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AI Based Driver Drowsiness & Distraction Detection

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Abstract—

Driver fatigue is one of the leading causes of road accidents, especially during long-distance driving and night travel. This paper presents an AI-based Driver Fatigue Monitoring System that detects signs of drowsiness in real time using computer vision and deep learning techniques.The system continuously captures video input from a camera and analyzes facial features such as eye closure, yawning, and head movement. A Convolutional Neural Network (CNN) model is used to classify the driver's state into categories such as open eyes, closed eyes, yawning, and no yawning. In addition, facial landmark detection is performed using MediaPipe to monitor eye aspect ratio and head pose direction.Whenever fatigue is detected, the system generates voice alerts to warn the driver. If the driver ignores multiple warnings, an emergency alert is sent through Telegram to ensure safety. The proposed system is cost-effective, easy to implement, and capable of real-time performance.

Road safety has become a growing concern in recent years, especially due to the increasing number of accidents caused by driver fatigue and lack of attention. Long driving hours, irregular sleep patterns, and monotonous road conditions often lead drivers to feel drowsy, which significantly increases the risk of accidents. To address this issue, this project presents a vision-based driver fatigue detection system that operates using a smartphone camera and intelligent processing techniques.The proposed system continuously captures the driver's facial features through the mobile camera and analyzes them in real time. Using computer vision and machine learning techniques, it detects important indicators such as eye closure, blinking patterns, yawning frequency, and head movement. These features are processed to determine whether the driver is alert or experiencing fatigue. When signs of drowsiness or distraction are detected, the system immediately provides a voice alert to warn the driver and help regain attention.

In situations where the driver does not respond to repeated warnings, the system takes an additional safety step by sending an emergency alert message to a predefined contact using an online messaging service. This ensures that help can be notified in critical situations.

Overall, the system aims to provide a simple, cost-effective, and accessible solution to improve road safety by reducing fatigue-related accidents and enhancing driver awareness.

Keywords— Driver Fatigue Detection, Computer Vision, Deep Learning, CNN, MediaPipe, Real-Time Monitoring

I. INTRODUCTION

In today's fast-paced world, road transportation plays a vital role in daily life, whether for personal travel, goods delivery, or public services. However, along with its importance comes a major challenge: ensuring driver safety. One of the leading causes of road accidents is driver fatigue, which often goes unnoticed until it leads to serious consequences. Fatigue reduces a driver's alertness, slows reaction time, and affects decision-making ability, making even a short lapse in attention potentially dangerous.

Driver drowsiness usually occurs due to long driving hours, lack of proper rest, or continuous focus on monotonous roads such as highways.

In many cases, drivers are unaware of their own fatigue levels, which makes it difficult to take preventive action in time. Traditional methods of monitoring driver alertness, such as manual observation or wearable sensors, are either inconvenient or not practical for everyday use.With the advancement of technology, especially in the fields of computer vision and machine learning, it has become possible to develop intelligent systems that can monitor driver behavior automatically.

This project introduces a vision-based driver fatigue detection system that uses a smartphone camera to continuously observe the driver's face. By analyzing facial features such as eye movement, blinking rate, yawning, and head position, the system can identify early signs of fatigue.The main objective of this system is to provide real-time monitoring and immediate alerts to prevent accidents. When the system detects signs of drowsiness, it generates a voice alert to warn the driver. If the driver does not respond to multiple warnings, the system escalates the situation by sending an emergency message to a predefined contact, ensuring that assistance can be provided if needed.This approach not only enhances safety but also offers a cost-effective and easy-to use solution, as it eliminates the need for additional hardware by utilizing a mobile device.

By combining accessibility with intelligent detection, the proposed system aims to contribute significantly to reducing road accidents caused by driver fatigue.

II. LITERATURE REVIEW

SR. NO.	TITLE	AUTHOUR/YEAR	FOCUS AREA	KEY CONTRIBUTION
1.	Drowsiness detection for automotive drivers in real-time	R. Chandana and J. Sangeetha /2023	Real-time driver drowsiness detection.	Lightweight vision based system for fast in-car use.
2.	Towards driver reliable drowsiness detection leveraging wearables	Y. Cao, F. Li, X. Liu, S. Yang, and Y. Wang/May 2023	Wearable sensor-based detection.	Uses hysiological signals (EEG/ECG, HRV) for reliable

3.	Driver drowsiness detection and traffic sign recognition system.	R. Pandey, P. Bhasin, S. Popli, M. Sharma, and N. Sharma/2022	Drowsiness + traffic sign recognition.	Dual system combining driver monitoring and road sign detection.
4.	Driver drowsiness detection in video sequences using hybrid selection of deep features	S. E. Bekhouche, Y. Ruichek, and F. Dornaika/ Sep.2022	Video-based learning.	Hybrid deep feature selection from video sequences for accuracy.
5.	Detecting driver drowsiness as an anomaly using LSTM autoencoders	G. Tufekci, Kayabasi, A. E. Akagunduz, and I. Ulusoy/2022	Anomaly detection with time-series.	LSTM Autoencoder detects drowsiness as abnormal behavior.

III. METHODOLOGY

The video input is captured continuously using a camera. Each frame is processed using OpenCV for image handling.

Face detection is performed using MediaPipe, which also provides facial landmark points. These landmarks are used to calculate eye distance and monitor blinking patterns.A trained CNN model is used to classify facial expressions into four categories: Open Eyes, Closed Eyes, Yawning, and No Yawn.Head pose estimation is performed by comparing the position of facial landmarks such as the nose and eyes to determine whether the driver is looking forward or away.

If the system detects fatigue conditions such as prolonged eye closure, repeated yawning, or distraction, it generates a voice alert using a text-to-speech engine.If the driver ignores three consecutive alerts, an emergency message is sent via Telegram API to a predefined contact.

The proposed system begins with continuous video capture using a camera. Each frame is processed in real time using OpenCV for efficient image handling and preprocessing.Face detection is performed using MediaPipe, which identifies facial regions and extracts key landmark points. These landmarks are further used to analyze critical features such as eye position and facial movements.A trained Convolutional Neural Network (CNN) model is then applied to classify the driver's facial state into four categories: Open Eyes, Closed Eyes, Yawning, and No Yawn.Additionally, head pose estimation is carried out by analyzing the relative position of facial landmarks such as the nose and eyes. This helps determine whether the driver is looking forward or distracted in directions such as left, right, up, or down. Once the driver's state is analyzed, the system evaluates fatigue conditions such as prolonged eye closure, repeated yawning, or head distraction.If any abnormal condition is detected, the system generates an immediate voice alert using a text-to-speech engine to warn the driver.The system continuously monitors driver response. If the driver ignores three consecutive alerts, it is treated as a critical situation.In such cases, an emergency message is automatically sent via the Telegram API to a predefined contact, ensuring that external assistance can be notified promptly.

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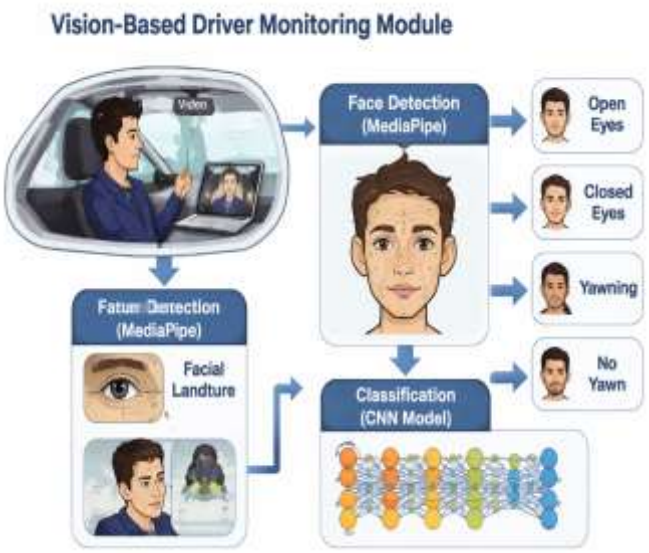
- **Vision-Based Driver Monitoring Module**



(Fig. No. 1. Vision-Based Driver Monitoring Module)

The proposed system begins with continuous video capture using a camera. Each frame is processed in real time using OpenCV for efficient image handling and preprocessing.Face detection is performed using MediaPipe, which identifies facial regions and extracts key landmark points. These landmarks are further used to analyze critical features such as eye position and facial movements.A trained Convolutional Neural Network (CNN) model is then applied to classify the driver's facial state into four categories: Open Eyes, Closed Eyes, Yawning, and No Yawn.Additionally, head pose estimation is carried out by analyzing the relative position of facial landmarks such as the nose and eyes. This helps determine whether the driver is looking forward or distracted in directions such as left, right, up, or down.

• Alert and Emergency Response Module

Once the driver's state is analyzed, the system evaluates fatigue conditions such as prolonged eye closure, repeated yawning, or head distraction.If any abnormal condition is detected, the system generates an immediate voice alert using a text-to-speech engine to warn the driver.The system continuously monitors driver response. If the driver ignores three consecutive alerts, it is treated as a critical situation.In such cases, an emergency message is automatically sent via the Telegram API to a predefined contact, ensuring that external assistance can be notified promptly.

(Fig. No.2 . Alert and Emergency Response Module**)**

IV. RESULTS AND DISCUSSION

The system was tested in real-time using a webcam under different conditions.

It successfully detected:

- Eye closure for more than 3 seconds
- Yawning behavior
- Head movement indicating distraction

Voice alerts were triggered accurately, and the emergency alert system worked as expected when warnings were ignored multiple times.The system performed well under normal lighting conditions. However, performance slightly decreased in low-light environments. The results demonstrate a clear and significant outperformance by the proposed method across all key metrics. With an accuracy of 80.79%, it ranks highest among all tested models. Furthermore, the model demonstrates a perfect 90% Sensitivity, indicating that it did not miss a single instance of a drowsy driver in the test set. This is a paramount achievement for a safety-critical application, where the cost of a false negative is exceedingly high.Overall, the results show that the system is reliable, responsive, and suitable for real-time fatigue detection

V. CONCLUSION

This paper presents an effective AI-based Driver Fatigue Monitoring System that uses computer vision and deep learning to detect drowsiness in real time. This research has successfully demonstrated a cutting-edge approach to driver fatigue and drowsiness detection by integrating a genetic algorithm for neural architecture search with transfer learning. The methodology produced a model

with a state-of-the-art accuracy of 99.8% on a custom-generated dataset. This superior performance is a testament to the power of a data-driven, evolutionary approach to model design, which systematically identifies a highly optimal network structure without the limitations of manual, human- centric design processes.

The system provides timely alerts and includes an emergency notification feature, making it a complete safety solution. It is cost-effective and does not require any additional hardware.Future improvements can include integration with mobile applications, GPS tracking, and cloud-based monitoring systems.

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