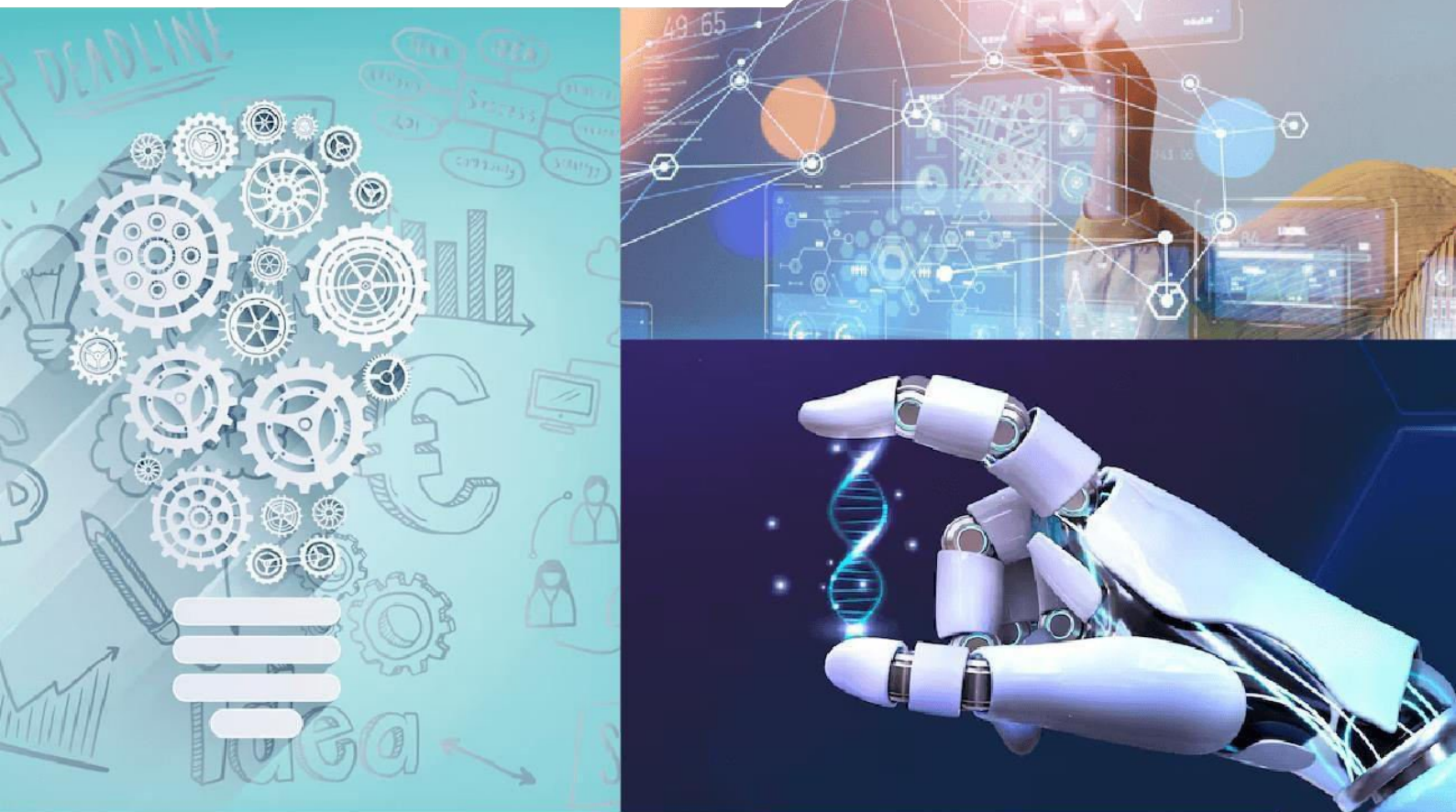




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Real-Time Drowsiness Detection System

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ABSTRACT. Driver drowsiness remains a major contributor to road accidents, particularly during long-distance travel and monotonous driving conditions. Traditional detection approaches either rely on intrusive physiological sensors or provide delayed responses based on vehicle behavior. This study presents a real-time, non-intrusive drowsiness detection system that utilizes computer vision techniques to monitor facial features such as eye closure and yawning.

The proposed system employs MediaPipe Face Mesh to extract 468 facial landmarks and calculates Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) for detecting drowsiness and yawning, respectively. A threshold-based state machine ensures reliable detection by analyzing temporal patterns rather than isolated frames. The system integrates a Flask-based web interface for real-time monitoring, along with an alert mechanism using voice and sound notifications.

Additionally, the system logs detection events into a structured CSV format, enabling historical analysis and performance tracking. Experimental results demonstrate that the system effectively detects early signs of fatigue while maintaining real-time performance on standard hardware. The proposed approach emphasizes accuracy, low cost, and practical deployment, making it suitable for real-world driver safety applications.

KEYWORDS: Drowsiness Detection, Computer Vision, MediaPipe Face Mesh, Eye Aspect Ratio (EAR), Mouth Aspect Ratio (MAR), Real-Time Monitoring, Driver Safety, Alert System, Fatigue Detection.

I. INTRODUCTION

Ensuring road safety is a critical concern as driver fatigue continues to cause a significant number of accidents worldwide. Drowsiness reduces reaction time, impairs decision-making, and increases the likelihood of collisions. Traditional methods such as caffeine intake or rest breaks are unreliable as they depend on self-awareness, which often fails during fatigue onset.

Recent advancements in computer vision have enabled the development of automated systems capable of monitoring driver alertness in real time. Unlike sensor-based systems, vision-based approaches are non-intrusive and cost-effective, making them suitable for widespread adoption.

The proposed Real-Time Drowsiness Detection System utilizes facial landmark detection to continuously monitor eye and mouth movements. By computing EAR and MAR values, the system identifies prolonged eye closure and yawning patterns, which are key indicators of fatigue. The integration of a web-based dashboard allows users to visualize metrics in real time, while alert mechanisms ensure timely intervention.

This work aims to provide a reliable, scalable, and practical solution that bridges the gap between theoretical detection models and real-world deployment.

II. LITERATURE REVIEW

2.1 Multi-Modal Drowsiness Detection Approaches

Existing systems for detecting driver fatigue primarily rely on physiological signals such as EEG or ECG, which provide high accuracy but are intrusive and impractical for everyday use. Vehicle-based approaches, such as steering pattern monitoring, detect fatigue indirectly but often fail to identify early signs.

2.2 Vision-Based Detection Systems

Vision-based systems use facial features to detect drowsiness. Techniques involving eye closure detection and blink rate analysis have gained popularity due to their simplicity and effectiveness. However, many systems rely on static thresholds without considering temporal patterns, leading to false positives.

2.3 Machine Learning and AI-Based Systems

Recent research incorporates machine learning and deep learning models to improve detection accuracy. While these approaches enhance performance, they often require large datasets, high computational power, and training time, limiting their practical applicability.

2.4 Limitations of Existing Systems

Despite advancements, current systems face several challenges:

- Lack of real-time performance on low-cost hardware
- High false alarm rates
- Limited integration of multiple fatigue indicators
- Absence of historical data tracking and analysis

Summary

The literature indicates a need for a system that combines real-time performance, multi-feature analysis, and practical deployment without requiring expensive hardware or complex models.

III. METHODOLOGY

3.1 System Architecture

The proposed system consists of the following components:

- Video Capture Module (OpenCV)
- Face Landmark Detection (MediaPipe Face Mesh)
- Feature Extraction (EAR & MAR)
- Decision Engine (Threshold-based State Machine)
- Alert System (Audio + Voice Alerts)
- Data Logging (CSV-based storage)
- Web Dashboard (Flask)

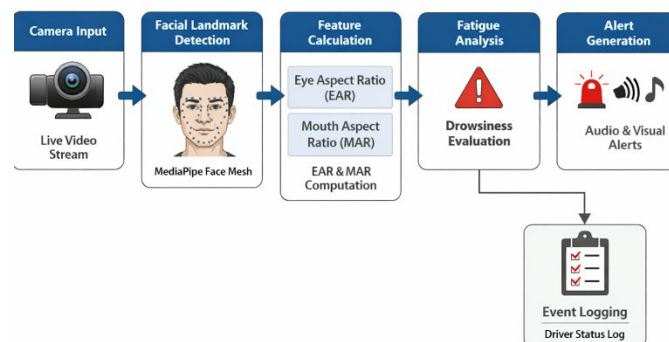


Fig 3.1: System Architecture Diagram

3.2 Facial Feature Extraction

The system extracts facial landmarks using MediaPipe and computes:

- **Eye Aspect Ratio (EAR):** Detects eye closure
- **Mouth Aspect Ratio (MAR):** Detects yawning

These ratios are calculated using Euclidean distance between specific landmark points, ensuring accurate measurement of facial movements.

3.3 Drowsiness Detection Logic

A threshold-based approach is used:

- $EAR < 0.25 \rightarrow$ Eye closure detected
- $MAR > 0.6 \rightarrow$ Yawning detected

A frame-based validation mechanism ensures that detection occurs only when conditions persist over time, reducing false positives. The system operates as a state machine, transitioning between normal, drowsy, and yawning states.

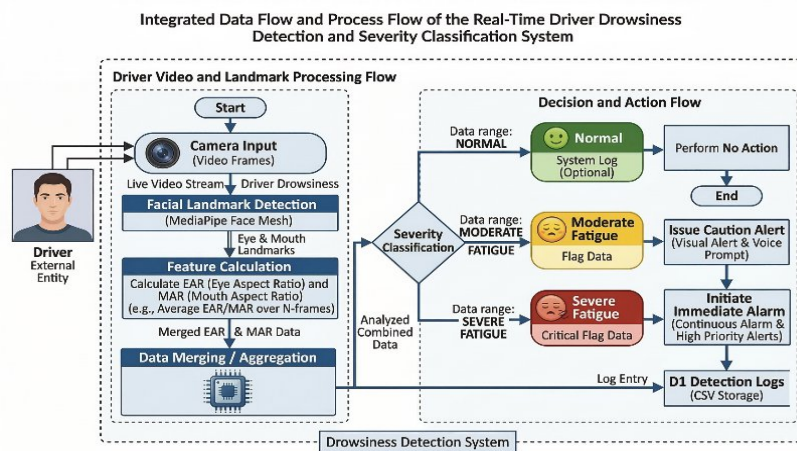


Fig 3.2: Drowsiness Detection Flowchart

3.4 Real-Time Monitoring and Alerts

The system provides:

- Voice alerts using text-to-speech
- Sound alerts using audio playback
- Visual alerts on the dashboard

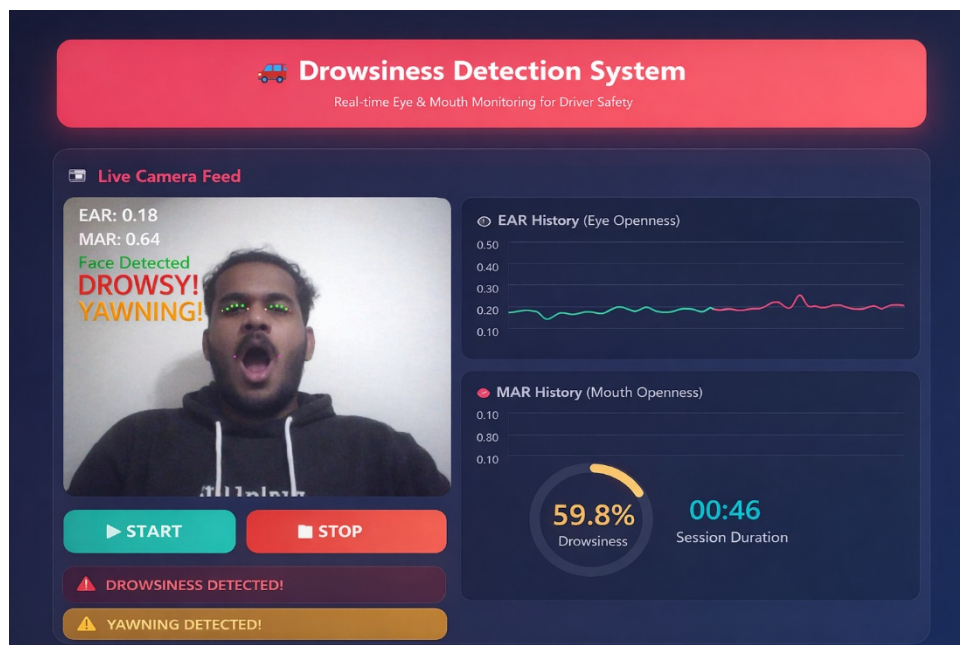
Alerts are triggered only once per event using a cooldown mechanism to prevent repetition.

3.5 Data Logging and Analysis

Detection results are stored in a CSV file, including:

- Timestamp
- EAR and MAR values
- Detection status
- Event type (Drowsy/Yawn Start/End)

This enables post-session analysis and visualization of fatigue trends.



3.3: Dashboard with EAR, MAR Graphs and Drowsiness Percentage

IV. CONCLUSION

This paper presents a real-time drowsiness detection system that leverages computer vision techniques for monitoring driver fatigue. By combining EAR and MAR-based detection with temporal validation, the system achieves reliable performance while minimizing false alarms.

The integration of a web-based dashboard and data logging enhances usability and enables detailed analysis of driver behavior. Unlike existing systems that rely on expensive hardware or complex models, the proposed solution is lightweight, cost-effective, and deployable on standard devices.

Future improvements may include integration with IoT devices, mobile applications, and advanced machine learning models to further enhance accuracy and scalability

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