An AI-Driven Approach for Driver Drowsiness Detection and Emergency Accident Alert System

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ABSTARCT: This paper presents an AI-powered driver drowsiness detection and smart accident alert system designed to enhance road safety and reduce accidents caused by fatigue and alcohol consumption. The system employs an Arduino microcontroller as the central control unit, integrating MEMS sensors, an ultrasonic sensor, an MQ-3 alcohol sensor, and AI-based drowsiness detection modules for continuous real-time monitoring of driver behavior. Sensor data is analyzed using intelligent algorithms to detect signs of drowsiness, impaired driving, and potential collision risks. When abnormal conditions such as driver fatigue or alcohol presence are identified, the system immediately triggers alerts through a buzzer and displays warning messages on an LCD screen to ensure timely driver awareness. The ultrasonic sensor further supports obstacle detection and impact recognition, enabling additional safety measures during critical situations. A DC motor module is used to simulate vehicle operation for system testing and validation. The proposed system is cost-effective, reliable, and suitable for real-time implementation. By combining artificial intelligence with embedded systems and alcohol detection, it provides an efficient and practical solution for preventing accidents and improving overall road safety.

KEY WORDS: AI, Driver Drowsiness Detection, Accident Prevention, MEMS Sensor, Ultrasonic Sensor, Facial Recognition, Machine Learning, Real-Time Monitoring, IoT Alerts, Vehicle Safety

1. INTRODUCTION

Road accidents resulting from driver fatigue and reduced attention have become a serious challenge in modern transportation systems, leading to significant loss of life and property. To address this issue, this project proposes an advanced driver assistance system designed to enhance road safety through continuous real-time monitoring and intelligent alert mechanisms. The system focuses on preventing accidents by analysing driver behaviour and vehicle conditions before a critical situation occurs.The proposed system utilizes a camera along with multiple sensors to monitor key facial features of the driver, including eye blinking rate, eye closure duration, head movements, and yawning patterns. Computer vision and machine learning techniques are employed to process these parameters and accurately detect signs of drowsiness or fatigue. When abnormal behavior is identified, the system promptly activates alerts such as a buzzer or vibration to regain the driver's attention and reduce the risk of accidents.

In addition to drowsiness detection, the system integrates a smart accident alert mechanism using vibration sensors to identify collisions or sudden impacts. In the event of an accident, the system automatically transmits the vehicle's real-time location along with emergency notifications to predefined contacts or emergency services through IoT-based communication. This feature ensures rapid response and timely medical assistance, thereby improving survival rates and overall road safety.

This framework comprises of primary unit

- Vehicle Unit

The vehicle unit introduced in the vehicle senses the accident and sends the area of the accident to the principle server. The principle server finds the nearest rescue vehicle to the mishap spot furthermore the shortest way between the emergency vehicle, mischance spot and the closest healing facility. The server then sends this way to the emergency vehicle. Likewise utilizing this data the server controls all the knobs in the way of emergency vehicle and make it ON, which ensures that the rescue vehicle reaches the hospital without delay. The architecture system is indicated in the figure.1

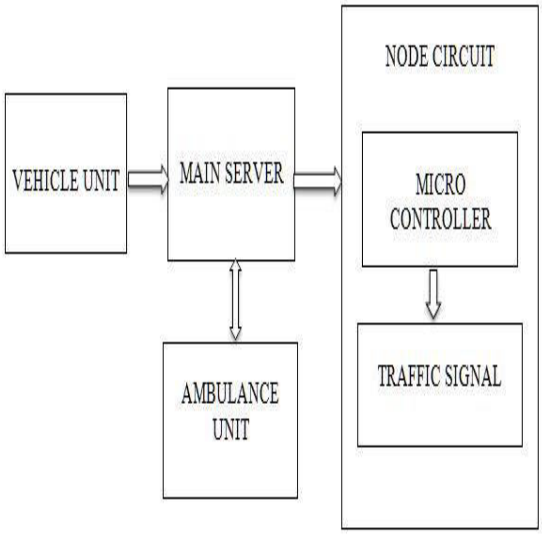

Fig 1. Vehicle Unit Architecture

The proposed system enables bi-directional interaction between the driver and the intelligent monitoring system, ensuring minimal interference during normal driving while providing strong intervention during unsafe conditions. By integrating real-time monitoring, machine learning, and AI-based communication, the system offers a reliable, cost-effective, and robust solution to enhance driver safety, prevent accidents, and enable rapid emergency response.

This project aims to reduce such risks by incorporating Artificial Intelligence (AI), Computer Vision, IoT technology, and real-time monitoring systems along with an MQ-3 sensor for alcohol detection. A camera is installed on the vehicle dashboard to continuously capture live video of the driver's face during driving. Using computer vision and machine learning algorithms, the captured frames are analyzed to detect key facial features such as eye position, eyelid movement, mouth opening (yawning), and head tilt. Parameters including eye closure duration (PERCLOS), blink frequency, yawning rate, and head nodding patterns are evaluated to determine the driver's alertness level. When signs of fatigue or drowsiness are detected, immediate alerts are triggered through a buzzer, vibration motor, or voice warning to regain the driver's attention and prevent potential accidents.

In addition to monitoring driver behavior, the system integrates an MQ-3 sensor to detect alcohol levels in the driver's breath, helping to prevent impaired driving. The system also supervises vehicle motion using accelerometer and vibration sensors to identify sudden impacts, abnormal movements, or collisions. Upon detecting an accident or unsafe condition, the alert bot module retrieves the vehicle's real-time location, and the IoT communication module automatically sends emergency notifications to predefined contacts or nearby emergency services. This ensures rapid medical assistance and significantly reduces response time during critical situations, thereby improving overall road safety.

2.LITERATURE SURVEY

1.Programmed Movement of Emergency vehicle to Accident Spot By Guddi Singh, Jyoti Singh. People in general or crisis administrations don't have the foggiest idea about the close-by area and the level of administrations. The absence of such data may cause a few causalities. Consequently, the exploration inquiry emerges in a manner to answer how to run the crisis vehicle to achieve the mishap spot in correct time. Thus, directing the vehicle and making movement sign control according to vehicle development is important. There is death toll because of the postponement in the entry of Emergency vehicle to the mischance place. To accomplish these obliged conditions we propose executing a System called Emergency Vehicles Monitoring System (EVMS) Emergency vehicle checking System can incorporate administrations. The GPS gadgets convey the information concerning the Emergency vehicle position and their briefest course. The primary server the Google guide permits to pick briefest course between crisis vehicle and mischance spot.

3. PROPOSED SYSTEM

The proposed AI-powered Driver Drowsiness Detection and Smart Accident Alert System is designed as an intelligent safety framework that continuously monitors driver alertness, vehicle conditions, and environmental factors to prevent accidents and ensure rapid emergency response. The system integrates multiple sensors with an Arduino microcontroller, which acts as the central processing unit. A regulated power supply provides stable operation to all components, enabling reliable real-time performance.The system uses a MEMS accelerometer and tilt sensor to detect accidents through sudden motion and orientation changes. In case of a collision, it sends the vehicle's location to a control center for quick emergency response. An ultrasonic sensor monitors nearby obstacles and provides warnings to prevent collisions.An AI-based camera module analyzes facial features such as eye closure, blinking, yawning, and head movement to detect driver fatigue. Additionally, an MQ-3 sensor identifies alcohol levels in the driver's breath, helping to prevent impaired driving and improve overall safety.

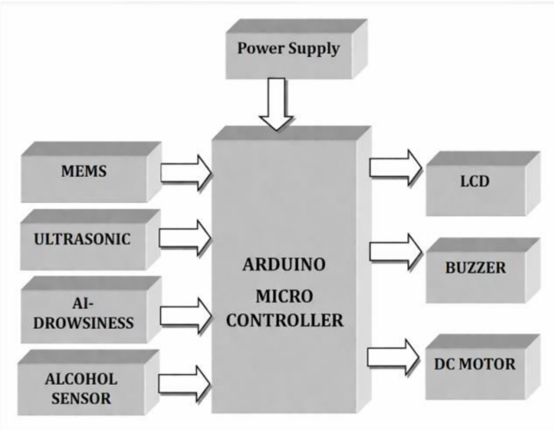

Fig 2: Proposed System

The system starts when the power supply activates the Arduino and connected modules. It continuously collects data from MEMS, ultrasonic, MQ-3 alcohol sensor, and an AI-based drowsiness detection module. The MEMS tracks head movement, the ultrasonic sensor monitors distance for posture changes, the MQ-3 detects alcohol, and the AI analyzes eye activity for fatigue.The Arduino processes this data in real time and compares it with set thresholds. Under normal conditions, monitoring continues, but if drowsiness or alcohol is detected, the system triggers alerts through an LCD and buzzer, and activates a DC motor to simulate safety actions like speed reduction, ensuring improved driver safety.

This cycle repeats continuously, ensuring real-time driver monitoring and accident prevention.

i) Video Acquisition Module:

This module captures the driver's face in real time using a dashboard-mounted camera. The video stream is converted into frames to monitor eye movement, blinking, and head position.

ii) Pre-Processing Module:

Captured frames are enhanced by resizing, gray scale conversion, and noise reduction. Techniques like normalization improve accuracy under different lighting conditions.

iii) Face Detection Module:

This module detects the driver's face and eyes using algorithms like Haar Cascade or HOG. It analyzes eye closure (PERCLOS) to identify drowsiness based on slow eyelid movement and blinking patterns.

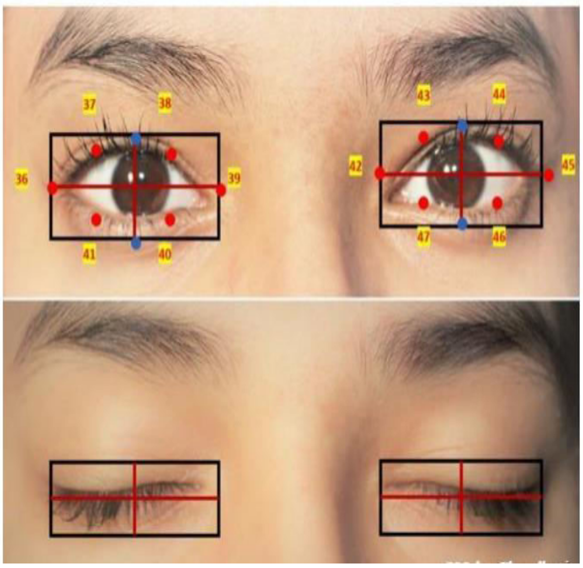

Fig 3: Difference between the eye marks when the eyes are open and the eyes are closed

iv.**Eye Detection and Feature Extraction Module:**After detecting the face, the system extracts the eye region and calculates features like Eye Aspect Ratio (EAR), blink duration, and frequency. These parameters help identify signs of fatigue such as prolonged eye closure or reduced blinking.

v.**Drowsiness Detection Module:**This module analyzes the extracted features using thresholds or machine learning models to determine drowsiness. If eye closure exceeds limits or EAR drops continuously, the system classifies the driver as drowsy.

vi.**Alert Generation Module (IoT Bot App):**When drowsiness is detected, alerts such as buzzer sounds, voice warnings, or vibrations are triggered. Additionally, notifications are sent through an IoT-based bot/mobile app to inform concerned persons and enhance safety.

4. RESULTS AND DISCUSSION

The AI-powered driver drowsiness detection system demonstrated accurate real-time monitoring using MEMS, ultrasonic sensors, and facial analysis. The multi-sensor approach improved detection reliability by identifying head movement, distance changes, and eye fatigue with reduced false alarms. Additionally, the alert system successfully sent emergency notifications, enhancing driver safety and enabling quick response in critical situations.

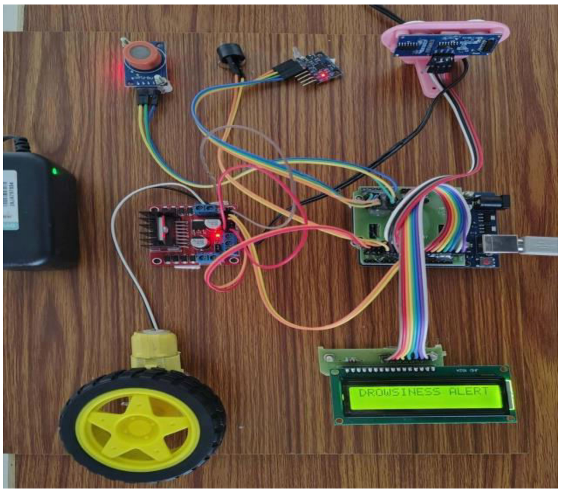

Fig 4: Hardware Implementation

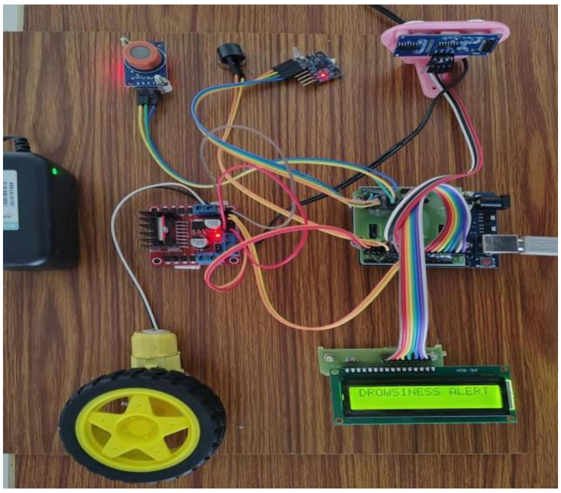

Fig 5: Obstacle Detection Using an Ultrasonic Sensor

The system uses a DC motor to simulate vehicle movement, while a MEMS/tilt sensor monitors orientation and motion. An ultrasonic sensor measures the distance between vehicles to maintain safe spacing and help prevent collisions.

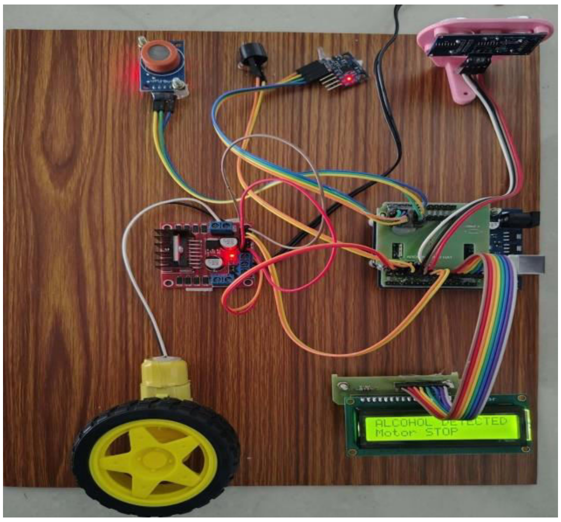

Fig 6: Alcohol Detection and Engine Lock Mechanism

The system incorporates an alcohol sensing unit that continuously evaluates the driver's breath for the presence of ethanol concentration. The sensed analog values are transmitted to the microcontroller, where they are compared against a predefined safety limit. If the detected level exceeds the permissible range, the controller immediately disables the motor functionality to restrict vehicle operation. Simultaneously, a warning message is shown on the display unit and an audible alert is generated. This mechanism plays a crucial role in minimizing risks associated with impaired driving.

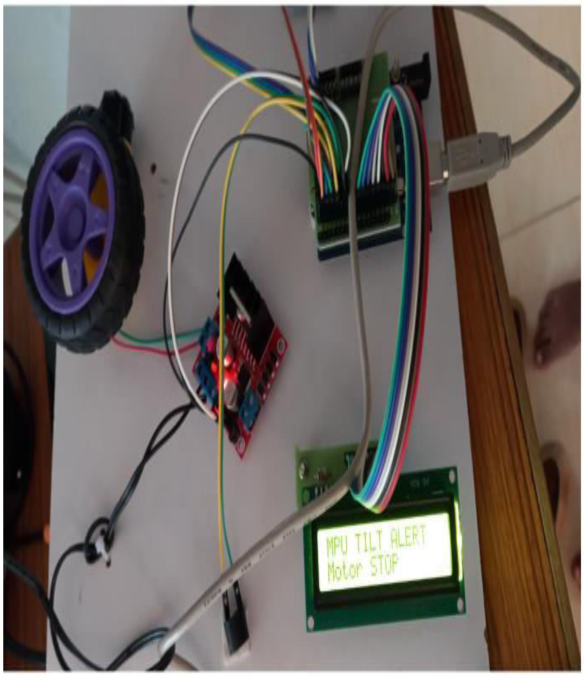

Fig 7: Vehicle Tilt Detection and Safety Control Using MPU Sensor

The MPU tilt sensor detects abnormal vehicle orientation and automatically stops the motor while displaying a warning message to prevent accidents.e

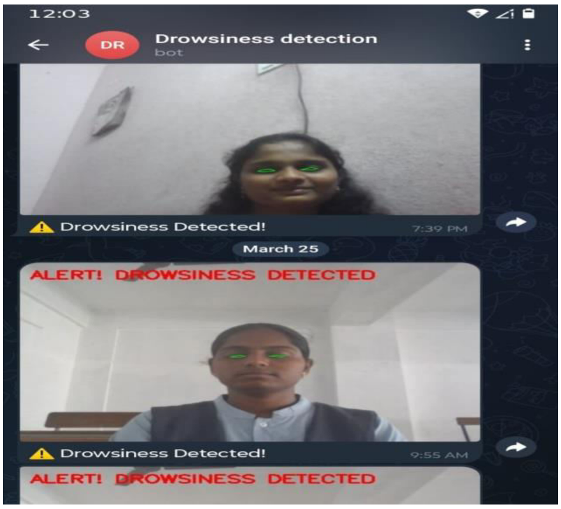

Fig 7: Facial-Based Drowsiness Detection SystemThe system uses a camera to monitor facial features and eye movements, detecting drowsiness and displaying a warning to alert the driver and prevent accidents

Fig 8: LCD Indication of Driver Drowsiness Detection

The LCD displays a "Drowsiness Alert" message when fatigue is detected, notifying the driver in real time.

5. CONCLUSION

The AI-powered driver drowsiness detection and smart accident alert system provides an effective solution for improving road safety by integrating AI-based facial analysis with MEMS, ultrasonic, and MQ-3 alcohol sensors. It enables real-time monitoring of driver behavior, detecting fatigue and alcohol consumption to prevent unsafe driving conditions. The system also identifies abnormal vehicle motion, collisions, and obstacle proximity, and immediately alerts the driver through visual and audio signals. It is cost-effective, accurate, and suitable for real-time implementation, offering a reliable approach to reducing accidents and enhancing modern transportation safety.

FUTURE SCOPE

The system can be further improved by integrating advanced deep learning models for higher detection accuracy and adaptive learning. It can also be connected with GPS and cloud-based IoT platforms for real-time tracking and emergency response. Additionally, incorporating features like lane detection and vehicle-to-vehicle communication can enhance overall safety and smart driving capabilities.

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