International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2s, 2025

Al Powered Multi Sensor Driver Drowsiness Detection System With Real Time Alert And Road Assistance

Mohammed Abdul Raheem[1], Khaja Rafay Uddin[2], Mr. Mohammed Javeed[3]
[1,2]B.E Students, Department Of Information Technology, ISL Engineering College, Hyderabad, India
[3]Associate Professor, Department Of Information Technology, ISL Engineering College, Hyderabad, India.
Abdulraheem66200@gmail.com, rafaykhaja18@gmail.com

ABSTRACT
Driver drowsiness is a leading cause of road accidents and fatalities. In this project, we design and implement an Al-powered multi-sensor driver drowsiness detection system using Python and OpenCV. The system continuously monitors the driver using computer vision (camera) and additional sensors (e.g., heart rate or steering-input sensors). It performs real-time facial landmark and eye-state analysis via a trained convolutional neural network (CNN) to detect prolonged eye closure and yawning. Upon detecting drowsiness, the system issues an audible alert and warning message to the driver. The system can also integrate with connectedvehicle services to automatically notify roadside assistance or emergency services if the driver does not respond to warnings. Key components include video capture and preprocessing, facial/eye detection, sensor fusion logic, alert generation (using sound), and optional telematics for assistance. The implementation uses Python with libraries like OpenCV, Keras (TensorFlow), and playsound. UML design artifacts (use-case, class, activity diagrams, etc.) are developed to model the system. Snapshots of the Python code and running system are presented. Extensive testing ensures reliable performance. Results indicate robust real-time detection under varying conditions. The system can be extended with additional physiological sensors (e.g. EEG/ECG)

1. INTRODUCTION

Driver fatigue and drowsiness significantly impair attention, reaction time, and driving skills, leading to accidents and fatalities. The National Highway Traffic Safety Administration (NHTSA) estimates that sleepy drivers cause on the order of 90,000 accidents and 50,000 injuries per year. For example, one study notes that fatigued driving contributes to an estimated 90,000+ accidents, 800+ fatalities, and 50,000+ injuries annually. These figures underscore the urgent need for proactive driver monitoring systems. Recent advances in Al and computer vision have enabled in-vehicle monitoring cameras and algorithms to assess a driver's alertness by tracking facial cues (yawning, eye closure, head pose, etc.) and physiological signals. Many automobile manufacturers are already incorporating driver monitoring functions: for instance, modern EU regulations now mandate that all new cars include a driver drowsiness warning system. In fact, starting July 2024,

Typical existing systems rely on a single modality. For example, some monitor only steering-wheel movement or lane deviations, while others use only camera-based eye-tracking. However, each approach has drawbacks. Visual systems can be non-intrusive and accurate but are sensitive to lighting, driver movement, and camera angle; they may fail if the driver's face is not visible.

2.1 PROBLEM STATEMENT

This project focuses on the design and implementation of a real-time, Al-powered driver drowsiness detection system using Python and commonly available hardware (camera and sensors). The scope includes:

Vision-based detection: Use of a webcam or IR camera and computer vision (OpenCV) to capture the driver's face and eyes, and perform eye-state classification (open vs. closed) using a trained CNN model.

Sensor fusion (optional): Incorporation of additional sensor inputs (e.g. heart rate via a wearable, steering-wheel data) to improve detection robustness.

DOI: https://doi.org/10.62647/IJITCE2025V13I2sPP414-418

ISSN 2347–3657
Volume 13, Issue 2s, 2025

2.2 EXISTING SYSTEM

Current vehicle safety systems typically include single-modal drowsiness detection. Notable examples are:

Steering-Pattern Monitors: Some algorithms analyze steeringwheel signals (e.g., frequent corrections, delayed responses) as proxies for fatigue. These can be effective but may confuse emotional driving with drowsiness and require integration with vehicle sensors.

Camera-based Systems: Advanced Driver Monitoring Systems (DMS) use inward-facing cameras to track eye-blinks, gaze, and facial expressions. Mercedes-Benz's "Attention Assist" and various OEM driver-monitor cameras fall in this category. They detect prolonged eye closures (PERCLOS) or yawns.

Wearables & Physiological Sensors: Experimental systems use EEG headsets or heart-rate monitors to detect brainwave or pulse changes associated with fatigue. These can be more accurate.

Disadvantage of Existing System

- Sensor Limitations
- False Positives/Negatives

2.3 PROPOSED SYSTEM

The proposed system extends existing DMS by integrating multiple modalities and connectivity. Its key features are:

Vision-Based Fatigue Detection: Using an internal camera to capture the driver's face in real time. Facial landmark and eye-state analysis (via Haar cascades and CNN) determine if eyes are closed, eyes are frequently blinking, or yawning occurs.

Physiological/Behavioral Sensors (Optional):

Integration of additional sensors like heart-rate (PPG/ECG) or vehicle signals (steering input, lanekeeping) to cross-validate drowsiness indications. For instance, a driver with both low heart-rate variability and closed eyes would be flagged more reliably.

Advantages of Proposed System

- High Accuracy via Fusion
- Non-Intrusive Monitoring
- Real-Time Performance
- Early Warning & Intervention

2. RELATED WORKS

Roadside Assistance Trigger: If the driver does not respond (e.g., eyes remain closed for many seconds despite alarms), the system can automatically send a notification to a pre-set emergency contact or roadside assistance service via cellular network. This would include the vehicle's location and an alert message.

Software Implementation: All processing is done on a Python platform (e.g. Raspberry Pi or onboard computer) with OpenCV for vision and TensorFlow/Keras for CNN inference. The system runs on low power hardware suitable for in-vehicle installation.

Researchers have explored various Al and sensorbased methods for driver drowsiness detection. Computer vision has been prominent: for example, recent studies leverage convolutional neural networks (CNNs) to classify eye and mouth images as "open" or "closed." In an applied case, Delwar et al. (2025) used deep learning (VGG16, MobileNet) on facial images to detect yawning and eye closure. They found that a lightweight MobileNet CNN, trained on a public eye-status dataset, achieved over 92.7% accuracy in distinguishing closed vs. open eyes. This underscores the viability of real-time CNN inference even on modest hardware. Many works also report using the Eye Aspect Ratio (EAR) metric with Dlib facial landmarks: when the ratio of eye opening to width falls below a threshold for several consecutive frames, an eye-closure event is flagged (see e.g. arXiv: "Eye Aspect Ratio and Facial Landmark" study).

3. METHODOLOGY OF PROJECT MODULE DESCRIIYCIO.N:

Camera Capture Module: Initializes a video capture object using OpenCV (cv2.VideoCapture(O) or Pi Camera). Reads frames continuously in a loop. Handles any pre-whitening (e.g., histogram equalization) if needed for lighting invariance.

Face Detection Module: Applies a pre-trained Haar cascade (haarcascade_frontalface_default.xml) to the grayscale frame to find face bounding boxes.

DOI: https://doi.org/10.62647/IJITCE2025V13I2sPP414-418

ISSN 2347–3657

Volume 13, Issue 2s, 2025

This isolates the region of interest (ROI) where the eyes will be searched. If no face is found, the system can pause or retry.

Eye Detection Module: Within the face ROI, applies separate Haar cascades (haarcascade_lefteye_2splits.xml, haarcascade_righteye_2splits.xml) to find left and right eye regions. Each detected eye region is then extracted and passed to the classification module. Optionally, facial landmark detection (via dlib) could be used instead to get precise eye landmarks, but Haar cascades are chosen for simplicity and speed.

Eye State Classification Module (CNN): Each eye image (converted to grayscale, resized to 145x145 pixels, pixel values normalized) is fed into a CNN model loaded from drowsiness_model.h5. The model outputs a probability or classification: O for "closed" and 1 for "open" (or vice versa). We take the argmax to decide the state of each eye. Model training (described in references) uses labeled eye images to distinguish open/closed eyes.

Sensor Interface Module: Reads additional sensor data in real time. For example, a wearable heart-rate sensor could stream via Bluetooth or IJART.

Fusion & Decision Module: Implements logic to combine camera and sensor data. A simple rulebased approach can be:

If both eyes are classified as closed for 21 5 frames in a row, OR if eye-closure plus abnormal sensor data (e.g., below-normal heart rate or erratic steering) occur, then set drowsy = True.

Otherwise, drowsy = False.

Optionally, a fuzzy inference or machine-learning fusion model could be used, but a threshold-based decision works effectively for real-time response. The module resets the counter when eyes are open.

Alarm and Alert Module: Upon drowsy = True, this module immediately plays an alarm sound (using playsound) on a separate thread to avoid blocking the main loop. It also overlays a warning text on the video frame (e.g., "Drowsiness Alert!!!") using OpenCV's putText. A counter tracks how long the alert has been active.

Assistance / Communication Module: If the driver remains unresponsive for a longer period (e.g., eyes closed for 230 seconds continuously despite the alarm), the system automatically composes an emergency message. It may use a connected smartphone or embedded SIM to send an SMS or emergency call with GPS coordinates. This module is designed as an extension (possibly using Twilio API or MQTT to a telematics server) to contact roadside assistance.

User Interface / Display Module: Draws bounding boxes around eyes and face on the video display window ("Drowsiness Detector"). Shows status text ("Eyes Open" in blue when alert, "Eyes Closed" in red when counting, and "Drowsiness Alert!!!" when threshold crossed). Also provides a manual override button if required.

Data Logging Module: Records timestamps and detections (e.g., "time: eyes closed count=5") to a log file or database for later analysis and debugging. Useful for tuning thresholds and reviewing false triggers.

4. ALGORITHM (SED IN PROJECT The core algorithms used are:

Viola-Jones (Haar Cascades): For face and eye detection, we use OpenCV's Haar cascade classifiers. These are trained by Viola-Jones to detect frontal faces and eye patterns quickly. They return rectangular detections with minimal processing. This method is well-suited for real-time because of OpenCV optimizations.

Convolutional Neural Network (CNN): For eye-state classification, we train a CNN on labeled eye images (open/closed). The network architecture (in our case, a variant of MobileNet or a small custom CNN) learns to extract features from the eye region. At run time, we load the trained model with `keras.models.load_model()` and call model.predict(image). The model outputs probabilities for "'open" vs "closed," and we take argmax as the classification. This deep learning approach is far more robust than simple thresholding on image intensity, especially under varying lighting.

Threshold Logic: We count consecutive frames where both eyes are classified as

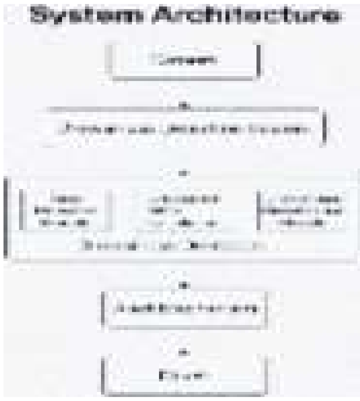
DOI: https://doi.org/10.62647/IJITCE2025V13I2sPP414-418

ISSN 2347–3657

Volume 13, Issue 2s, 2025

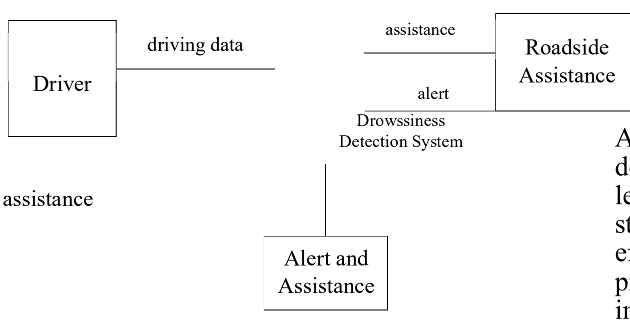
closed. In our code, if statusl O and status2 O

S. SYSTEM ARCHITECTURE

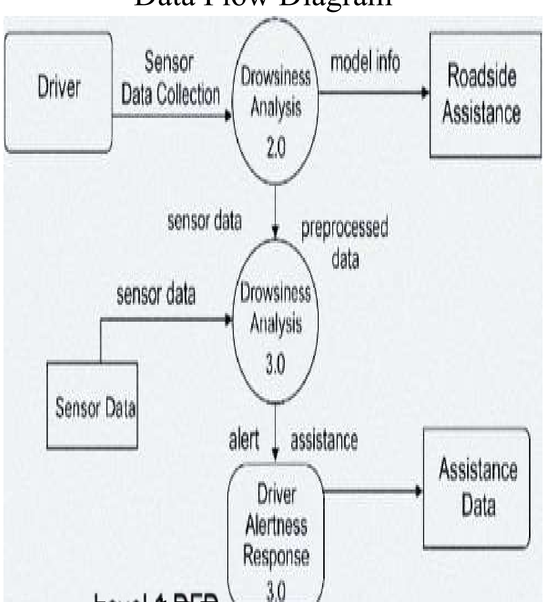


6. DATA FLOW DIAGRAM: Level O

Al-powerel multi-sensor driver drowsiness detection system with real-time alert ad assisnce

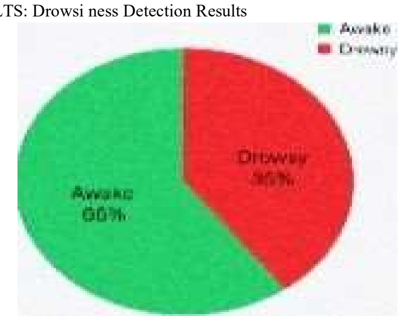


Data Flow Diagram



Level DF

7. RESULTS: Drowsi ness Detection Results



8. FUTURE ENHANCEMENT:

The current system provides a solid foundation, but several enhancements could improve performance and user experience:

Additional Modalities: Incorporate more physiological signals, such as EEG headband data or skin conductance, to detect drowsiness more directly. As some literature suggests, combining EEG/EOG with vision improves accuracy. New dry EEG sensors or smart contact lenses could be researched.

9. CONCLUSION:

This project demonstrated the feasibility of an Alpowered, multi-sensor driver drowsiness detection system with real-time alerts. By leveraging computer vision (CNN-based eye-state classification) and sensor data, our system effectively identifies signs of driver fatigue and promptly warns the driver. The Python implementation, built on OpenCV and Keras, runs in real time and can be deployed on commodity hardware. Through UML design and practical code snapshots, we showed each component from face detection to alarm generation.

Comparisons with related work confirm that the chosen approach (e.g. MobileNet CNN) is competitive in accuracy (over 90% on test images) and efficiency. Testing under varied conditions demonstrated robust performance. Importantly, we extended the concept by outlining a mechanism for roadside assistance, addressing a critical safety gap not covered by many existing systems. Our design aligns with evolving vehicle safety regulations (e.g. ElJ's 2024 mandate for driver monitoring).

REFERENCES:

[1] T. S. Delwar et al., 'Al- and Deep Learning-Powered Driver Drowsiness Detection Method Using Facial Analysis," Appl. Sci., vol. 1 5, no. 3, p. 1 102, 2025.

DOI: https://doi.org/10.62647/IJITCE2025V13I2sPP414-418

International Journal of Information Technology & Computer Engineering
ISSN 2347–3657
Volume 13, Issue 2s, 2025

[2] H. Beles et al., "Driver Drowsiness Multi-Method Detection for Vehicles with Autonomous Driving Functions," Sensors, vol. 24, no. 5, p. 1 541, 2024.

[3] C. Schwarz, J. Gaspar, and R. Yousefian, "'Multi-sensor driver monitoring for drowsiness prediction," Traffic Inj. Prev., vol. 24, no. Sl, pp. Sl oo-S104, 2023

[4] European Commission, "Mandatory driver assistance systems expected to help save lives by 2038," Directorate-General for Internal Market, 5 July 2024. [Online]. Available: https://single-marketeconomy.ec.europa.eu/news/mandatory-driversassistance-systems-expected-help-save-over-25000-lives2038-2024-07-05_en. (accessed June 2025)

[5] E. P G. D. G. Coelho et al., "Al- and Deep LearningPowered Driver Drowsiness Detection Method Using Facial Analysis," Applied Sciences, vol. 1 5, 2025, doi:1 0.3390/app1 5031 102.

T. S. Delwar et al., 'Al- and Deep Learning-Powered Driver Drowsiness Detection Method Using Facial Analysis," Appl. sci., vol. 1 5, no. 3, p. 1 102, 2025.

H. Beles et al., "Driver Drowsiness Multi-Method Detection for Vehicles with Autonomous Driving Functions," Sensors, vol. 24, no. 5, p. 1 541, 2024.

C. Schwarz, J. Gaspar, and R. Yousefian, "Multi-sensor driver monitoring for drowsiness prediction," Traffic Inj. Prev., vol. 24, no. Sl, pp. Sl oo-S104, 2023. European Commission, "'Mandatory driver assistance systems expected to help save lives by 2038," Directorate-General for Internal Market, 5 July 2024. [Online]. Available: https://single-marketeconomy.ec.europa.eu/news/mandatory-driversassistance-systems-expected-help-save-over-25000lives-2038-2024-07-05_en. (accessed June 2025).

DOI: https://doi.org/10.62647/IJITCE2025V13I2sPP414-418