Alcohol Detection in Motor Vehicle

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ABSTRACT - This paper presents the design and implementation of an alcohol detection and vehicle control system that aims at preventing drunk driving, thus increasing road safety. The level of alcohol in the breath is measured by an MQ-3 alcohol sensor installed in the system. In case the level exceeds the given threshold, the system will react to bring the car to a halt and send a notification with GPS coordinates via SMS to selected contacts. In this, a whole system is coordinated with an Arduino Uno microcontroller interfacing with various units of GSM modules, GPS modules, LCD displays, and motor drivers. The accuracy response time and power efficiency of the proposed system will be tested. Results indicate that alcohol is captured very effectively, the vehicle will be stopped, and alerts are sent, making the system viable for applications in safety measures with vehicles.

Keywords: Alcohol detection, vehicle safety, Arduino, motor control, GSM & GPS module.

I. INTRODUCTION

Intoxicated driving is one of the main causes of road accidents. The approaches put in place now are either by law enforcement, where detection happens after the accident has taken place, or post-accident testing; thus, they are ineffective in preventing accidents. This project is proposing an integrated approach through an alcohol detection sensor, coupled with vehicle control and communication systems, in a proactive approach to accident prevention. The developed system, employing an Arduino Uno at its core, detects alcohol in the driver's breath, halts the vehicle's operation, and transmits an SMS with GPS coordinates to a contact. This paper details hardware and software design, power requirements, communication protocols, and testing of the system.

II. LITERATURE SURVEY

Previous work: Much research in alcohol detection for vehicle safety has been conducted with different approaches, that include the integration of a Breathalyzer with an ignition interlock device. Some systems alert the authorities located near and others lock out the vehicle but not send location information. Generally, such systems lack the functionality of real-time communication and GPS, which severely limits its scope. This project integrates GSM and GPS with an alcohol sensor. It offers a comprehensive solution that transcends those limitations.

Comparative analysis: Unlike other systems, this project uses low-cost components, compatible with Arduino, to present a reliable solution, integrated for safety. In that regard, it appears unique and stands out from the rest among the existing solutions alcohol detection, location tracking, and SMS notification.

III. METHODOLOGY

A. System overview: The alcohol detection in motor vehicle comprises an MQ-3 alcohol sensor, a SIM800L GSM module, Ublox Neo 6M GPS module, L298N motor driver, 16x2 LCD with I2C interface, and a BO motor. In the event when the alcohol sensor detects the alcohol, the system will stop the vehicle and then send the SMS with the GPS location in form of google maps link to the respective contact. The Arduino Uno has been arranged as the master controller to integrate all components and process data from sensors to induce a particular action.

B. Algorithm: Alcohol Detection System.

1. Initialization Phase

- Serial communication is enabled to run serial debugging and module communication.
- SIM800L GSM module is initialized so that it may be ready to receive SMS.
- Initialize the GPS module for receiving location data.
- Connect the LCD and assign a welcome message.
- Assign the motor control pins as outputs and initialize the motors to a stopped state.

2. Main Loop

- This program will be an infinite loop of the following steps.

3. Sensor Value Acquisition

- From the Arduino, read the value from the analog output from the MQ-3 sensor that's connected to the A0-pin of Arduino.
- Display read from alcohol sensor on LCD.

4. Alcohol Detection Test

- Compare the sensor reading with a predefined threshold value assigned as 800.
- **Sensor reading >= Threshold:**
  - Display "Alcohol Detected!" on LCD.
  - Stop motor and ensure vehicle security.
  - Proceed for GPS data acquisition to send SMS alert.
- **Else:**
  - Display "No Alcohol" on LCD.
  - Start or continue to run the motor.
  - Reset the alcohol Detected flag for next cycle.

5. GPS Data Acquisition

- Try to get a GPS fix within a 20 second window.
- Listen for location update reading data repeatedly from GPS module.
- **if GPS location is received:**
  - Extract latitude and longitude values.
  - Update gpsFix to be true and go to send SMS alert with location.
- **if GPS data does not arrive within 20 seconds:**
  - Log an error message and go to send SMS alert. Do not wait for GPS location.

6. SMS Alert Transmission

- Construct an SMS message based on the GPS data acquired.
  - **If gpsFix is high:** Use the GPS location to add a Google Maps link in the SMS message.
  - **If gpsFix is low:** use a no-GPS-location message.
- Send the SMS alert from the GSM SIM800L, with an emergency contact number.
- Show "Location Sent" on the LCD if the GPS location was sent; otherwise, show "Alcohol Detected".

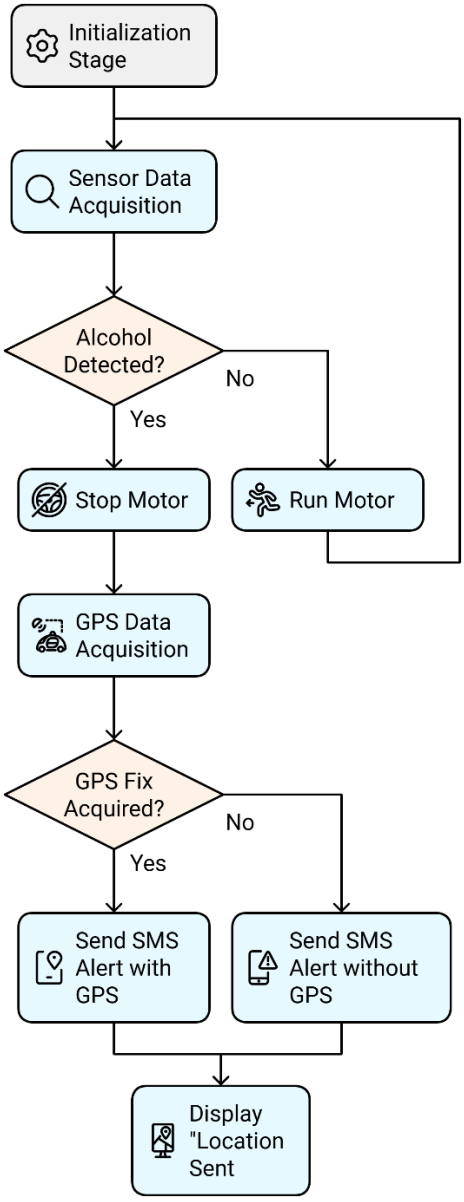

Figure 1: System flow chart.

C. System Design and Architecture

Figure 8 shows the setup of the proposed alcohol detection in motor vehicle with the interconnection with every module. All the modules will share a common ground where all the components will be grounded to distribute the signals and power properly.

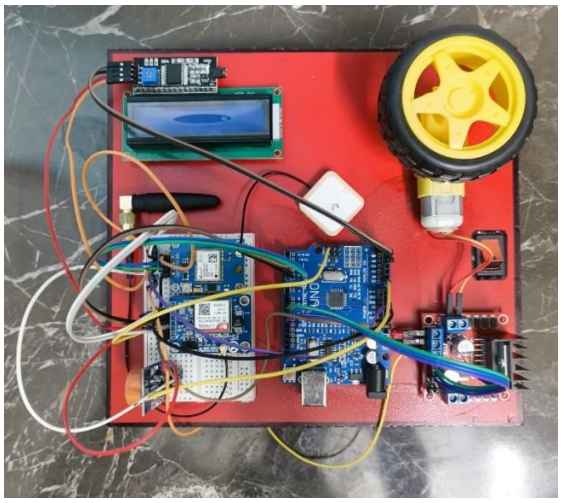

Figure 2: Alcohol Detection in Motor Vehicle

1. MQ-3 Alcohol Sensor

- **A0:** Connected to Arduino A0 pin to read analog alcohol signal.
- **GND:** To the common ground.
- **VCC:** Connected to the 5V pin at the Arduino side shared with LCD.

2. 16 x 2 LCD Display with I2C Interface

- Common ground.
- It is connected through the 5V pin of the Arduino. Here, the same power source is used by the MQ-3 sensor.
- It is connected to the Arduino A4 for data communication through the I2C protocol.
- It is connected to the Arduino A5 for the clock signal through the I2C protocol.

3. Ublox Neo 6M GPS Module

- Common ground.
- It is connected to the ICSP corner 1st pin of the Arduino, which provides the 5V.
- **RX:** Connected to Arduino digital pin 5 for receiving data.
- **TX:** Connected to Arduino digital pin 4 for transmitting data.

4. SIM800L GSM Module

- **VCC:** Connected to 5V on the Arduino
- **GND:** Connected to common ground.
- **TX:** Connected to Arduino digital pin 2 for transmitting data
- **RX:** Connected to Arduino digital pin 3 for receiving data.

5. L298N Motor Driver

- **OUT 1 & OUT 2:** Connected to the motor terminals to change the motor direction and speed.
- **12V:** It is connected to the positive terminal of the battery and thus will supply power to the motor
- **GND:** It is common ground and is connected to the negative terminal of the battery.
- **EN:** To drive/enable the motor, it is connected to digital pin 9 of Arduino.
- **IN 1:** Connected to Arduino's digital pin 10. It will enable control of motor direction.
- **IN 2:** For motor direction control, this is connected to the Arduino's digital pin 11.

6. Arduino Uno: It can be powered in two ways one with the 9V battery and another with the 9V adaptor whereas Motor driver uses separate 12V battery to avoid overloading and we are not connecting 12V to Arduino Uno because the Arduino board regulator has to convert from 12V to 5V which is reducing 7V and it can cause the Arduino Uno to get heated up fast. Therefore, giving 9V of supply to Arduino uno is more effective and reliable.

In summary, each component interfaces with the Arduino by specific pins for power, ground, and communication with data. All ground pins are connected to provide a common ground for stabile operation and communication between components. The Arduino further processes the signals from the MQ-3 sensor for sending commands to the motor driver and GSM module regarding alcohol detection, while GPS and LCD modules will be the supply of real-time data display and location tracking.

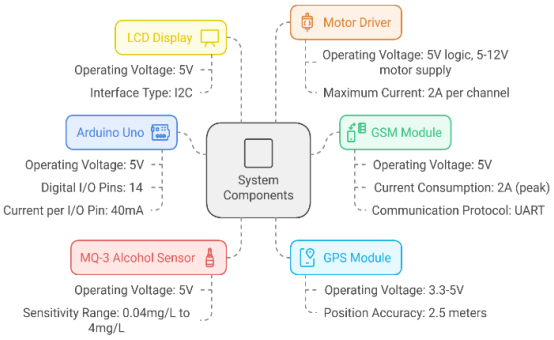

Figure 3: System Components Overview

D. Software implementation

- ***Detection and Control Logic:*** Arduino is continuously monitoring the output of the MQ-3 sensor. As soon as it crosses a predefined threshold related to alcohol quantity in the mixture, it sends a stop signal to the motor driver which stops the motor, gets ready to prepare an SMS alert that contains GPS location.
- ***Data Communication Protocols:*** The SIM800L GSM module and Ublox Neo 6M GPS module utilize serial communication (UART). I2C protocol is applied in the case of a 16x2 LCD display so that the communication with the same takes place. The protocols enable safe data transfer as well as update in real time the same LCD display.

IV. RESULTS

A. Performance metrics: The system was evaluated based on accuracy, response time, and power consumption. The accuracy of alcohol detection was within acceptable limits with various concentrations of alcohol. The response time evaluated was below two seconds after detection to motor stop and SMS initiation. The power consumption was optimized for reliable performance with the chosen battery setup.

B. Test cases and scenarios: Many test cases were performed. Different concentration levels of alcohol were taken into consideration and checked how the system would respond to it. In each test case, the system was able to identify the presence of alcohol in the breath and responded to it by cutting off the motor and sending an alert message on the mobile.

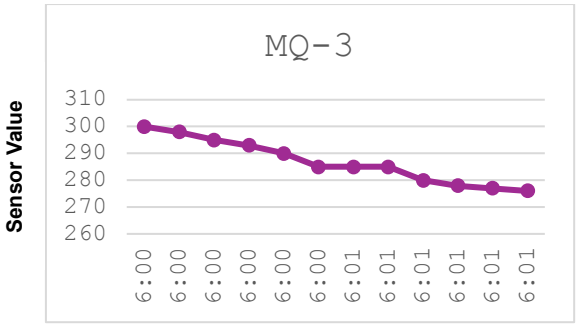

Figure 4: Alcohol sensor in normal condition.

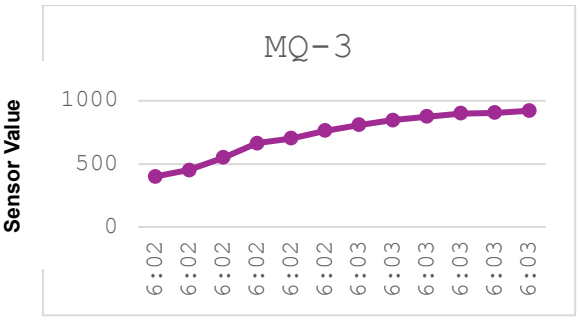

Figure 5: Alcohol sensor when alcohol is detected.

C. Screenshots of SMS alerts and location: Screenshot shown in Figure 9 that SMS alerts during testing with GPS coordinates. From this, it can be noted that the system can be used to give the location-based alerts in real time.

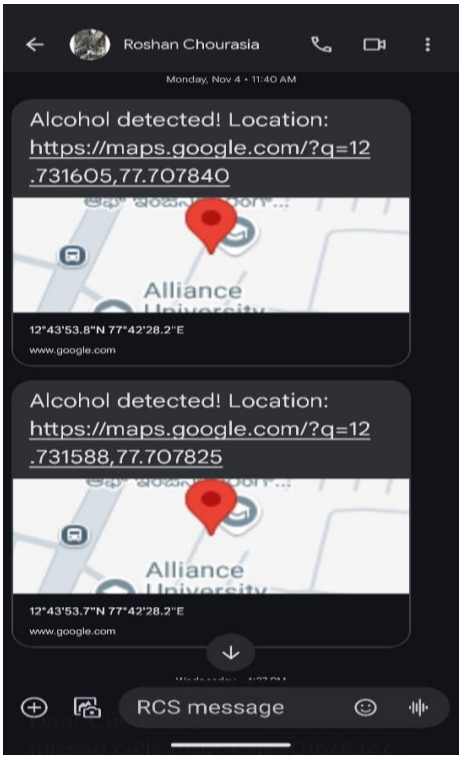

Figure 6: SMS Alters.

D. System Accuracy and response time: MQ-3 alcohol sensor was able to detect alcohol within seconds, whereas an SMS message with GPS coordinates received within 10 seconds of movement depending upon GSM network coverage. The GPS is accurate up to a few meters.

V. DISCUSSION

Experimental results show that the presented alcohol detection system can be used to prevent drunk driving. The GSM and GPS modules provide integration to introduce real-time alert mechanisms, which are useful for vehicle safety applications. However, some of the other drawbacks, such as low accuracy of GPS in indoor environments and false positives in alcohol detection, are some limitations to improve upon in future versions.

VI. LIMITATIONS

- ***Dependency on GPS signal:*** The module would not be efficient in regions of low satellite visibility, particularly in tunnels or thickly built-up urban areas.
- ***Weather Sensitivity:*** Adverse weather conditions may impact GPS and GSM performance, thereby delaying the SMS alert.
- ***Battery life:*** The stability of the supply power is what dictates the performance of the system. The 12V battery that powers the motor driver may drain very fast, thus becoming the reliability of the system.

VII. CONCLUSION

A. Summary of findings: The low-cost vehicle alcohol detection system will stop the vehicle and send a real-time SMS alert with the GPS coordinates, thus successfully completing this project. The overall performance of the system in tests proves it to be an enhancer of road safety.

B. Impact: This system is capable of reducing accidents that occur due to drunk driving to a considerable extent, especially among fleet management or public transportation firms by integrating alcohol detection with GPS and GSM.

C. Future enhancements: Future improvements may include location data stored in clouds, a sensitive alcohol sensor, and integration with a mobile app for greater ease and monitoring, latest and higher versions of sensors and modules, and add multiple contacts with calling feature.

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