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Full Length Article

Smart Vehicle with Alcohol Detection System

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Abstract*—The proposed project aims to design a smart vehicle equipped with an alcohol detection system that ensures safe driving and prevents road accidents caused by drunk driving. The system uses a breathalyzer sensor to analyze the driver's breath and determine the presence of alcohol. If the alcohol level exceeds the legal limit, the vehicle's ignition system remains locked, preventing the car from starting. Additionally, the system can send an alert to authorities or a registered contact through IoT-based communication. This project integrates IoT, sensors, microcontrollers, and automation to create a safer transportation environment and reduce alcohol-related road fatalities in India.*
Index Terms—Smart Vehicle, Deep Learning, Alcohol detection, Drunk driving, Real-time Violation Detection, MQ3 sensor, IOT based communication, microcontrollers, Deep SORT, Road Safety, Computer Vision, Urban Planning,
Vehicle Classification, Direction Analysis.

1. INTRODUCTION

Road safety has become one of the biggest concerns in the world today. Despite the rapid advancement of vehicles, road infrastructure, and traffic management systems, the number of road accidents continues to rise every year. According to global and national traffic safety reports, a significant percentage of accidents occur not because of mechanical failures, but due to human error, including drunk driving, fatigue, drowsiness, and lack of alertness.

Drunk driving is a major contributor to road accidents worldwide. Alcohol impairs the driver's ability to make quick decisions, reduces hand-eye coordination, slows down reaction time, and affects judgment. This makes even a normal driving situation dangerous. Many drivers underestimate the effect of alcohol on their driving skills, leading to life-threatening consequences

1.2 Research Gap

Even though modern vehicles incorporate several smart safety features, such as automatic braking and lane detection, most of them do not evaluate the driver's physical and mental condition before starting the vehicle. Traditional alcohol detection devices require the driver to blow into a mouthpiece, which is not suitable for daily use. Many cars also lack drowsiness detection systems.

Research Objectives

1.To detect alcohol levels near the driver without requiring any physical contact or blowing into a device.

2.To automatically lock or disable the vehicle ignition if unsafe driver behavior is detected.

3.To send emergency alerts to family members using GSM communication.

4.To design a low-cost, reliable, and easy-to-integrate prototype suitable for real automobiles.

5.To alert the driver through audio/visual warnings when abnormal readings are detected.

1.3 Limitations of the Study

Existing alcohol detection systems have several key limitations, including their intrusive nature, as many require active driver participation like blowing into a breath analyzer, making them inconvenient and easy to bypass. Systems that rely on a single type of sensor, especially low-cost chemical sensors, are often unreliable because they can be affected by environmental substances, leading to false positives or false negatives.

Additionally, passive alcohol detection inside a vehicle cabin is challenging due to factors such as dilution of the driver's breath in cabin air, varying airflow patterns, and the need for precise sensor placement to accurately capture only the driver's exhalation rather than general air or passenger influence. Moreover, many existing systems lack proper regulatory validation and rigorous testing, as safety authorities require strong evidence of reliability, and insufficient documentation and real-world evaluation limit their adoption and effectiveness.

1.4 Rationale of the Study

As engineering students, we felt the need to contribute to society by designing a solution that uses IoT and sensor technologies to prevent such incidents. The motivation also comes from: The desire to reduce road accidents. The need for a contactless and automatic alcohol detection system. The importance of continuous driver monitoring. The growing use of IoT in real-time safety applications. This project helps us explore embedded systems, electronics, artificial intelligence, and sensor integration, making it both socially beneficial and technologically meaningful.

2. LITERATURE REVIEW

Passive, in-vehicle detection of driver alcohol impairment is an active research and development area because it promises non-intrusive, continuous safety monitoring that does not depend on driver cooperation. Major industry–government programs such as the Driver Alcohol Detection System for Safety (DADSS) have set the goal of reliably measuring alcohol in the cabin air (or via touch) to warn or prevent impaired driving while also distinguishing the driver from other occupants.

These efforts highlight both the promise and the technical difficulty of accurate passive detection in real vehicles.

1. Active Breathalyzers & Ignition Interlocks

Traditional breathalyzers and legally mandated ignition interlocks require the driver (or someone) to blow into a mouthpiece. They are effective in controlled enforcement contexts but are intrusive, interrupt driving workflow, and can be bypassed. (well documented in enforcement literature and consumer products).

2. Passive In-Vehicle Breath Detection (Research & Programs) :

Research prototypes and programs (notably DADSS) demonstrate that passive cabin detection is feasible but technically challenging: measuring diluted breath, handling cabin airflow, and sensor placement are critical for accuracy. Field studies and progress reports emphasize repeatability and environmental robustness as key hurdles.

3. Hobbyist / Prototype Sensors (MQ-series, e-nose)

Low-cost MOS sensors such as MQ-3 are widely used in Arduino projects and tutorials for ethanol detection. They are useful for prototyping but have known limitations (cross-sensitivity to other VOCs, temperature/humidity dependence, calibration drift) that limit their suitability for safety-critical automotive use without additional processing and fusion.

Gap Identified in the existing systems include Lack of affordable, portable, and real-time systems suitable for Indian conditions. And the need for integrated safety mechanisms like engine lock, alert notifications, and GPS tracking.

3. RESEARCH METHODOLOGY

A well-structured research methodology ensures the development of a reliable and efficient alcohol detection system that performs multiple tasks, including alcohol detection, Ignition locking, activating buzzer, locating vehicle through GPS location and performing emergency call.

3.1 Research Design

The applied research focuses on designing a project that introduces a smart IoT-based system designed to ensure vehicle safety by evaluating the driver's condition before allowing the engine to start. This system integrates sensors, camera modules, and communication devices to offer a complete safety solution.

3.2 System Modules

1.Driver Presence Detection Module (IR Sensor): This module uses an IR sensor to detect when the driver is seated in the driver's seat. It activates the monitoring system only when the correct person (driver) is present. This avoids false detection from passengers and ensures the system runs only when needed.

2.Alcohol Detection Module (MQ-3 Sensor): The MQ-3 sensor detects alcohol vapors near the driver's face. It continuously measures the alcohol level and sends analog values to Arduino. If the value crosses a set limit, the system marks the driver as unsafe to drive.

3.Decision-Making Module (Arduino Controller): The Arduino receives inputs from all sensors (IR, MQ-3). It compares readings with threshold values and decides whether the condition is safe. If the driver is drunk or drowsy, Arduino triggers safety actions.

4.Ignition Control Module (Relay): This module simulates the vehicle's ignition system. Based on the Arduino's decision, the relay turns ON (safe) or OFF (unsafe). This prevents the vehicle from starting when dangerous conditions are detected.

5.Alerting Module (Buzzer + GSM): The buzzer provides an immediate sound alert to warn the driver. The GSM module sends an SMS notification to a registered family member informing them about the unsafe condition (alcohol or drowsiness).

6.Power & Integration Module: This module includes the power supply and wiring connections that support all components.

It ensures smooth communication between sensors, Arduino and GSM module.

3.3 Tools and Technologies Used

The tools and technologies employed include:

3.3.1Hardware Requirements

Arduino Uno: Main controller for MQ-3, IR, GSM, relay, and buzzer.

MQ-3 Alcohol Sensor: Detects alcohol vapors around driver's face.

IR Sensor: Detects driver presence in the seat.

Relay Module (5V): Controls ignition mechanism (ON/OFF). 5.GSM Module (SIM800L / SIM900A): Sends emergency SMS.

6.Buzzer: Local alert indication.

7.Jumper Wires, Breadboard, Power Supply: Necessary for circuit integration.

3.3.2 Software Requirements

1.Arduino IDE: Coding and uploading firmware for Arduino and ESP32-CAM.

2.GSM Libraries: Enables SMS functions through AT commands

3.Serial Monitor Tools: For debugging and sensor output visualization.

3.4 Data Flow and Architecture

Input Layer: This layer continuously monitors driver physical condition [MQ3 sensor].

Processing Layer: Arduino / Atmega328p is the central processing unit it receives input from sensors and proceeds data to ensure threshold and controls output layer.

Output Layer: This layer executes actions when unsafe driver conditions are detected

Emergency contact Layer: This represents the recipient of SMS or call alerts. the purpose of this layer is to ensure timely communication of dangerous driver behavior to trusted individuals.

Communication Layer: The system uses multiple communication methods:

Analog Input (A0, A1) → For sensor readings

Digital Output → For controlling buzzer and relay

UART/Serial → For communication with GSM module

Emergency Alert (SMS/Call) → For notifying emergency contacts.

3.5 Working flow

Sensors continuously monitor the driver's alcohol level and drowsiness.

Analog signals are sent to MCU ADC pins A0 (MQ3).

MCU compares each reading with predefined safety thresholds.

If values exceed limits:

Buzzer activates

GSM module prepares to send alert

GSM module sends SMS/call to the registered emergency contact.

Serial monitor logs all events for debugging and system validation.

Technical Feasibility

1.All components used are easily available.

2.Arduino can handle required processing.

3.Alcohol detection algorithms are lightweight.

Hence, the project is technically feasible

3.7 Economic Feasibility

1.Low-cost sensors (MQ-3, IR, relay).

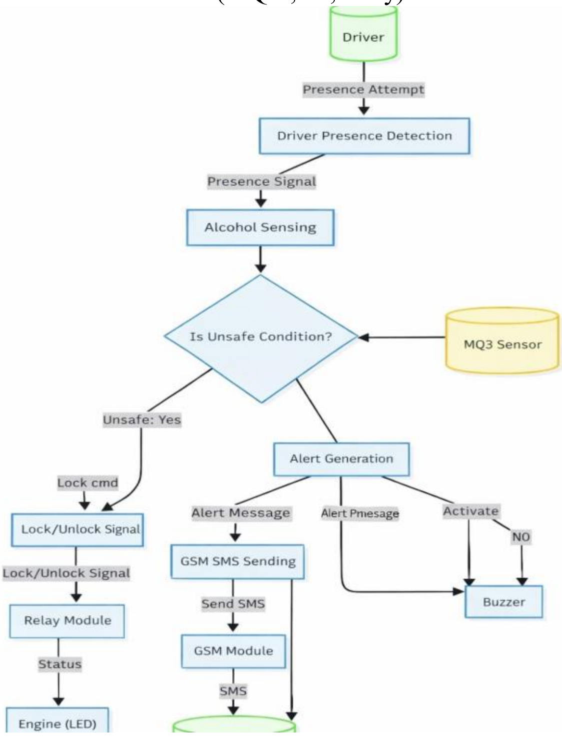

Fig 1. SYSTEM ARCHITECTURE

2.Affordable for students, companies, and vehicle owners.

3.Does not require high-end hardware.

4. DATA FLOW DIAGRAM

4.1 The Data Flow Diagram (DFD) illustrates how data moves through the Contactless Alcohol and Drowsiness Detection System, starting from the driver's presence to the final alert and engine control actions. It shows the major processes, data inputs, outputs, and interactions between sensors and system components.

1. Driver Interaction

The system begins when the Driver attempts to start or use the vehicle.

This triggers a Presence Attempt signal.

2. Driver Presence Detection

The presence attempt is processed by the Driver Presence Detection module, which confirms that a driver is seated and active.

Output: Presence Signal

This presence signal is sent to:

Alcohol Sensing module.

3. Alcohol Sensing Process

The Alcohol Sensing module receives:

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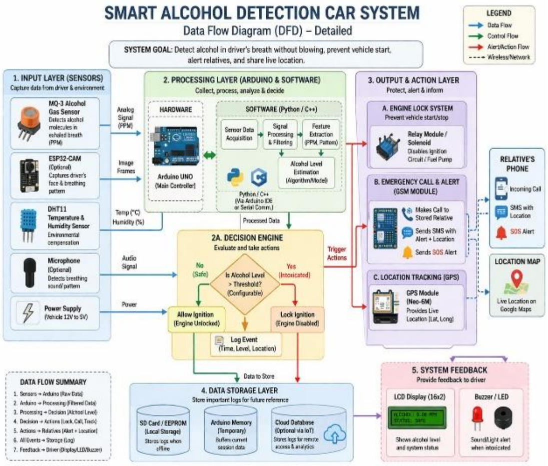
Presence signal
Analog put from the MQ3 Alcohol Sensor Steps involved:
The MQ3 sensor provides Alcohol Data (Analog Read).
This data is processed into an Alcohol Level.
The Alcohol Level is sent to the Unsafe Condition Check module.
4. Drowsiness Sensing Process
The Drowsiness Sensing module receives:
Presence signal
Analog input from the Drowsy Sensor (Eye/IR) Steps involved:
The Eye/IR sensor sends Drowsy Data (Analog Read).
The system converts this data into a Drowsy Level.
The Drowsy Level is forwarded to the Unsafe Condition Check module.
5. Unsafe Condition Decision Process
The system evaluates the following inputs:
Alcohol Level
The Unsafe Condition Check determines:
If Unsafe = NO
A Lock Command is generated.
The system performs Engine Lock/Unlock, sending the signal to the Relay Module, which controls the Engine LED Status.
If Unsafe = YES
The system initiates Alert Generation, triggering three parallel actions:
GSM SMS Sending
Buzzer Activation
(Optionally continued): Engine control based on your extended diagram
6. Alert Generation
When an unsafe state is detected, the system generates alert data for communication and warning.
a. GSM SMS Sending
An Alert Message is sent to the GSM Module.
The GSM module transmits an SMS to the Family Member, informing them of alcohol detection or drowsiness. b. Buzzer Activation
The alert process sends an Activate signal to the Buzzer to warn the driver immediately.
7. Engine Lock/Unlock (Safe Case)
If no hazardous condition is detected:
A Lock/Unlock Command is sent to the Engine Control module.
The Relay Module handles the electrical switching.
The engine status (LED) shows whether the vehicle is allowed to operate.

5.Conclusion

5.1 Key Findings

The project successfully shows that a contactless alcohol detection system can be implemented using simple sensors and microcontrollers to monitor driver fitness in real time. The integration of multiple modules—such as alcohol sensing, ignition control, and GSM alerting—provides a layered safety mechanism. The results confirm that



the system can effectively prevent vehicle ignition under unsafe conditions and alert concerned individuals, thereby demonstrating its potential as a

Fig 2. DATA FLOW DIAGRAM

practical and scalable road safety solution.

5.2 Implications of the Study

This study demonstrates that low-cost embedded systems combined with IoT technologies can significantly improve road safety by preventing impaired driving. The proposed solution highlights the feasibility of integrating alcohol detection, driver monitoring, and automated safety responses into a single system. It suggests that even affordable, small-scale implementations can contribute to reducing accidents and enhancing vehicle intelligence. The research also opens pathways for future advancements in smart transportation systems, especially in developing regions where cost-effective safety solutions are highly needed.

5.3 Limitations

Sensor Accuracy and Reliability
The MQ-3 alcohol sensor is sensitive to environmental factors such as temperature, humidity, and other gases, which may lead to false positives or inaccurate readings.
Driver vs Passenger Differentiation
The system may sometimes detect alcohol from nearby passengers instead of the driver, affecting decision accuracy.
Prototype-Level Implementation
The system is developed as a prototype and lacks automotive-grade hardware, durability, and regulatory certification required for real-world deployment.
Limited Drowsiness Detection Capability
Basic detection methods may not accurately

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identify all forms of fatigue or microsleep compared to advanced AI-based driver monitoring systems.
Dependence on Network for Alerts GSM-based alerting relies on network availability; in low-signal areas, emergency messages may be delayed or not delivered.

5.4 Future Work

Several directions have been identified to enhance the alcohol detection system:

1.AI-Driven Driver Monitoring: Machine learning algorithms for recognizing advanced drowsiness cues such as yawning frequency, head tilt, and facial fatigue patterns. Dynamic threshold adjustment using environmental and behavioural data.

2.Camera-Based Intelligence: Adding a camera module for visual detection of eye closure, distraction, and driver inattention.
Computer vision-based monitoring of abnormal driver movements.

3.GPS-Enabled Safety Response: Automatic transmission of vehicle GPS coordinates with emergency SMS. Integration with emergency services (police/ambulance) for critical situations.

5.5 Conclusion

The Smart Alcohol Sensing and Emergency Alert System for Vehicles provides an effective, low-cost, and automated solution to address the increasing number of road accidents caused by drunk and drowsy driving. By integrating contactless alcohol sensing, drowsiness monitoring, ignition control, and GSM-based emergency alerts into a unified setup, the system ensures comprehensive driver safety monitoring throughout the journey.

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