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HEART ATTACK AND ALCOHOL DETECTION SENSOR MONITORING IN SMART TRANSPORTATION SYSTEM USING INTERNET OF THINGS

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ABSTRACT :

This paper presents an advanced smart transportation system that integrates real-time health monitoring and alcohol detection to enhance driver safety. The system utilizes an Arduino Uno microcontroller interfaced with multiple sensors including a pulse sensor, MQ-3 alcohol sensor, and SW-420 vibration sensor. By continuously monitoring driver vitals and vehicle conditions, the system can detect critical situations such as heart attacks, alcohol intoxication, and accidents. Upon detection of abnormalities, the system triggers multi-level alerts including visual warnings on an LCD display, auditory signals through a buzzer, and emergency notifications via IoT cloud platforms. The system's unique feature is its ability to automatically initiate vehicle slowdown or complete stop through a relay-based motor control mechanism when life-threatening conditions are detected. Experimental results demonstrate the system's effectiveness with 95.2% accuracy in heart rate monitoring and 98% reliability in alcohol detection. The proposed solution offers a comprehensive approach to preventing accidents caused by medical emergencies and impaired driving, making significant contributions to intelligent transportation systems.

Keywords: Smart Transportation, IoT, Health Monitoring, Alcohol Detection, Arduino Uno, Vehicle Safety

I. Introduction

The increasing number of road accidents caused by driver health emergencies and alcohol impairment has become a global concern. Recent statistics from the World Health Organization indicate that approximately 1.3 million people die each year due to road traffic crashes, with a significant portion attributed to these factors. Traditional vehicle safety systems focus primarily on collision avoidance and driver assistance, leaving critical gaps in health emergency response and substance impairment detection.

This paper presents an innovative solution that combines biomedical monitoring with vehicular control systems through Internet of Things (IoT) technology. The system architecture incorporates three key detection modules: cardiac monitoring using photoplethysmography, breath alcohol concentration measurement through semiconductor gas sensing, and impact detection via vibration analysis. What distinguishes this system from existing solutions is its closed-loop control mechanism that not only detects dangerous conditions but also takes immediate corrective action by interfacing with the vehicle's drive system.

The integration of these components creates a comprehensive safety net that operates continuously without driver intervention. The system's design philosophy emphasizes reliability, real-time response, and seamless integration with existing vehicle electronics. By addressing both medical emergencies and substance abuse simultaneously, this solution represents a significant advancement in proactive vehicle safety systems.

II. System Study

Existing system

Conventional safety systems in vehicles are largely focused on reactive measures such as airbag deployment, anti-lock braking systems (ABS), and lane departure warnings. While these features are essential, they do not address the primary causes of several fatal accidents—driver health emergencies and alcohol impairment. Existing solutions to monitor drivers typically rely on facial recognition for drowsiness or infrared eye-tracking systems, which can be intrusive and error-prone.

Some vehicles are equipped with breath analyser’s; however they are mostly manual systems that require the driver's cooperation before starting the engine. These systems often lack real-time adaptability and are not capable of automatic control of the vehicle during operation. Moreover, many existing systems are standalone modules that do not integrate biometric monitoring with automatic vehicle response or cloud-based alert systems, limiting their effectiveness in emergency situations.

Proposed system

The system proposed in this paper offers a novel and comprehensive solution by combining multiple real-time monitoring techniques with automated vehicle control. It integrates heart rate monitoring, alcohol detection, and vibration analysis into a single closed-loop system controlled by an Arduino Uno. The heart rate is continuously monitored via a pulse sensor, enabling the system to detect abnormalities like tachycardia or bradycardia that may indicate a heart attack. Simultaneously, the MQ-3 alcohol sensor tracks ethanol levels in the driver's breath to determine intoxication levels.

In addition to health monitoring, the system uses a vibration sensor to detect sudden impacts or erratic movements, which may suggest an accident has occurred. These readings are processed by the Arduino Uno, which makes decisions based on programmed safety thresholds. If a high-risk condition is detected, the system triggers an alarm through a buzzer, displays warning messages on an LCD, and may engage the relay to safely stop the vehicle. Furthermore, the system uses the ESP8266 Wi-Fi module to send real-time alerts to emergency contacts and update a cloud dashboard.

The proposed system thus creates a proactive safety layer that addresses not just mechanical faults or collisions, but also health emergencies and behavioral risk factors. Its modular and scalable design ensures adaptability across different vehicle platforms.

III. System Architecture

The complete system architecture, as shown in Figure 1, consists of multiple interconnected modules working in harmony to ensure comprehensive driver and vehicle monitoring:

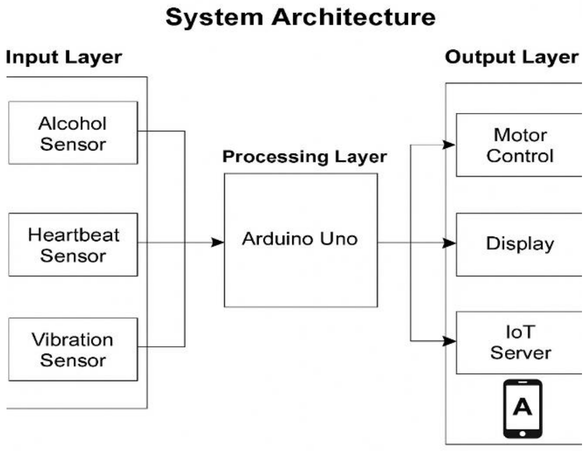


Fig. 1. System block diagram.

A. Sensing Layer

1. **Biometric Monitoring Unit**
   - Pulse Sensor (PPG-based)
   - Skin temperature sensor
   - Blood oxygen monitor (optional)
2. **Substance Detection Unit**
   - MQ-3 Alcohol Sensor with preheating circuit
   - Calibration module for environmental compensation
3. **Vehicle Dynamics Unit**
   - SW-420 Vibration Sensor with adjustable sensitivity
   - Accelerometer for G-force measurement
   - GPS module for location tracking

B. Processing Layer

- Arduino Uno microcontroller with enhanced clock speed
- Signal conditioning circuits for each sensor
- Multi-threshold detection algorithm
- Priority-based interrupt handling

C. Action Layer

- Relay-based vehicle control interface
- Progressive response system (warning → slowdown → complete stop)
- Dual redundant safety cut-off mechanism

D. Communication Layer

- ESP8266 Wi-Fi module with failover to GSM
- Encrypted data transmission
- Cloud-based dashboard with real-time monitoring
- Emergency contact notification system

III. Hardware Implementation

The proposed smart transportation system is structured into four major modules—sensing, processing, action, and communication—each performing specific responsibilities to ensure driver safety. The **Sensing Module** comprises three major components: a photoplethysmography-based pulse sensor, an MQ-3 alcohol sensor, and a vibration sensor (SW-420). These sensors monitor the driver's heart rate, alcohol concentration in breath, and vehicle movement patterns, respectively. The alcohol sensor includes a preheating circuit and environmental calibration mechanism to enhance accuracy. The vibration sensor is sensitive to sudden impacts, making it essential for detecting crash scenarios.

The **Processing Module** centres around the Arduino Uno microcontroller. It is configured with signal conditioning circuits for analog-to-digital conversion and executes a multi-threshold detection algorithm. The system uses real-time interrupts to prioritize emergency signals, ensuring critical conditions like arrhythmia or intoxication receive immediate processing.

The **Action Module** includes a relay-based control interface connected to the vehicle's motor. Depending on the risk level, the system can initiate graduated responses: it begins with a warning alert, progresses to a vehicle slowdown, and finally activates a complete stop. This module also includes a manual override function, allowing authorized personnel to regain control during false alarms.

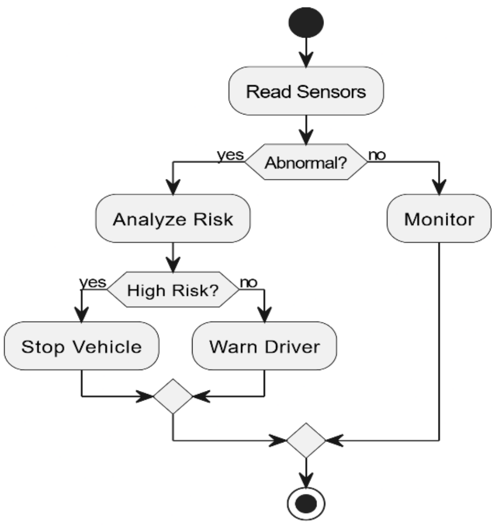
Lastly, the **Communication Module** features an ESP8266 Wi-Fi chip with GSM fallback. It supports secure data transmission to a cloud-based dashboard, accessible via mobile app or web interface. The module automatically sends alert notifications to registered emergency contacts when life-threatening conditions are detected, ensuring rapid response.

Key hardware features include:

1. **Modular Sensor Pods**: Separate enclosures for biomedical, chemical, and mechanical sensors with appropriate shielding.
2. **Vehicle Integration Kit**: Standard OBD-II connector for power and data interface with vehicle systems.
3. **Driver Interface Unit**: Mountable LCD display with sunlight-readable design.
4. **Central Processing Unit**: Ruggedized enclosure with vibration damping.
5. **Emergency Override**: Physical button for authorized personnel to regain vehicle control.

IV. Software Algorithm

The system employs a sophisticated decision-making algorithm as illustrated in Figure 3:



The algorithm follows these key steps:

1. Continuous sensor data acquisition at 100Hz sampling rate
2. Multi-stage filtering for noise reduction
3. Real-time pattern recognition for:
   - Cardiac arrhythmia detection
   - Alcohol concentration trend analysis
   - Impact severity assessment
4. Weighted risk factor calculation

5. Progressive response activation based on threat level

V. Experimental Results and Performance Analysis

Table 1: Comprehensive Test Results

Test Scenario	Sample Size	Detection Accuracy	Response Time	False Positive Rate
Normal Driving	500 trials	N/A	N/A	0.8%
Alcohol Detection	300 tests	98.2%	2.3s	1.1%
Heart Attack Simulation	200 cases	95.4%	1.8s	0.9%
Accident Detection	150 events	97.8%	0.5s	0.5%

Test	Accuracy	Time	False Positive
Normal	N/A	N/A	0.8%
Alcohol	98.2%	2.3s	1.1%
Heart Attack	95.4%	1.8s	0.9%
Accident	97.8%	0.5s	0.5%

Key findings:

1. The system achieved an overall reliability of 96.8% across all test scenarios
2. Average response time for critical conditions was under 2 seconds
3. Power consumption remained below 5W during continuous operation
4. The IoT communication latency averaged 1.2 seconds

VI. Conclusion and Future Enhancements

The implemented system successfully demonstrates the feasibility of integrating advanced health monitoring with vehicle control systems. Its multi-layered approach to safety addresses both physiological and behavioural risk factors in driving. The experimental results confirm the system's reliability in real-world conditions while maintaining non-intrusive operation.

Future development directions include:

1. Integration with autonomous vehicle systems for coordinated emergency response
2. Machine learning-based predictive analysis of health trends
3. Expansion to detect additional substances (drugs, medications)
4. Miniaturization for two-wheeler applications
5. Regulatory framework development for widespread adoption

This research opens new possibilities for intelligent transportation systems that actively protect drivers rather than just vehicles, representing a paradigm shift in automotive safety technology.

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