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Driver Fatigue Detection and Emergency Vehicle Stop System

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ABSTRACT:

Driver fatigue is a critical factor in road accidents, especially on highways and during long-haul drives. This project focuses on detecting signs of fatigue in drivers using non-intrusive real-time monitoring. The system captures facial and eye movement data using a camera, processes the information using image processing algorithms, and detects drowsiness based on eye closure duration and blink rate. Upon detection of fatigue, the system activates an emergency vehicle stopping mechanism and a wake-up alert through a buzzer or vibration motor. The prototype has been tested using a small-scale model, and the results indicate a strong potential for application in real-world vehicles.

I. INTRODUCTION:

Fatigue-related accidents are a major safety concern in the transportation sector. Research shows that drowsy drivers are as dangerous as drunk drivers due to impaired response time and poor decision-making. The aim of this project is to develop a safety mechanism that can monitor the driver's alertness and intervene automatically if fatigue is detected. This system can significantly reduce accidents by acting faster than human reflexes and providing both warnings and physical actions to stop the vehicle.

2. LITERATURE REVIEW

Several methods for driver fatigue detection have been explored in recent years. Techniques include:

Eye-tracking using infrared cameras

EEG signal monitoring (brain wave analysis)

Head nodding and yawning detection

Vehicle behavior analysis (lane deviation, erratic steering) While EEG-based systems offer high accuracy, they are intrusive and impractical for daily use. Vision-based systems provide a non-intrusive solution and are cost-effective. Most studies emphasize the need for combining detection with active response systems, which our project addresses through emergency vehicle control integration.

3. METHODOLOGY

The system is implemented in multiple stages:

1. Image Acquisition: A camera is mounted on the dashboard to capture live video of the driver’s face.

2. Facial Feature Extraction: Using OpenCV, facial landmarks such as eye contours and eyelid positions are detected.

3. Fatigue Detection Algorithm: The EAR (Eye Aspect Ratio) is calculated. A threshold value is set (e.g., EAR < 0.25 for more than 2 seconds indicates drowsiness).

4. Controller Logic: An Arduino or Raspberry Pi receives the fatigue signal and triggers:

A buzzer or vibration motor to alert the driver.

A servo motor or actuator to slow down or stop the vehicle safely.

Safety logic is implemented to ensure the system does not trigger due to false positives (e.g., blinking or looking away briefly).

4. DESIGN AND FABRICATION

Mechanical Design:

A small-scale vehicle model is fabricated with mounting brackets for sensors.

Emergency braking system includes a servo motor connected to the braking lever.

Electrical Components:

Raspberry Pi with camera module or USB webcam

Ultrasonic sensors (optional for obstacle detection)

Buzzer and vibration motor for wake-up alerts

Software Tools:

Python for image processing

Open CV for face and eye detection

Arduino IDE for hardware integration

Wiring is carefully done to ensure compactness and safety in the prototype.

5. RESULTS AND DISCUSSION

The system detects eye closure and drowsiness with ~85% accuracy under good lighting.

Reaction time from detection to system response is under 1 second.

During testing on a toy car model, the braking system successfully stopped the vehicle within a 1-meter distance.

The buzzer produced sound levels above 80 dB, sufficient to wake a lightly dozing person.

Challenges include low-light performance, camera misalignment, and false triggers due to glasses or facial hair.

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