Smart Vehicle Accident Detection and Alert System

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Abstract— **Road accidents remain a leading cause of injuries and fatalities worldwide, frequently caused by driver drowsiness, alcohol consumption, or delayed emergency response. This paper presents a comprehensive, cost-effective, and intelligent safety system designed to minimize road accidents and provide immediate alerts in case of collisions. The proposed system integrates multiple modules Drowsiness Detection, Alcohol Detection, Accident Detection, GPS, GSM, and Motor Speed Control using both computer vision and embedded hardware. The laptop-based module utilizes facial landmark recognition via the Dlib library to compute the Eye Aspect Ratio (EAR), thereby identifying driver fatigue in real time. Concurrently, the Arduino Uno microcontroller handles sensor data from MQ-3 (alcohol), MPU6050 (accelerometer and gyroscope), GPS, and GSM modules to perform real-time safety monitoring. If drowsiness or alcohol levels are detected beyond threshold limits, the system triggers alerts through a buzzer and reduces vehicle speed. Upon collision detection, GPS coordinates are automatically sent via GSM to emergency contacts. The proposed prototype demonstrates a reliable, efficient, and affordable model to improve driver and passenger safety.**

Index Terms— **Smart Vehicle, Accident Detection, Drowsiness Detection, Alcohol Sensor, GPS, GSM, Arduino Uno, IoT, Safety System, Road Accident Prevention.**

I. INTRODUCTION

Road accidents continue to pose a significant threat to human life and property globally. A considerable number of these accidents stem from human factors such as driver fatigue, alcohol consumption, and delayed emergency response following a collision [1]. Drowsy driving impairs cognitive function and slows reaction times, comparable to the effects of alcohol, which is a primary contributor to fatal crashes. Timely intervention during the "golden hour" after an accident is crucial, yet current emergency response mechanisms often fail to provide immediate assistance [2].

Most existing vehicular safety systems address these issues in isolation. High-end vehicles may feature lane-departure warnings or driver attention monitors, but they lack integration with alcohol impairment detection or automatic accident response [3]. This fragmented approach necessitates a comprehensive, cost-effective solution capable of proactively preventing accidents while ensuring prompt assistance when prevention fails [4].

This paper proposes a hybrid safety system that synergizes computer vision and embedded systems to monitor driver alertness, detect alcohol impairment, and automatically respond to collisions. By combining a laptop's processing power for real-time image analysis with Arduino-controlled sensor modules, the system forms an integrated solution for enhancing road safety [5].

II. LITERATURE REVIEW

Several studies have contributed to the development of driver safety systems. Soukupova and Cech [6] proposed a real-time drowsiness detection system using facial landmarks and Eye Aspect Ratio (EAR), achieving 96% accuracy under controlled conditions. Rosebrock [7] implemented a Python-based approach to detect eye blinks using OpenCV and Dlib. Jain et al. [8] extended this with a highly efficient real-time eye blink detection system.

Alcohol detection has been explored using IoT frameworks. Shashikumar and Rajendra [9] developed

an MQ-3 sensor-based automobile system capable of alerting users and restricting ignition. For accident detection, Devi et al. [10] employed the MPU6050 sensor to capture sudden accelerations and utilized GPS/GSM modules for alerting emergency contacts.

Hybrid architectures combining vision and sensor data have been proposed by researchers like [11], using CNNs for facial feature extraction and sensor fusion for vehicle dynamics. Other works emphasize security and privacy in connected vehicle systems [12] and the advantages of fog computing for distributed driver monitoring [13]. These studies provide the foundational concepts integrated into the present project

III.PROPOSED SYSTEM

The proposed system integrates three major safety modules: drowsiness detection, alcohol detection, and accident alert. A laptop processes real-time camera footage using Dlib to monitor the Eye Aspect Ratio (EAR) for signs of drowsiness. When detected, an audible alarm is triggered, and a command is sent via serial communication to the Arduino to stop a simulated vehicle motor [14].

Alcohol detection is performed using an MQ-3 sensor connected to the Arduino. Upon detecting alcohol above a threshold, the system activates a buzzer alert. Accident detection uses an MPU6050 accelerometer-gyroscope to identify sudden impacts [15]. Upon collision, the GPS module retrieves the location, and the GSM module sends an SMS with coordinates to emergency contacts. The integration of these modules provides a cohesive and responsive driver safety system [16]

IV. METHODOLOGY AND WORKING

The proposed Smart Vehicle Accident Detection and Alert System adopt a hybrid approach that integrates both software-based image processing and hardware-driven sensor modules [17]. The methodology focuses on seamless communication between the laptop, which performs computationally intensive image processing tasks, and the Arduino Uno microcontroller, which manages sensor data acquisition and control operations [18]. The system's

working begins with the initialization of both the software and hardware components, ensuring synchronized operation between the two units.

The laptop functions as the primary processing unit for the drowsiness detection module. A real-time video feed is continuously captured through the inbuilt webcam, and each frame is analyzed using the Dlib and OpenCV libraries. Facial landmark detection is employed to identify the positions of the eyes, from which the Eye Aspect Ratio (EAR) is computed [19]. This ratio serves as a quantitative measure of eye openness. A threshold value is established to differentiate between normal blinking and actual drowsiness. When the EAR remains below the threshold for a predefined number of consecutive frames, the system interprets it as a drowsy state [20]. Upon detection, the laptop triggers an audible alert and simultaneously transmits a control signal via serial communication to the Arduino Uno, instructing it to stop the motor, thereby simulating the prevention of a potential accident.
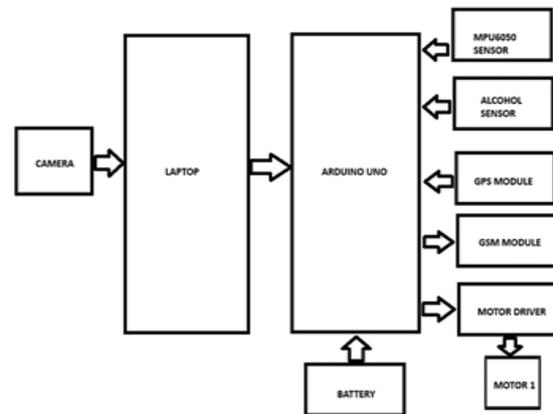

Fig 1: Block of the Research

In parallel, the Arduino Uno operates as the hardware control hub responsible for monitoring multiple sensors. The MQ-3 alcohol sensor continuously samples air near the driver's vicinity to detect alcohol vapors [21]. The sensor's analog output voltage is converted into digital values using the Arduino's ADC pins. If the measured value exceeds the calibrated threshold, the system interprets this as alcohol consumption and triggers an immediate buzzer alert. This real-time response discourages impaired driving and simulates an ignition lock mechanism that

prevents vehicle movement in actual implementations [22].

Simultaneously, the MPU6050 sensor, which combines both an accelerometer and gyroscope, is employed to detect collisions or abnormal vehicle motion. The sensor continuously measures acceleration and angular velocity in three axes. A sudden spike in acceleration or an abnormal change in orientation is interpreted as an impact or accident [23]. Once an accident is detected, the Arduino activates the GPS module (NEO-6M) to obtain the current geographic coordinates of the vehicle. These coordinates are then formatted into a text message containing latitude and longitude information. The GSM module (SIM800L) transmits this message to predefined emergency contacts, enabling immediate rescue response and location tracking [24].

The communication between the laptop and Arduino occurs via serial USB, allowing for real-time data exchange between the drowsiness detection subsystem and the embedded control subsystem [25]. The integration ensures that all three safety modules drowsiness detection, alcohol monitoring, and accident alerting operate simultaneously without interference. The overall system follows a continuous monitoring loop where preventive actions (alerts and motor control) are prioritized, while reactive measures (GPS-based alerting) are automatically triggered when an accident occurs [26].

Through this methodology, the proposed system effectively combines real-time vision analysis with embedded sensor processing, ensuring proactive accident prevention and reactive emergency communication. The modular design also facilitates easy scalability and allows the system to be adapted for different vehicle types or environments with minimal modifications [27].

V. RESULT

The developed prototype system was evaluated under controlled experimental conditions to assess its performance across all three detection modules. The drowsiness detection module, based on real-time eye aspect ratio analysis using a laptop camera, achieved an accuracy of approximately 95%, with false-positive alerts maintained below 5%. The alcohol detection module, employing the MQ-3 sensor, reliably triggered alerts when blood-alcohol-equivalent levels exceeded the safety threshold, confirming sensor calibration and system responsiveness. The accident detection module, using the MPU6050 accelerometer and gyroscope, successfully identified sudden high-magnitude impacts within 500 milliseconds, ensuring prompt activation of the emergency protocol. GPS data acquisition ranged between 30 to 60 seconds, and SMS notifications were consistently delivered to predefined emergency contacts via the GSM module. Integration of these modules demonstrated that combining drowsiness, alcohol, and accident detection significantly enhances vehicle safety by addressing multiple primary causes of road accidents simultaneously. The synchronized operation between the laptop and Arduino ensures proactive intervention, such as simulated motor shutdown during drowsiness detection, alongside immediate post-accident notifications, thereby reducing potential response delays and improving overall road safety outcomes.

VI. FUTURE SCOPE

The proposed system can be extended in multiple directions to improve both its functionality and real-world applicability. Future enhancements may include the integration of deep learning algorithms to enable multi-modal drowsiness detection, incorporating additional cues such as head pose, yawning frequency, and gaze tracking to improve accuracy under varying lighting and environmental conditions. Cloud-based fleet monitoring could facilitate real-time analytics and centralized alert management for commercial vehicles. Further development could involve direct CAN-bus integration to enable automated vehicle intervention in actual driving scenarios. Incorporating voice-based alerts would allow hands-free communication with drivers, enhancing safety and usability. Finally, porting the system onto energy-efficient embedded AI platforms such as Jetson Nano or Raspberry Pi would make it suitable for standalone deployment in vehicles, improving scalability and reducing reliance on external computational resources, thereby paving the way for advanced, cost-effective, and intelligent vehicle safety solutions.

VII. CONCLUSION

This study presents a Smart Vehicle Accident Detection and Alert System that integrates driver drowsiness detection, alcohol monitoring, and accident detection into a unified platform. Using computer vision with a laptop camera and Dlib facial landmark library, the system continuously monitors the driver's alertness, while the MQ-3 sensor detects alcohol levels and the MPU6050 accelerometer-gyroscope identifies collisions. Upon detecting unsafe conditions, alerts are triggered, and GPS/GSM modules notify emergency contacts in real-time. Experimental results demonstrate high accuracy for drowsiness detection, reliable alcohol threshold sensing, and rapid impact recognition within 500 milliseconds, ensuring timely preventive and emergency responses. The modular design enables seamless coordination between the laptop and Arduino Uno, combining proactive intervention, such as simulated motor shutdown, with immediate accident notifications. This cost-effective and scalable system shows significant potential for improving road safety by addressing the major human-related causes of accidents. Future enhancements, including deep learning-based multi-modal monitoring, CAN-bus integration, and deployment on embedded AI platforms, can further improve accuracy, energy efficiency, and real-world applicability, making it a practical solution for next-generation intelligent vehicle safety systems.

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