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Comprehensive Vehicle Safety System: Alcohol Detection, Accident Alerts and voice warnings

Prof. Kiran Khedkar, Sanika Aherkar, Amruta Jagtap, Vedanti Gosavi
Department of Electronics and Telecommunication
PGMCOE, Wagholi, Pune, India.

Abstract*: Drunk driving is a major cause of road accidents across the globe. Despite strict traffic laws, there are still many cases where drivers operate vehicles under the influence of alcohol. This paper presents a smart safety system that detects alcohol in the driver's breath and prevents the engine from starting. The system uses the MQ3 alcohol sensor, Raspberry Pi Pico microcontroller, GPS module for real-time location tracking, and GSM module for sending SMS alerts. When alcohol is detected, the system locks the engine and sends an alert with the vehicle's location. This low-cost and efficient system is ideal for personal and commercial vehicles to enhance road safety*

Keywords: Alcohol Detection, Engine Locking System, Road Safety, GPS Tracking, Raspberry Pi Pico, GSM Alerts, MQ3 Sensor, Smart Vehicle System, RGB Indicator, LM2596 Converter

I. INTRODUCTION

Alcohol consumption affects a driver's ability to make decisions, slows down reaction time, and increases the chances of accidents. As per the World Health Organization (WHO), around 1.3 million people die in road accidents every year, and drunk driving is one of the leading causes. Traditional alcohol detection devices like breathanalyzers can detect alcohol but do not prevent a person from driving. Hence, there is a need for a system that can both detect alcohol and take immediate preventive action.

This project proposes a smart safety system that checks the driver's breath using an MQ3 alcohol sensor. If alcohol is detected above a safe limit, the system uses an LM2596 DC-DC converter to cut off power supply to simulate an engine lock. Instead of a motor or relay, an RGB LED is used to show system statusgreen when it is safe, red when alcohol is detected, and blue when the system is ready or on standby.

The system also includes a GPS module to get the vehicle's location and a GSM module to send an SMS alert to emergency contacts if alcohol is detected. A buzzer and LCD display are used for audio-visual alerts, giving real-time feedback to the driver. This system is simple, cost-effective, and helps in preventing drunk driving while improving safety response.

II. LITERATURE SURVEY

The development of vehicle safety systems has seen major advancements in recent years, particularly in driver monitoring and accident prevention. Alcohol detection systems using breath sensors like MQ3 are widely used in research to measure alcohol concentration in a driver's breath. Williams et al. (2018) explored the use of infrared spectroscopy for more accurate alcohol sensing, but such systems are costly and complex. The MQ series sensors are more suitable for low-cost, real-time application. GPS and GSM-based tracking and alerting have also been used to improve emergency response. Patel et al. (2020) discussed air quality and smoke detection sensors in vehicles, showing how sensor integration can improve passenger and driver safety. Researchers like Kumar et al. (2021) and Brown (2021) have used machine learning to analyze driver behavior and predict hazards. Though their systems require high computational power, they open possibilities for advanced safety systems in future vehicles. Telematics and location tracking, as highlighted by Smith et al. (2020), are useful in sending real-time alerts and improving post-incident response. Studies by Nguyen et al. (2023) show that autonomous features like automatic braking help avoid accidents caused by delayed driver response. These studies support the integration of alcohol detection, vehicle control, and location-based alert systemsjust as proposed in this paper provide a reliable solution for preventing drunk driving and improving road safety.

III. EXISTING SYSTEM

Current safety solutions in vehicles are mostly focused on features like seatbelt alerts, airbags, and GPS navigation. While effective for general safety, these systems do not actively prevent drunk driving. Some high-end vehicles come with built-in alcohol detection systems, but these are expensive and not commonly available in most standard models. Aftermarket alcohol sensors are also available, but they typically only provide warnings or sound alarms when alcohol is detected. They do not control the vehicle's ignition system or offer any form of communication like GPS tracking or SMS alerts. As a result, these systems fall short in taking real-time action or improving emergency response. There is a clear need for a more integrated, affordable, and automated solution to address this gap in road safety.

IV. PROPOSED SYSTEM

The proposed system is designed to detect alcohol in the driver's breath and take immediate action to prevent unsafe vehicle operation. The system utilizes an MQ3 alcohol sensor to detect the presence of alcohol vapours when the driver exhales near the sensor. The sensor generates an analog signal, which is sent to the Raspberry Pi Pico microcontroller for processing. If the detected alcohol level exceeds a predefined limit, the microcontroller simulates an engine lock by disabling power through an LM2596 DC-DC converter.

To visually indicate system status, an RGB LED (ROG light) is used. The light glows green when no alcohol is detected, red when alcohol is present, and blue during system standby or initialization. This provides a clear and immediate visual cue to the driver.

In addition to the alcohol detection feature, the system includes a GPS module that retrieves the vehicle's current location. Upon alcohol detection, the location is transmitted via a GSM module as an SMS alert to a predefined emergency contact number. The alert contains both a warning message and the vehicle's real-time coordinates, allowing for immediate response by family or authorities.

The system is compact, cost-effective, and suitable for installation in a wide range of vehicles including personal cars, school transport, and commercial fleets. Unlike conventional alcohol detection systems that only display results, this solution combines detection, simulated power control, visual indicators, and real-time communication to enhance road safety and driver accountability.

V. SYSTEM ARCHITECTURE

The Alcohol Detection System with Power Control and GPS Tracking is a smart embedded solution designed to improve road safety by preventing drunk driving. At the core of the system is a Raspberry Pi Pico microcontroller, which manages and processes inputs from various sensors and modules. An MQ3 alcohol sensor is used to detect alcohol levels in the driver's breath. If the alcohol level crosses a preset limit, the system simulates engine lock by cutting power using an LM2596 DC-DC converter, effectively preventing unsafe vehicle operation. An RGB LED (ROG light) is used to visually indicate the system status—green for safe, red for alcohol detected, and blue for standby.

In parallel, the system uses a GPS module to obtain the vehicle's real-time location. This location data, along with an alert message, is sent via a GSM module (SIM800L) to pre-configured emergency contacts through SMS. A 16x2 LCD display shows messages like "Alcohol Detected" or "System Normal" for real-time user feedback. Additional indicators such as a buzzer provide audible alerts to warn the driver immediately upon alcohol detection. All components are powered by a regulated 5V power supply. By combining alcohol detection, visual indicators, power control, GPS tracking, and emergency communication, this system offers a practical and reliable solution for reducing alcohol-related road accidents.

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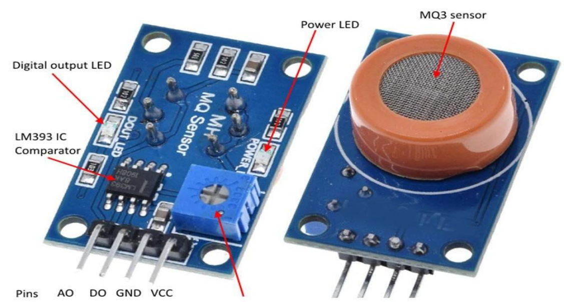
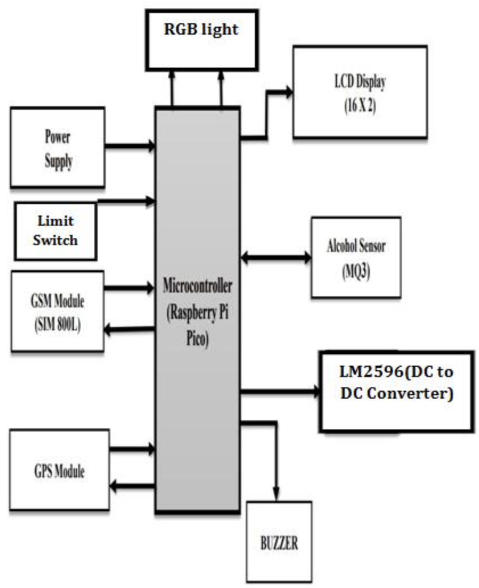
VI. METHODOLOGY





The proposed system is built around the Raspberry Pi Pico microcontroller, which coordinates the functions of all key modules, including the MQ3 alcohol sensor, GPS, GSM, and RGB indicator. Once powered on, the system initializes the alcohol detection sensor (MQ3), GPS module for live location tracking, and GSM module for communication. It also activates the RGB LED and LCD display for real-time visual feedback.

The system constantly monitors alcohol levels through the MQ3 sensor. When the driver exhales near the sensor, it sends an analog signal to the microcontroller. If the alcohol level remains below the safety threshold, the system shows a "Normal" message on the LCD, glows green on the RGB LED, and continues monitoring.

If the alcohol concentration exceeds the set limit, the system immediately switches the RGB LED to red, sounds a buzzer for alert, and disables the simulated ignition control through the LM2596 power module. Simultaneously, the GPS module fetches the vehicle's current location, and the GSM module sends an SMS alert containing the location data to a preconfigured emergency contact.A short delay ensures proper message delivery, after which the system resets to its monitoring state. This architecture offers a compact, low-cost, and automatic solution to improve vehicle safety by detecting alcohol, preventing ignition, and providing real-time alerts.

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VII. HARDWARE

MQ3 Alcohol Sensor

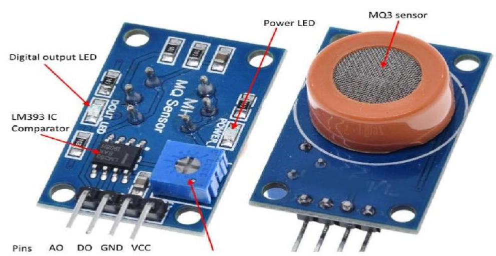

Fig.1

The MQ3 alcohol sensor detects alcohol in the air, especially ethanol from a driver's breath. It gives an analog signal based on alcohol level. In this project, it helps detect if the driver is drunk and sends a signal to lock the engine and trigger alerts.

Raspberry pi pico

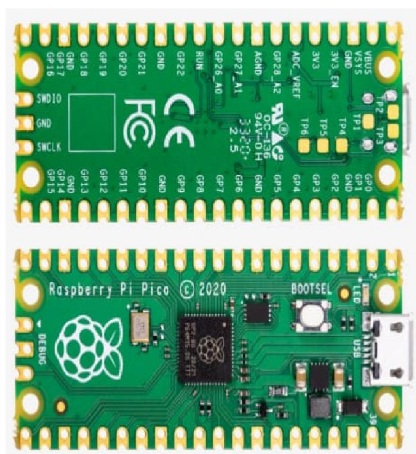

Fig.2

The Raspberry Pi Pico is a small, powerful microcontroller based on the dual-core ARM Cortex-M0+ processor. It features 264KB RAM and supports up to 16MB flash memory. In this project, it acts as the main controller, reading data from sensors (alcohol, GPS), sending alerts via GSM, and controlling outputs like the motor, LCD, buzzer, and LEDs. Its low power use and real-time processing make it ideal for smart vehicle applications..

GPS Module

Fig.3

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GPS(Global Positioning System) module is used to get the real-time location (latitude and longitude) of the vehicle. In this project, it sends the vehicle's current location to the microcontroller, which is then included in the SMS alert sent through the GSM module when alcohol is detected.

GSM Module

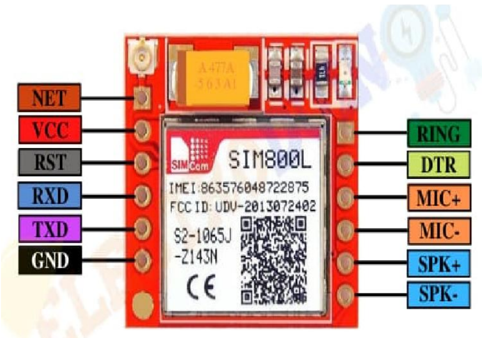

Fig.4

Fig.5

GSM stands for Global System Communication in our vehicle safety system is responsible for sending real-time SMS alerts to emergency contacts. When the system detects alcohol or an accident, the Raspberry Pi Pico communicates with the GSM module to transmit a warning message along with the vehicle's GPS location. This ensures quick notification and enables timely assistance. The use of GSM technology allows for wireless communication over a cellular network, making the system effective even in remote areas without internet connectivity.

LCD display

The LCD (Liquid Crystal Display) is a screen used to display messages and system status in real time. In this project, a 16x2 LCD is used, which can show two lines of 16 characters each. It helps inform the driver about the system's current state—for example, displaying messages like "No Alcohol Detected" when it's safe to drive, or "Alcohol Detected – Engine Locked" when the system prevents the vehicle from starting. This provides clear and immediate feedback to the user, improving awareness and safety.

Buzzer

Fig.6

A buzzer is an electronic device that produces sound to give an alert or warning. In this project, the buzzer is used to give an immediate audio alert when alcohol is detected. It helps grab the driver's attention, indicating that the engine is locked and the vehicle cannot be started due to unsafe conditions.

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LM2596(DC to DC Converter)

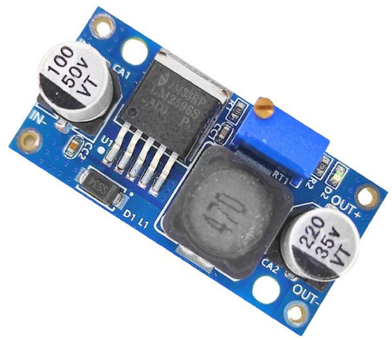

Fig.7

The LM2596 is a DC-DC buck converter used in the system to control power flow. It plays a key role in simulating the engine locking function electronically. Under normal conditions, it supplies regulated voltage to the system components, allowing normal operation. However, if alcohol is detected in the driver's breath above the set threshold, the microcontroller disables the LM2596 output. This cuts off power to the system's main functional units, effectively simulating an engine lock. This method offers a compact, efficient, and reliable way to manage power without mechanical parts

RGB LED (ROG Light)

Fig.8

The RGB LED module shown in Fig. 8 is used in our project to provide clear visual status indications. It has three LEDs—Red, Yellow, and Green—each representing different system states. When no alcohol is detected, the Green LED glows, indicating it's safe to drive. If alcohol is detected above the threshold, the Red LED lights up, warning the driver and disabling the engine. The Yellow LED can be used during system initialization or caution states. This simple yet effective visual feedback helps enhance user awareness and system safety.

Limits witch

Fig.9

In our proposed vehicle safety system, a limit switch is used as a manual trigger to start the alcohol detection process. When the driver presses the switch, it signals the system to begin breath analysis using the MQ3 sensor. This approach ensures detection only occurs when needed,saving power and improving accuracy. Once activated, the system checks alcohol levels and, if they exceed the set limit, it locks the engine, triggers alerts, and sends an emergency SMS with GPS location. This enhances control and adds a user-interactive feature to the system

VIII. EXPERIMENTAL RESULTS

Extensive testing of the Comprehensive Vehicle Safety System demonstrated the following outcomes:
Improved Safety Compliance: The system reliably detected alcohol presence using the MQ3 sensor and activated safety protocols, including visual alerts and engine lock simulation, reducing the chance of drunk driving incidents.
Accurate Alerts: The GSM module successfully sent SMS alerts with real-time GPS coordinates, ensuring quick and precise communication with emergency contacts in case of alcohol detection.
Effective User Feedback: The use of ROG lighting, LCD display, and buzzer provided clear visual and audio status indications, making the system user-friendly and responsive in real-time situations.

IX. CONCLUSION

The Comprehensive Vehicle Safety System with alcohol detection, accident prevention, and voice alerting demonstrates strong potential in enhancing road safety by preventing drunk driving through real-time detection and automated intervention. By integrating key technologies such as the MQ3 alcohol sensor, GPS-GSM communication, and a Raspberry Pi Pico microcontroller, the system ensures that the vehicle remains inoperable when alcohol is detected and immediately notifies emergency contacts with location details. The use of an LM2596 module ensures stable power supply to the components, while the ROG light offers a modern and visually striking method to indicate system status—enhancing user feedback and awareness. Future improvements could involve adding biometric identification, cloud-based data logging, and integration with broader vehicular safety ecosystems to improve overall functionality and user experience.

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