** ensures the sensor maintains the optimal temperature for accurate detection.

2. **Metal Mesh Cap:**
    - Protects the sensor element from **dust, debris, and mechanical damage**.
    - Allows gases to pass freely to the sensing layer for accurate measurement.
3. **Heater Resistor (RH):**
    - Provides the necessary pre-heating to stabilize the sensor. ○ Ensures the sensor operates at the correct temperature to detect alcohol consistently.
4. **Load Resistor (RL):**
    - Forms a **voltage divider circuit** with the sensor's resistance.
    - Converts the resistance change into a measurable **analog voltage output**.
5. **Comparator Circuit (LM393 IC):**
    - Compares the analog sensor voltage with a set threshold.
    - Provides a **digital output (DO)** signal when alcohol concentration exceeds the threshold. ○ The threshold can be adjusted using the potentiometer.
6. **Potentiometer:**
    - Allows **fine adjustment of the sensor's sensitivity**. ○ Controls the point at which the digital output goes HIGH, enabling threshold customization.
7. **Output Pins:**
    - **VCC:** Power supply (5V). ○ **GND:** Ground connection. ○ **AO (Analog Output):** Provides a **continuous voltage proportional** to alcohol concentration.
    - **DO (Digital Output):** Produces **HIGH or LOW signal** depending on the preset threshold.

This modular design allows the MQ-3 sensor to be easily interfaced with microcontrollers like **Arduino Uno** and forms the foundation for accurate alcohol detection.

6.BLOCK DIAGRAM



7. Block Diagram Explanation

The **block diagram** of the Alcohol Detection System illustrates the overall working structure and interconnection of components used in the project. Each block represents a functional unit that contributes to the detection and indication process.

1. **Power Supply**
   The system operates using a **5V DC power source**, which can be provided through a USB connection or an external adapter. This powers the Arduino Uno, the MQ-3 sensor, LEDs, and the buzzer.

2. **MQ-3 Alcohol Sensor**
   The MQ-3 sensor is the **core sensing element** of the system. It detects alcohol vapours present in the surrounding air or the user's breath and converts the concentration into an **analog voltage signal**. The sensor's sensitivity makes it suitable for detecting alcohol levels accurately in real-time.

3. **Arduino Uno Microcontroller**
   The **Arduino Uno** acts as the **control and processing unit**. It receives the analog signal from the MQ-3 sensor, processes the data, and compares it with the predefined threshold levels. Based on the calibration results, the Arduino determines the alcohol level category — **Safe**, **Warning**, or **Danger** — and triggers the corresponding output responses.

4. **Calibration Process (Innovative Feature)**
   Before operation, the sensor undergoes a **calibration procedure** to establish baseline and threshold values under clean air conditions. This ensures reliable performance and compensates for environmental factors such as temperature and humidity, enhancing system accuracy — a key innovative feature of this project.

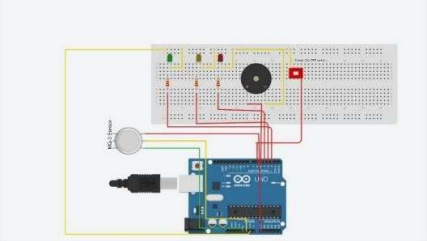
5. **Indication and Alert Unit (LEDs and Buzzer)**
   This section provides **immediate feedback** to the user.

   - **Green LED**: Indicates a safe condition (no alcohol detected). ○ **Yellow LED**: Warns of moderate alcohol presence.
   - **Red LED + Buzzer**: Signals a dangerous alcohol level requiring immediate attention.
     The use of a **three-level indication system** is another innovative aspect of this project, designed to enhance clarity and usability.

6. **Output Display (Serial Monitor)**
   For testing and analysis, the sensor's analog values and status messages are displayed on the **Arduino IDE Serial Monitor**, allowing users to observe real-time readings during calibration and operation.

Together, these blocks form a compact and efficient system capable of detecting alcohol and generating warnings to promote road safety and responsible driving behaviour.

8. CIRCUIT DIAGRAM



Circuit Connections

MQ-3 Sensor → Arduino Uno:

- VCC → 5V
- GND → GND
- AO → A0

LEDs → Arduino Uno (with 220 Ω resistors):

- Green → D2
- Yellow → D3
- Red → D4

Buzzer → Arduino Uno:

- Buzzer (+) → D5

- Buzzer (–) → GND

9.OUR INNOVATION

Calibration Process

The MQ-3 sensor is widely used for alcohol detection; however, it **does not inherently provide multi-level classification** of alcohol concentration. Our innovation in this project is to design a system that can detect alcohol at **three distinct levels — Safe, Warning, and Danger** — providing more informative and actionable feedback. To achieve this, a precise **calibration process** is essential to ensure accurate readings under varying environmental conditions.

a. Warm-up Time

The MQ-3 sensor contains a heating element that stabilizes its sensing characteristics. Allow the sensor to **warm up for 2–5 minutes** after powering on before taking any readings.

b. Baseline Measurement (Clean Air)

Upload the following calibration code to the Arduino Uno:

```
const int mqPin = A0;


void setup() {
  Serial.begin(9600);
  Serial.println("MQ-3 Calibration Started...");
}


void loop() {   int value =
analogRead(mqPin);
Serial.println(value);
delay(500);
}
```

- Open the **Serial Monitor** at 9600 baud.
- Record the sensor values in **clean air**; this establishes the **baseline reading** (e.g., 200–250). **c. Alcohol Exposure Test**
- Bring a cotton pad or tissue soaked with sanitizer/alcohol near the sensor.
- Observe the **sensor value increase** (e.g., 700–800), indicating alcohol detection. **d. Set Thresholds**
- Choose a **low threshold** slightly above the baseline.
- Choose a **high threshold** between moderate and maximum observed values.

Example:

- Clean air = 220
- Alcohol vapors = 750
- Suggested thresholds: TH_LOW = 300, TH_HIGH = 600

e. Validation

- Test the system **multiple times** with varying alcohol concentrations.
- Verify that the **LEDs and buzzer respond correctly** according to the defined Safe, Warning, and Danger levels.

10.Working Principle

The Alcohol Detection System is designed to sense alcohol vapors in the surrounding environment or in a driver's breath and provide immediate feedback. The system relies on the **MQ-3 alcohol sensor** and the **Arduino Uno microcontroller** for processing and output generation.

1. **MQ-3 Sensor Functioning**
   The MQ-3 sensor consists of a **semiconductor layer made of Tin Dioxide (SnO_2)** and an integrated **heating element**. In normal air, the sensor has a specific resistance. When alcohol vapors are present, they interact with the semiconductor surface, causing a **change in its electrical resistance**. This resistance change is **proportional to the alcohol concentration** in the air.

2. **Voltage Conversion**
   The sensor is connected in a **voltage divider circuit** with a load resistor. The resistance change is converted into a **corresponding analog voltage**. This voltage varies continuously depending on the concentration of alcohol vapours and can be read by an analog input pin on the Arduino Uno.

3. **Microcontroller Processing**
   The Arduino Uno continuously reads the analog voltage output from the MQ-3 sensor. The analog reading ranges from 0 to 1023, representing the sensor's detected alcohol concentration. The microcontroller **compares this value against pre-calibrated threshold levels** to determine the alcohol concentration category.

4. **Three-Level Alcohol Detection (Innovation)**
   Unlike standard MQ-3 implementations that detect alcohol as a simple HIGH or LOW signal, our system **innovatively classifies the alcohol level into three distinct categories**:

   - **Safe (Low alcohol):** Sensor value below the low threshold. A **Green LED** lights up to indicate that it is safe to drive.
   - **Warning (Moderate alcohol):** Sensor value between the low and high thresholds. A **Yellow LED** lights up to caution the driver that alcohol has been detected.
   - **Danger (High alcohol):** Sensor value exceeds the high threshold. A **Red LED** and **buzzer** are activated to indicate a dangerous level of alcohol, alerting the driver to take immediate action.

5. **Real-Time Alerts**
   The system continuously monitors alcohol levels, providing **real-time visual and audio alerts**. This ensures the driver is informed immediately, enhancing road safety. The **three-level detection mechanism** is the core innovation of this project, providing more precise and actionable feedback than conventional single-level alcohol detection systems.

6. **Summary of Operation Flow**

   - MQ-3 detects alcohol → resistance changes → voltage output generated → Arduino reads analog value → compares with thresholds → activates corresponding LED and buzzer.

This working principle ensures **accurate detection, reliable classification, and immediate feedback**, making the system practical for realworld applications in vehicles or workplaces.

11.Arduino Code

The Arduino Uno is programmed to read the analog output of the MQ-3 sensor and classify alcohol levels into **three categories: Safe, Warning, and Danger**. Based on the classification, it triggers **visual (LEDs) and audio (buzzer) alerts**.

Code With Switch

This version allows the user to **disable the Red LED and buzzer**, while the Green and Yellow indicators continue functioning. //

Alcohol Detection with MQ-3 & Arduino Uno + Buzzer/Red LED Switch

```
const int mqPin = A0;     const int greenPin = 2;  const int
yellowPin = 3;  const int redPin = 4;  const int buzzerPin = 5;
const int switchPin = 6; // Switch to disable red LED & buzzer
// Threshold values (adjust after calibration)  const int
TH_LOW  = 300;     const int TH_HIGH = 600;

bool disableAlert = false;

void setup() {    Serial.begin(9600);    pinMode(greenPin, OUTPUT);
pinMode(yellowPin, OUTPUT);    pinMode(redPin, OUTPUT);
pinMode(buzzerPin, OUTPUT);    pinMode(switchPin,
INPUT_PULLUP); // Use internal pull-up resistor
}

void loop() {    // Read switch state   disableAlert =
(digitalRead(switchPin) == LOW); // LOW means pressed

 int sensorValue = analogRead(mqPin);
 Serial.print("Sensor Value: ");
 Serial.println(sensorValue);

 if (sensorValue < TH_LOW) {
digitalWrite(greenPin, HIGH);
digitalWrite(yellowPin, LOW);
digitalWrite(redPin, LOW);      digitalWrite(buzzerPin,
LOW);
 }
 else if (sensorValue < TH_HIGH) {
digitalWrite(greenPin, LOW);
digitalWrite(yellowPin, HIGH);
digitalWrite(redPin, LOW);      digitalWrite(buzzerPin,
LOW);
 }    else {
digitalWrite(greenPin, LOW);
digitalWrite(yellowPin, LOW);
if(disableAlert) { // If switch
pressed, turn off alert
digitalWrite(redPin, LOW);
digitalWrite(buzzerPin, LOW);
```

```
  } else {      digitalWrite(redPin,
HIGH);
digitalWrite(buzzerPin, HIGH);
  }
 }
delay(500);
}
```

Working:

- The **switch** provides flexibility to disable the Red LED and buzzer without affecting the system's ability to detect alcohol.
- This feature is particularly useful in situations where audio alerts may be disruptive but visual warnings are still required.
- The **three-level detection system** remains the core innovation, providing **enhanced accuracy and actionable alerts**.

12.Advantages

- **Simple and Cost-Effective:** Uses readily available components, making it affordable and easy to assemble.
- **Portable Design:** Compact and lightweight, suitable for vehicle installation or as a standalone device.
- **Easy Arduino Uno Integration:** Simplifies programming and hardware interfacing, reducing development time.
- **Real-Time Alcohol Detection:** Provides immediate visual and audio feedback, enhancing road safety.
- **Innovative Three-Level Detection (Our Innovation):** Unlike standard MQ-3 implementations, the system classifies alcohol concentration into **Safe, Warning, and Danger levels**, providing **more informative and actionable feedback** for the user.
- **Calibration-Based Accuracy (Our Innovation):** The sensor is carefully calibrated to account for environmental factors, ensuring **reliable and consistent readings** across different conditions.
- **Scalable for Future Enhancements:** Can be expanded with ignition cut-off, wireless alerts, or mobile app integration for advanced safety features.

13. Future Scope

- **Integration with Vehicle Ignition Systems:** A relay module can be added to **automatically cut off the vehicle ignition** when dangerous alcohol levels are detected, preventing drunk driving.
- **Wireless Alerts:** The system can be enhanced to **send real-time notifications** to traffic authorities, fleet managers, or guardians via GSM, Wi-Fi, or IoT platforms, enabling prompt action.
- **Digital Display of Alcohol Levels:** Alcohol concentration can be shown on an **LCD screen or mobile application**, providing users with detailed, real-time information.
- **Enhanced Multi-Level Detection:** The current three-level classification can be further refined into more granular levels for **even more precise monitoring**.
- **Integration with Smart Vehicle Systems:** The system can be connected with modern vehicle safety and driver-assistance technologies for **automated safety interventions**.

The **three-level detection mechanism** and **calibration-based accuracy** introduced in this project provide a strong foundation for these future enhancements.

14.Conclusion

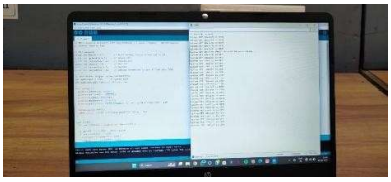
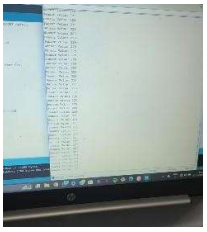
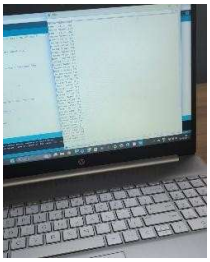
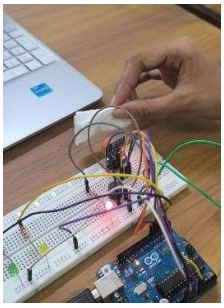
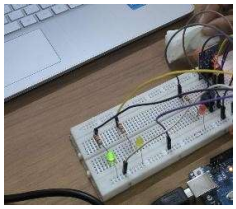
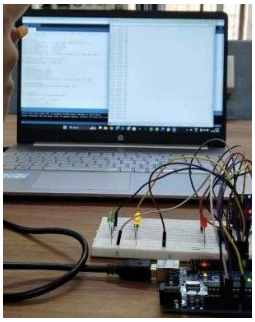
This project successfully demonstrates a **low-cost, portable alcohol detection system** using the **MQ-3 sensor** and **Arduino Uno**. The system continuously monitors alcohol concentration and provides **real-time alerts** through LEDs and a buzzer, helping to **enhance road safety** and reduce accidents caused by drunk driving.

A key innovation of this project is the **three-level detection mechanism**, which classifies alcohol concentration into **Safe, Warning, and Danger levels**, providing **more informative and actionable feedback** than conventional single-level systems. Additionally, the **calibration process** ensures accurate readings under varying environmental conditions, increasing the system's reliability and practical usability.

The design is **simple, cost-effective, and scalable**, making it suitable for integration into vehicles, workplaces, and public safety systems. The project also lays a foundation for **future enhancements**, such as wireless alerts, ignition control, and digital display of alcohol levels, demonstrating the potential of embedded systems in **automated safety applications**.

15.Appendices

Output

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