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Real-Time Driver Drowsiness Detection System Using Facial Landmarks

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ABSTRACT

Every year, countless road accidents occur—not due to faulty vehicles or bad roads, but because drivers feel sleepy and lose focus behind the wheel. Especially for those who drive long distances, work night shifts, or travel without proper rest, drowsiness becomes a silent danger that can lead to tragic outcomes. Studies show that driver fatigue is one of the major causes of road accidents globally. To tackle this issue, our project introduces a Real-Time Driver Drowsiness Detection System that helps keep drivers awake and alert. The idea is simple but powerful: by using a regular webcam (even the one built into your laptop), the system continuously watches the driver's face and eyes to check if they are showing signs of sleepiness. The system does this by calculating what's called the Eye Aspect Ratio (EAR)—a smart way to measure how open or closed the eyes are. If it notices that the driver's eyes are closed for too long, it immediately sounds an alarm to wake them up. What makes our system different is that it doesn't need expensive equipment. There are no special sensors or high-end cameras—just basic hardware, a webcam, and a normal computer. It's designed to be lightweight, affordable, and easy for anyone to use. The software runs in real time, works automatically in the background, and doesn't require the driver to press buttons or control anything manually. We've built this using Python programming, with popular tools like OpenCV, dlib, and pygame, ensuring that the system runs smoothly even on regular laptops. The goal is to make roads safer by giving drivers a second set of "digital eyes" watching over them—alerting them before a dangerous situation arises.

This project combines technology and real-life safety, offering a practical solution that could potentially save lives by preventing accidents caused by drowsiness. It's especially helpful for long-haul truck drivers, late-night commuters, and anyone who spends extended hours on the road.

1-INTRODUCTION

Road accidents are one of the leading causes of death across the world, and many of these accidents happen not because of speeding or drunk driving—but because drivers simply fall asleep behind the wheel. This condition is known as **driver drowsiness** and it usually affects people driving for long hours, especially at night. Long-distance truck drivers, night shift workers, and even everyday travellers can easily become victims of fatigue. This project aims to **detect driver drowsiness in real-time** using a regular webcam and some clever computer vision techniques. The system watches the driver's eyes through the webcam, calculates the **Eye Aspect Ratio (EAR)** using facial landmarks, and if it detects the eyes staying closed for too long, it **plays an alarm to wake the driver up.** This simple but powerful feature can help **prevent accidents and save lives**. The best part is that it does not require any fancy or expensive equipment—just a regular laptop or PC with a webcam is enough. The system is designed to be lightweight, fast, and user-

friendly so that **anyone can use it**, especially people who drive long distances and need an extra safety measure.

Existing System

At present, the systems that are used to detect driver drowsiness are based on advanced technologies like facial recognition and eye-tracking. These systems try to figure out if a driver is sleepy by analyzing eye movement, blinking patterns, or the tilt of the head. Many of them use machine learning models to detect if someone is likely to fall asleep. They often need high-end equipment like infrared cameras or advanced processors, which makes them expensive and not available in everyday vehicles.

Proposed System

The proposed drowsiness detection system aims to provide a simple, real-time, and affordable solution to help drivers stay alert and safe on the road. Using just a standard webcam, the system continuously monitors the driver's face, with a particular focus on their eye movements. It calculates the Eye Aspect Ratio (EAR), a measure that indicates whether the eyes are open or closed. When the eyes remain closed beyond a certain threshold, the system detects signs of drowsiness and immediately triggers an audible alarm to wake the driver. This approach does not require any specialized or costly equipment, making it accessible to everyday users. It can easily run on regular laptops or desktop computers, leveraging popular and open-source Python libraries such as OpenCV for computer vision, dlib for facial landmark detection, and pygame for playing alert sounds. The detection runs automatically in the background, allowing drivers to keep their attention fully on driving without needing to interact with the system. Designed to be lightweight and highly efficient, this system is particularly beneficial for long-distance drivers, night-shift workers, and anyone prone to fatigue during travel. It offers a practical alternative to expensive setups that use infrared cameras or additional sensors, reducing both cost and complexity. The core objective is to provide timely warnings before fatigue leads to dangerous situations. By continuously monitoring drowsiness and alerting the driver at the right moment, this project promotes safer driving habits and aims to prevent accidents caused by tiredness.

2.REQUIREMENT ANALYSIS

Functional Requirements

The Driver Drowsiness Detection System is designed to monitor a driver's eye movements and facial behavior using a webcam to detect signs of fatigue or drowsiness. It employs computer vision techniques and facial landmark tracking to detect when the driver's eyes remain closed beyond a certain duration—indicating drowsiness—and triggers a warning system to help prevent accidents. The system must meet the following functional requirements:

1. Face and Eye Detection Module

- The system must detect the driver's face in real time using a webcam.
- It should identify and track key facial landmarks, specifically around the eyes (using dlib or other facial landmark detectors).
- The module should handle slight movements and maintain tracking throughout the session.

2. Drowsiness Detection Module

- The system must compute the Eye Aspect Ratio (EAR) from the eye landmarks for both eyes.
- It should continuously compare EAR values against a pre-set threshold to determine if the driver's eyes are closed.
- If the EAR remains below the threshold for a certain number of consecutive frames, it should classify the driver as drowsy.

Non-Functional Requirements

These non-functional requirements ensure that the Driver Drowsiness Detection System is not only functional but also efficient, reliable, accessible, and secure—qualities that are critical in safety-critical real-time systems.

1.Performance:

The system ensures real-time processing, analyzing drowsiness indicators without delays, while optimizing resource usage to prevent high CPU and memory consumption, ensuring smooth performance during use.

2. Usability

This system allows users with no technical background to operate the system confidently.

Instructions and error messages are clear and user-friendly.

Hardware Requirements

System	:	I5 processor
RAM	:	Minimum 8GB
Camera	:	Webcam (built-in or external)
Speakers	:	For alarm alerts

Software Requirements

- Operating system : Windows 7,8,10
- Tools : Visual Studio code
- Libraries : OpenCV, dlib, SciPy,pygame
- Programming Language : Python

3-ARCHITECTURE

Data Flow Diagram The Data Flow Diagram (DFD) of the Driver Drowsiness Detection System Using Facial Landmarks illustrates how data flows through the application. It helps understand the system's components and how they interact with each other. Below is a simple explanation of the data flow in our project:

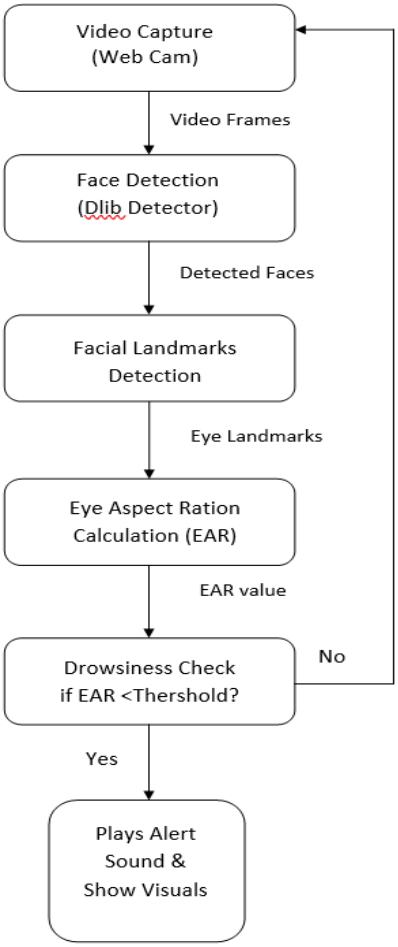


Fig 3.1 Data Flow Diagram

UML Diagrams

UML (Unified Modeling Language) is a standardized modeling language used in software engineering to visualize, specify, construct, and document the components and design of a software system. It provides a set of graphical notations and diagrams that help developers, analysts, and stakeholders understand the architecture, behavior, and interactions within a system.

Use Case Diagram:

The use case diagram shows how the user interacts with the system. The user starts the system, and it keeps monitoring their eyes using the webcam. If the system finds the user is drowsy by checking eye movements, it plays an alert sound to wake them up. The system runs automatically without needing any extra input from the user.

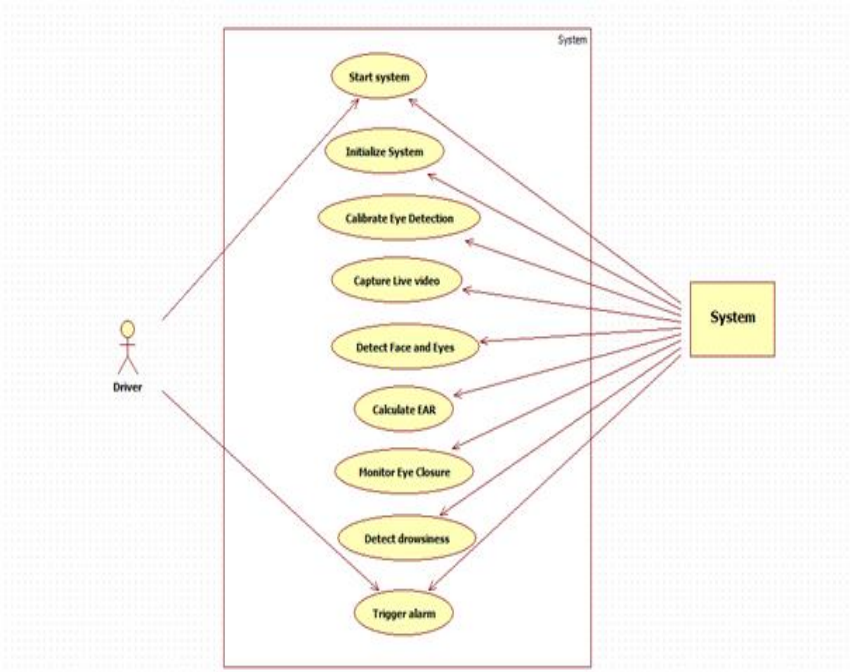


Fig 3.2.1 Use Case Diagram

4-IMPLEMENTATION

The Driver Drowsiness Detection System combines computer vision, image processing, and facial landmark analysis to monitor a driver's eye activity in real time and detect signs of drowsiness. The system uses a webcam to capture live video, processes the frames using OpenCV and dlib, and calculates the Eye Aspect Ratio (EAR) to determine if the eyes are closed for a prolonged period. If drowsiness is detected, an alert sound is triggered using pygame.

The project is developed using Python 3, and key libraries include OpenCV, SciPy, dlib, imutils, and pygame. It follows a simple real-time processing model, providing immediate feedback and alerts to the user. The system is lightweight and useful for increasing road safety by preventing sleep-related accidents, especially in long-distance travel or late-night driving scenarios.

Python

Python is the main language used in this project. It is easy to understand and supports useful libraries like OpenCV, dlib, SciPy, and Pygame. These libraries help with image processing, face detection, calculations, and sound alerts. Python makes it simple to build real-time systems like drowsiness detection with fewer lines of code.

OpenCV (Open Source Computer Vision Library)

OpenCV is used for handling all image and video-related operations. In our project, it captures the live video from the webcam, converts the frames to grayscale for faster processing, and displays the output with eye detection and alerts. It helps us draw shapes around the eyes and face to show the user what the system is tracking.

SciPy

We used the distance.euclidean() function from SciPy to calculate the distance between different eye landmarks. These distances are important for the EAR calculation and help us know how much the eyes are open or closed.

Pygame Mixer

Pygame's mixer is used to play an alert sound when the driver is found to be drowsy or when no face is detected. It helps quickly grab the driver's attention to avoid accidents.

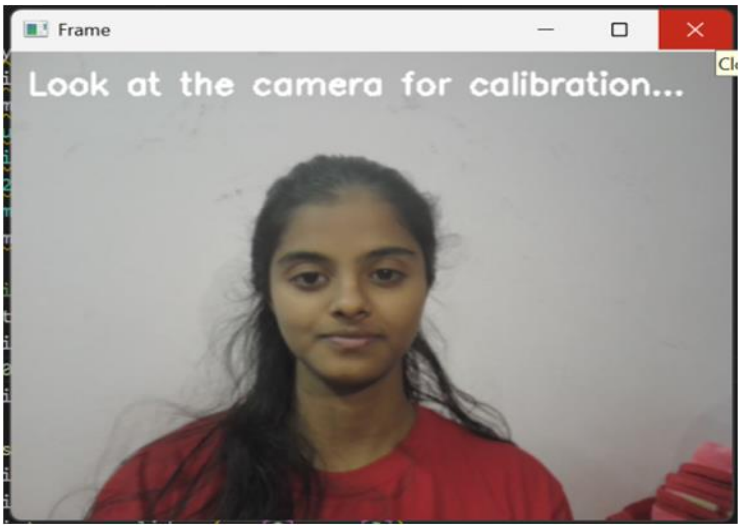
imutils

imutils is a small helper library that makes working with OpenCV easier. It helps resize frames and convert face shapes into arrays so we can use them easily in our calculations.

dlib

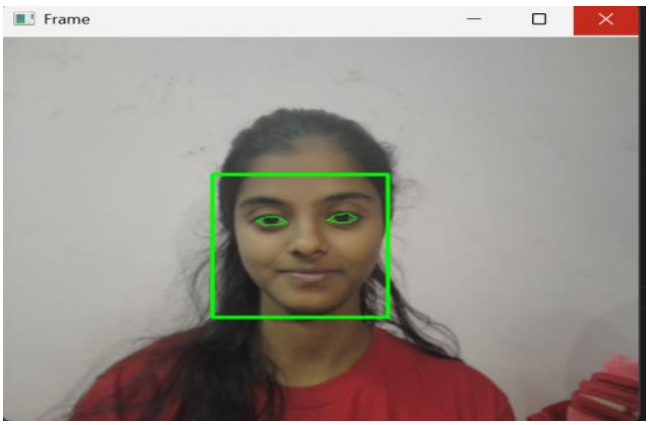
dlib is used to detect faces and locate facial landmarks (like eyes, nose, mouth, etc.). We used a pre-trained model called shape_predictor_68_face_landmarks.dat which detects 68 key points on the face. From these, we get the coordinates of the eyes to check if the driver's eyes are open or closed.

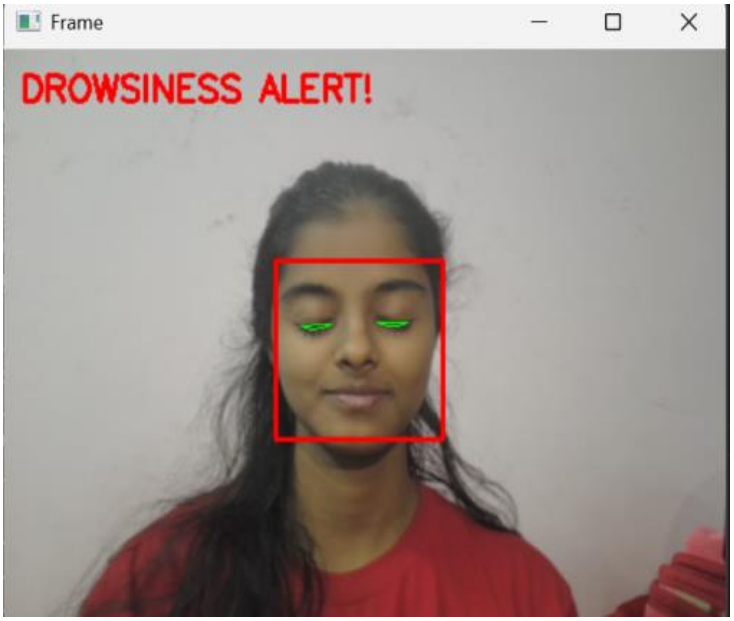
5-SCREENSHOTS



Screenshot 1 System calibrating eye aspect ratio (EAR) by analyzing eye openness in real-time

Screenshot 2 System detecting facial features and marking eye landmarks for real-time EAR monitoring.





Screenshot 3 Eyes closed detected — system triggers drowsiness alert with visual warning and alarm sound to alert the driver

Screenshot 4 Face not detected — system alerts the user with a sound and prompts them to stay visible for monitoring

6-CONCLUSION

In conclusion, we developed a real-time drowsiness detection system using computer vision. The idea is to track the driver's face and eyes and trigger alerts when signs of fatigue are detected. Although the system is still in the planning stage, it shows strong potential to help reduce road accidents caused by drowsiness and improve overall driving safety.

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