



A RESULT ON SMART DRIVER MONITORING SYSTEM

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Abstract:

Road accidents caused by driver drowsiness and distraction are a serious safety issue. Existing systems mainly use basic eye detection, which is often inaccurate and cannot detect behaviors like yawning, head movement, or mobile usage. They also lack real-time monitoring and smart alert features. This project proposes a Smart Driver Monitoring System using Raspberry Pi, computer vision, and IoT. A USB webcam captures real-time video of the driver, and techniques using OpenCV and MediaPipe/Dlib analyze facial features such as eyes, mouth, and head position to detect drowsiness and distraction. When unsafe behavior is detected, the system generates alerts and can slow down or stop the vehicle for safety. It also provides live monitoring through a web-based dashboard.

Keywords: Driver Monitoring System, Drowsiness Detection, Raspberry Pi, OpenCV, IoT, Real-Time Monitoring.



1. INTRODUCTION

Road safety is a critical concern worldwide, with a significant number of accidents occurring due to driver drowsiness and distraction. Fatigue, prolonged driving, and activities such as mobile phone usage reduce driver alertness, leading to slower reaction times and increased chances of collisions. According to various studies, drowsy driving is one of the leading causes of serious road accidents, especially during long-distance travel and night driving. Traditional driver monitoring systems mainly rely on basic eye detection techniques, which are often insufficient and inaccurate. These systems fail to consider multiple important factors such as yawning, head movement, and driver distraction. Additionally, most existing solutions lack real time alerts, intelligent decision-making, and remote monitoring capabilities, limiting their effectiveness in real-world applications. To overcome these limitations, this project proposes a Smart Driver Monitoring System using Raspberry Pi, computer vision, and IoT technologies. The system uses a USB webcam to continuously capture the driver's facial features and analyze them in real time. Advanced algorithms implemented using OpenCV and MediaPipe/Dlib are used to detect eye closure, mouth opening (yawning), and head position to accurately determine the driver's state. The system is designed to provide immediate alerts when drowsiness or distraction is detected. Furthermore, it integrates with motor control mechanisms to gradually reduce the vehicle speed and bring it to a safe stop if necessary. An IoT-based dashboard is also implemented to enable live video streaming and remote monitoring, enhancing overall safety and control. This project aims to develop a reliable, efficient, and real-time solution that improves driver awareness, reduces accident risks, and contributes to safer transportation systems.

2. LITERATURE SURVEY

Liawatimena et al. [1] (2025) proposed an annotated driver drowsiness detection dataset captured using Raspberry Pi 5. The study collected images and videos under different lighting conditions ranging from 0 to 615 lux, providing useful data for developing and evaluating real-time drowsiness detection systems. Alvarez Oviedo et al. [2] (2025) proposed a driver drowsiness detection and seat-belt monitoring system using Raspberry Pi 4 and Arduino Nano. The system monitors the driver's drowsiness along with seat-belt status, providing a combined safety solution for vehicles. V. Vijaya Bhasker et al. [3] (2025) developed a driver drowsiness detection system using Raspberry Pi and OpenCV. The system performs real-time detection by analyzing video frames and identifying prolonged eye closure as an indication of driver drowsiness. Ooppakaew et al. [4] (2024) proposed a drowsiness detection system for electric vehicles and smart cars using Raspberry Pi. The system uses facial landmarks and Eye Aspect Ratio (EAR) to monitor eye and mouth movements for identifying signs of drowsiness. Ashwini Sinha et al. [5] (2023) developed a driver drowsiness detection system using Raspberry Pi that tracks eyeball movement instead of relying only on eye-closure detection. This approach provides additional information for identifying changes in the driver's alertness. S. Aziz et al. [6] (2022) proposed a driver drowsiness detection system using OpenCV and Raspberry Pi. The system uses the PERCLOS method to



identify prolonged eye closure and provides alerts through a buzzer and water-spray mechanism when drowsiness is detected. Jadhav et al. [7] (2022) developed a Raspberry Pi-based driver drowsiness detection system using Haar Cascade, Eye Aspect Ratio (EAR), and frame analysis. The system analyzes eye closure across consecutive frames to identify drowsiness in real time. Anil Kumar Biswal et al. [8] (2021) proposed an IoT-based smart alert system for drowsy driver detection using Raspberry Pi and the Eye Aspect Ratio (EAR) method. The system also integrates GPS and email alerts to provide remote notifications when driver drowsiness is detected. Pooja D.C. et al. [9] (2020) proposed a driver drowsiness detection system using image processing techniques. The system detects the driver's face, eyes, yawning, and head movement to identify different visual signs of drowsiness. S. Priyadarsini et al. [10] (2019) developed a basic driver drowsiness detection system using Raspberry Pi. The system detects eye closure by analyzing video frames and activates a buzzer alert when drowsiness is identified. P. Anilkumar et al. [11] (2019) proposed a vehicle driver drowsiness detection system using Raspberry Pi and vision-based image processing techniques. The system uses PERCLOS, symmetry detection, and Hough Transform to analyze the driver's facial features and detect drowsiness. Chellappa et al. [12] (2018) developed a fatigue detection system using Raspberry Pi 3 based on eye-blink analysis. The system uses Eye Aspect Ratio (EAR) to monitor eye movements and activates an alert when signs of reduced driver alertness are detected.

Table 1 Comparative review of Smart Driver Monitoring System

Reference	Study Focus / Contribution	Results	Disadvantages
[1]	Developed a driver drowsiness dataset using Raspberry Pi 5 under different lighting conditions.	Provides useful images and videos for developing and testing drowsiness detection systems.	Mainly focuses on dataset generation and does not provide a complete real-time alert system.
[2]	Developed a system using Raspberry Pi 4 and Arduino Nano for driver drowsiness and seat-belt monitoring.	Enables simultaneous monitoring of driver alertness and seat-belt usage.	Requires additional hardware and mainly focuses on drowsiness and seat-belt monitoring.
[3]	Developed a real-time drowsiness detection system using Raspberry Pi and OpenCV based on eye closure.	Detects prolonged eye closure in real time and provides driver alerts.	May not detect other forms of distraction and can be affected by lighting conditions.
[4]	Used facial landmarks and Eye Aspect Ratio (EAR) to monitor eye and mouth movements.	Improves drowsiness detection by considering both eye and mouth movements.	Facial landmark detection may be affected by face position, lighting, and occlusion.
[5]	Developed a Raspberry Pi system that tracks eyeball movement for detecting drowsiness.	Provides additional information about driver alertness beyond simple eye closure.	Does not comprehensively detect distractions such as mobile phone usage.
[6]	Used OpenCV, Raspberry Pi, PERCLOS, and buzzer/water-spray alerts for drowsiness	Detects prolonged eye closure and provides immediate physical alerts.	Alert mechanism can be intrusive and the system mainly focuses on drowsiness.



	detection.		
[7]	Used Haar Cascade, EAR, and frame analysis for detecting eye closure.	Provides real-time detection of drowsiness using facial image processing.	Normal blinking may cause false alerts and performance can vary with lighting.
[8]	Developed an IoT-based system using EAR, GPS, and email alerts for drowsy drivers.	Provides drowsiness detection with remote notification capabilities.	Requires internet connectivity, GPS, and additional components, increasing system complexity.
[9]	Used image processing to detect face, eyes, yawning, and head movement.	Considers multiple facial indicators for detecting driver drowsiness.	Processing multiple features may increase computational requirements.
[10]	Developed a Raspberry Pi system using eye closure, frame counting, and buzzer alerts.	Provides a simple and low-cost method for real-time drowsiness detection.	Basic detection approach with limited accuracy and no comprehensive distraction detection.
[11]	Used PERCLOS, symmetry detection, and Hough Transform with Raspberry Pi for drowsiness detection.	Combines multiple image-processing techniques to identify driver drowsiness.	Computationally more complex and sensitive to environmental conditions.
[12]	Developed a Raspberry Pi 3 system using EAR and eye-blink analysis for fatigue/drowsiness detection.	Detects changes in eye blinking and provides alerts to the driver.	Uses an older Raspberry Pi platform and mainly relies on eye behavior.

III PROPOSED METHODOLOGY

The proposed Smart Driver Monitoring System operates through a sequence of well-defined steps to ensure accurate real-time detection of driver drowsiness and distraction.

Step 1: System Initialization

- Power is supplied to the Raspberry Pi, ESP32, motor driver, and camera module.
- Required software libraries such as OpenCV and MediaPipe/Dlib are initialized.
- The camera and IoT dashboard connection are configured.

Step 2: Image Acquisition

- A USB webcam continuously captures live video of the driver.
- The video stream is divided into individual frames for real-time processing.

Step 3: Face Detection

- Each frame is processed using computer vision algorithms.
- Face detection is performed to locate the driver's face in the frame.
- If no face is detected, the system waits and continues scanning.



Step 4: Facial Landmark Detection

- Once the face is detected, facial landmarks are extracted using MediaPipe/Dlib.
- Key points such as eyes, mouth, and head orientation are identified.

Step 5: Eye Detection and Blink Analysis

- The Eye Aspect Ratio (EAR) is calculated from eye landmarks.
- Continuous low EAR values indicate eye closure.
 - If eyes remain closed beyond a threshold time → drowsiness detected.

Step 6: Yawning Detection

- Mouth opening is measured using Mouth Aspect Ratio (MAR).
 - If the mouth remains open for a certain duration → yawning detected.

Step 7: Head Pose Estimation

- The system analyzes head position (left, right, down).
- Abnormal head tilt or frequent movement indicates distraction or fatigue.

Step 8: Distraction Detection

- The system detects: Looking away from the road Head turned sideways Possible mobile usage behavior
 - If detected continuously → distraction alert triggered.

Step 9: Decision Making (Multi-Parameter Analysis)

- Data from eyes, mouth, and head position are combined.
- If multiple conditions are met (e.g., eyes closed + yawning), the system confirms drowsiness.
- This improves accuracy compared to single-parameter systems.

Step 10: Alert Generation

- When drowsiness/distraction is detected: Buzzer is activated Warning message is displayed (optional OLED/web dashboard) Alerts are sent to IoT dashboard

Step 11: Vehicle Control Mechanism

- Signal is sent to ESP32/motor driver.
- The vehicle speed is gradually reduced.
- If the driver does not respond: The vehicle is automatically stopped after a delay

Step 12: IoT Dashboard Integration

- Real-time data (driver status, alerts) is sent to a web server.

- Live video streaming is displayed on the dashboard.
- Remote users can monitor driver behavior and system status.

Step 13: Continuous Monitoring

- The system continuously repeats all steps in real-time.
- Ensures uninterrupted monitoring while the vehicle is running.

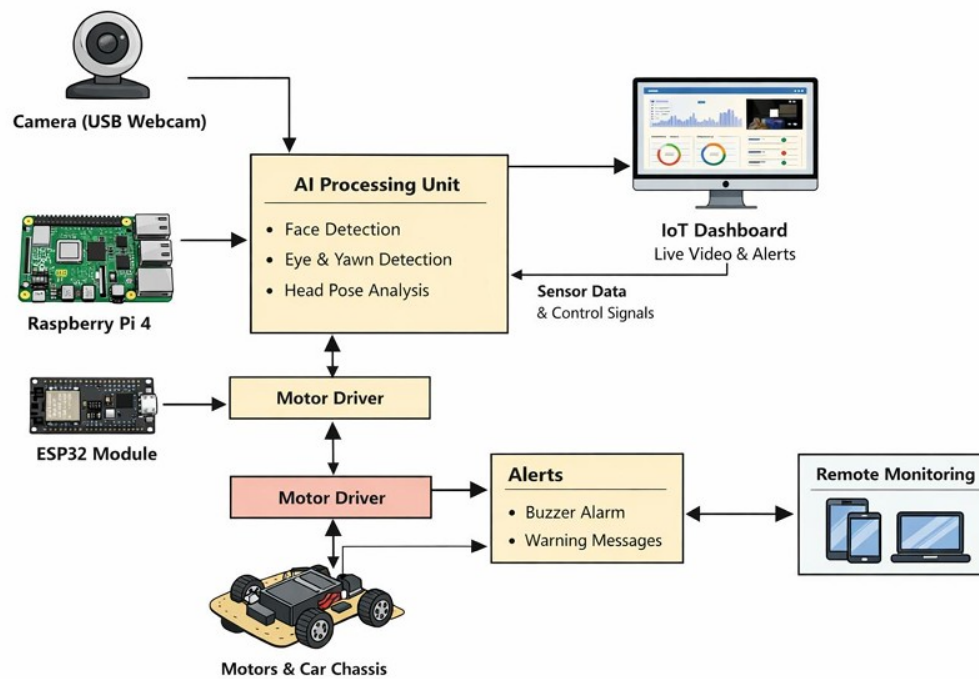


Fig. Block Diagram

3. RESULT

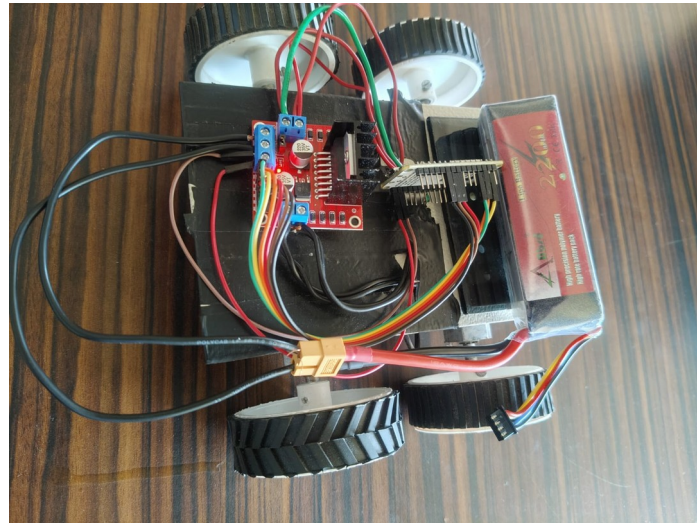


Fig. Car Model



Fig. When Car is Running without any distraction

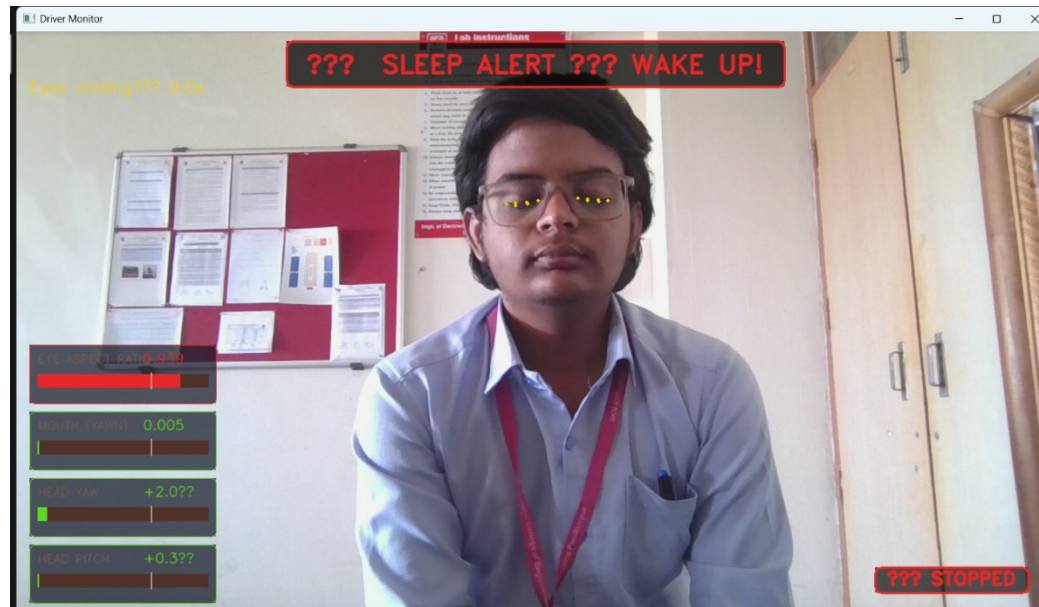


Fig. When User Eyes are Closed Car will Stop and give an alert

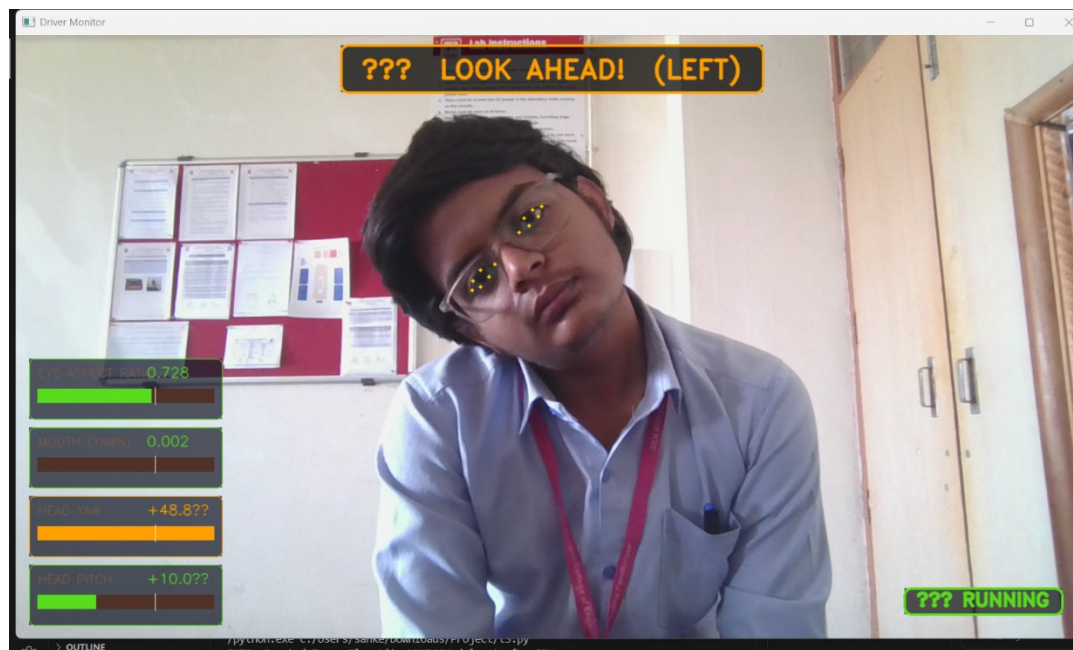


Fig. When User Head Move Left



Fig. When User Head Move Right



Fig. When User Yawning

4. CONCLUSION

The Smart Driver Monitoring System was successfully designed and developed to enhance road safety by continuously analyzing driver behavior in real time. The primary objective of the system



is to detect drowsiness and distraction using computer vision and IoT-based technologies, and to generate immediate alerts that help prevent road accidents. By integrating multiple hardware components such as Raspberry Pi 4, USB webcam, ESP32 module, motor driver, and a sensor-based alert system, the project demonstrates a reliable and efficient approach toward intelligent driver assistance. The system improves driving safety by combining multiple behavioral parameters instead of relying on a single detection method. Traditional systems often focus only on eye closure or blink rate, which can lead to inaccurate results. In contrast, this project uses a multi-parameter approach that includes eye movement, head pose estimation, facial expression analysis, and distraction detection such as mobile phone usage. This combination significantly increases the accuracy and reduces the chances of false detection, making the system more practical for real-world applications. One of the key achievements of this system is its ability to provide real-time alerts. Whenever signs of drowsiness or distraction are detected, the system immediately triggers warning signals through buzzer alerts, visual indicators, or system notifications. This instant response helps the driver regain attention and avoid potential accidents. Additionally, the integration of ESP32 enables wireless communication, allowing the system to be expanded into IoT-based smart vehicle applications. The project also introduces cloud-based monitoring, which allows remote tracking of driver behavior. This feature is particularly useful for fleet management systems, transport companies, and personal vehicle monitoring. All driving data and alert logs can be stored and analyzed in the cloud, enabling long-term behavioral analysis. Based on this data, a driver safety score is generated, which reflects the overall driving performance and helps in improving driving discipline over time.

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