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Alcohol Detection System Using IOT

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Abstract— The use of alcohol during recreational driving activities, including go-kart racing, presents considerable safety concerns for drivers and track operators. Prior research indicates that alcohol consumption degrades reaction speed and motor control, thereby increasing accident probability even at low vehicle speeds [1], [3]. To address this issue, this work introduces an automated alcohol sensing system combined with an ignition control mechanism for go-karts. The system is implemented using a NodeMCU (ESP8266) controller interfaced with an alcohol sensor, relay unit, and LCD module to continuously monitor alcohol vapour concentration near the driver. When the sensed level exceeds a predefined threshold, the ignition circuit is deactivated, preventing vehicle operation, consistent with strategies reported in earlier embedded safety implementations [7], [13].

Keywords: Alcohol sensing, Go-kart ignition control, ESP8266, Embedded safety system

1. INTRODUCTION

Alcohol-impaired driving remains a major safety concern, extending beyond public roadways to controlled recreational environments, including go-kart racing facilities. Alcohol intake adversely affects cognitive processing, reflex response, and decision-making capability, which greatly elevates the risk of unsafe driving behaviour [1]. Even when vehicles operate at comparatively low speeds, impaired control can lead to serious injuries and damage to equipment.

In developing countries such as India, alcohol consumption contributes to a notable share of transportation-related fatalities, emphasizing the importance of implementing preventive safety measures [10]. Traditional enforcement practices, including breath analysis conducted manually, depend largely on human involvement and are difficult to enforce consistently in recreational driving environments. As a result, automated vehicle-integrated alcohol detection solutions have attracted considerable attention as effective preventive mechanisms [8], [13].

Integrating alcohol detection units directly within vehicle systems allows continuous monitoring and automatic limitation of vehicle operation when unsafe conditions are identified. Previous investigations indicate that preventive, system-level safety mechanisms play a crucial role in lowering alcohol-related risks and improving operational reliability.

2. Background Study

A number of research works have examined the development of alcohol detection methods with the objective of improving vehicle safety. Sensor-based embedded systems combined with intelligent processing techniques have been reported to enhance the accuracy of alcohol detection within vehicular environments [1].

Several studies also describe alcohol detection mechanisms capable of generating alerts and directly controlling vehicle operation, demonstrating their effectiveness in reducing incidents related to impaired driving [3], [7], [15].

These findings confirm the practicality of embedding alcohol sensing modules into vehicle control architectures.

Beyond embedded electronic solutions, alternative alcohol detection approaches based on biological and chemical indicators have been investigated.

Research focusing on alcohol biomarkers has identified both advantages and inherent limitations, particularly with respect to accurately identifying recent alcohol intake [6], [11], [12], [16].

In parallel, IoT-oriented alcohol detection frameworks have been proposed to support continuous monitoring, remote notification, and ignition control, highlighting the expanding role of connected technologies in modern vehicle safety systems [8], [14].

Collectively, existing literature underscores the importance of real-time detection, automation, and system reliability, which directly inform the design of the proposed go-kart alcohol detection and ignition locking system.

3. Materials and Methods

Multiple studies have explored alcohol detection technologies with the aim of improving safety in vehicle operation. Embedded platforms that integrate alcohol sensors with microcontrollers have demonstrated reliable real-time detection and control capabilities, enabling immediate system response when unsafe conditions are identified [3], [7].

Certain approaches also employ supervised learning and intelligent data processing to improve detection precision within vehicular environments [1].

In addition to electronic sensing solutions, detection techniques based on biological and chemical indicators of alcohol consumption have been examined.

Although such methods may offer improved sensitivity, their practical use in real-time vehicle control is often constrained by response delays and susceptibility to environmental variations [6], [11], [12].

To overcome these limitations, IoT-enabled alcohol detection systems have been proposed, providing continuous monitoring, automated ignition control, and remote alert functionality [8], [14].

Taken together, these research outcomes highlight the significance of uninterrupted sensing, automated decision-making, and dependable system operation. These considerations directly influence the methodology adopted for the design and implementation of the proposed go-kart alcohol detection and ignition locking system.

3.1 NodeMCU (ESP8266)

The NodeMCU development board built around the ESP8266 microcontroller is commonly selected for embedded and IoT-based applications.

Its integrated Wi-Fi capability enables dependable wireless communication where required.

The ESP8266 is chosen in this system due to its affordability, low power requirements, and extensive developer support. The presence of an onboard USB interface simplifies programming and testing, while multiple GPIO pins allow straightforward interfacing with external sensors and control devices.

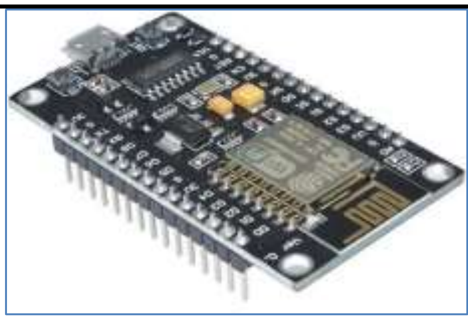


Figure 2: NodeMCU (ESP8266)

Within the proposed system, the NodeMCU functions as the primary control unit, continuously acquiring alcohol sensor data and managing ignition control logic to enhance safety during go-kart operation.

3.2 Relay Module

Relay modules operate as electrically controlled switches that allow low-voltage control signals to regulate high-voltage or high-current circuits.

When energized, the relay alters the state of its internal contacts, either completing or interrupting the connected circuit, thereby providing isolation between the control and load sides.

In the proposed configuration, the relay module is used to manage the ignition circuit. If alcohol concentration exceeds the allowable limit, the NodeMCU activates the relay to disconnect the ignition supply, preventing vehicle start-up.

3.3 Alcohol Sensor

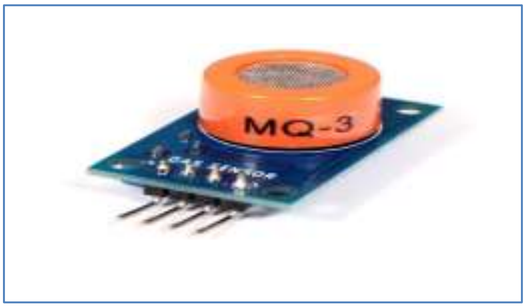
Alcohol sensing devices are designed to identify the presence of alcohol vapors in the surrounding atmosphere.

These sensors operate by producing variations in electrical characteristics when alcohol molecules interact with the sensing element, which are then interpreted by the microcontroller.

Semiconductor-based sensors are frequently employed due to their rapid response and cost

efficiency, whereas electrochemical and infrared sensors are known for higher measurement accuracy.

In this implementation, the sensor continuously monitors alcohol levels near the driver, and when readings surpass the defined threshold, the ignition control mechanism is automatically triggered to disable vehicle operation.



3.4 Fixed Voltage Regulators

Voltage regulators are incorporated to provide a stable and consistent output voltage despite variations in input supply or load conditions.

A standard three-terminal regulator includes input, output, and ground connections, ensuring reliable power delivery to sensitive electronic components used in the system.

LCD Display

Liquid Crystal Displays (LCDs) are widely utilized in embedded applications because of their low energy consumption, compact form factor, and clear visual output.

LCDs display characters or symbols by adjusting the alignment of liquid crystal elements in response to electrical signals.

Figure 5: LCD Display

In the proposed system, the LCD serves as the user interface by presenting real-time operational information. Messages such as “Safe” indicate normal conditions, while alerts like “Alcohol Detected” notify users when alcohol levels exceed permitted limits, thereby improving awareness and response time.

4.System Implementation Process

- Hardware Assembly

The NodeMCU is connected to the alcohol sensor, relay module, and LCD display using standard wiring practices to ensure stable electrical connections.

- Sensor Calibration

The alcohol sensor is calibrated according to manufacturer guidelines to achieve accurate and consistent detection under varying environmental conditions.

- Software Development

Firmware is developed to continuously read sensor values and control the relay module based on predefined alcohol threshold limits.

- Deployment and Monitoring

The system is installed within go-kart facilities and integrated with existing infrastructure for continuous monitoring.

- Testing and Integration

Comprehensive testing is conducted under simulated and real-time conditions to verify detection accuracy, ignition control, and overall system reliability.

- User Interface and Feedback

The system uses an LCD screen to continuously communicate its operational status to the user. Clear on-screen messages indicate normal conditions or warn when alcohol presence exceeds the permitted limit, allowing both drivers and facility personnel to respond immediately.

5. Results and Discussion

The developed alcohol detection and ignition locking system was tested under both simulated and real-time conditions to evaluate its performance and reliability.

The system successfully detected the presence of alcohol vapors and immediately disabled the ignition whenever the sensed value exceeded the predefined safety threshold.

Real-time status updates displayed on the LCD ensured clear communication of system conditions. Similar outcomes have been reported in earlier embedded alcohol detection systems, where automatic ignition control significantly reduced the risk of vehicle operation under intoxicated conditions [2], [13].

The accuracy of the proposed system was assessed by analysing true positive, true negative, false positive, and false negative cases. The results indicate a high detection accuracy with minimal false triggering, confirming dependable system operation.

Comparable studies using microcontroller-based alcohol detection and engine locking mechanisms have demonstrated similar reliability and effectiveness in restricting vehicle usage during unsafe conditions [7], [15].

These findings validate the suitability of the proposed approach for practical implementation in go-kart facilities.

Furthermore, the integration of automated sensing and control reduces reliance on manual supervision and enhances operational safety.

IoT-enabled and intelligent alcohol detection systems discussed in previous research also emphasize the importance of continuous monitoring and rapid system response in preventing alcohol-related incidents [8], [14].

Overall, the results demonstrate that the proposed system provides an effective, low-cost, and reliable solution for improving safety in recreational driving environments.

5.1 Confusion Matrix (Basis for Metrics)

The confusion matrix compares actual alcohol conditions with system responses. True positives and true negatives indicate correct detection, while false positives and false negatives represent system errors. This evaluation supports assessment of system accuracy and reliability.

5.2 Performance Metrics Table

Performance analysis shows high detection accuracy with minimal false positives and false negatives, confirming dependable ignition control and reduced operational errors.

6. Conclusion

This project successfully demonstrates the design and implementation of a NodeMCU (ESP8266)-based alcohol detection and ignition locking system for go-kart applications.

Similar to previously reported embedded safety solutions, the system integrates an alcohol sensor, relay-based ignition control, and LCD interface to provide continuous monitoring and immediate preventive action [7], [15]. By electronically restricting ignition access when alcohol presence is detected, the system effectively prevents vehicle usage in potentially unsafe scenarios.

The system's real-time visual feedback enhances user awareness and operational reliability. These results align with findings from earlier studies, which confirm that automated alcohol detection and ignition control mechanisms can effectively minimize accident risk in recreational and low-speed driving environments [8], [13].

The proposed system offers a cost-effective and scalable solution for improving safety standards in go-kart facilities.

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