INDIAN INSTITUTE OF
TECHNOLOGY PATNA

DRIVER DROWSINESS DETECTION SYSTEM

Capstone Project Report

Presented by
Shivam

Group No.
98

Hybrid UG Program in
Computer Science & Data Analytics

Date
May 2025

PROBLEM STATEMENT

Driver drowsiness is one of the leading causes of road accidents worldwide. Fatigue reduces a driver's attention, slows reaction time, and increases the risk of collisions.

High Accident Rate
A significant number of accidents are caused by drivers falling asleep or losing alertness.

Lack of Real-time Detection
Existing systems are mostly reactive and do not detect drowsiness in real time.

Low Awareness & Delayed Response
Drivers often do not realize they are drowsy, leading to delayed response and accidents.

Need for an Efficient Solution
There is a need for an accurate, real-time, and non-intrusive system to detect drowsiness and alert the driver early.

~20%
of road accidents are caused by driver fatigue.

1.5 Million+
lives lost every year due to drowsy driving (WHO).

2–3 Sec
of drowsiness can lead to a serious accident.

Real-time
detection can prevent accidents and save lives.

PROJECT OBJECTIVE

To develop a real-time, accurate, and efficient system that can **detect driver drowsiness** using computer vision techniques and alert the driver before a critical situation occurs.

01

Real-time Monitoring

Continuously monitor the driver's eye activity in real-time using a standard webcam.

02

Accurate Drowsiness Detection

Use the Eye Aspect Ratio (EAR) and temporal analysis to detect prolonged eye closure accurately while ignoring normal blinks.

03

Instant Alert Generation

Trigger immediate visual and audible alerts when drowsiness is detected to warn the driver in time.

04

Improve Road Safety

Help reduce road accidents caused by driver fatigue and promote a safer driving environment.

Our goal is to build a lightweight, efficient, and non-intrusive system that can run in real-time and contribute towards **safer roads and better lives.**

PROPOSED SOLUTION

SYSTEM OVERVIEW & ARCHITECTURE

The Driver Drowsiness Detection System is a real-time computer vision solution that monitors the driver's eye behavior using the **Eye Aspect Ratio (EAR).** It detects signs of drowsiness and triggers immediate alerts to prevent potential accidents.

PRODUCT DEMO

HOW IT WORKS (AT A GLANCE)

- Captures real-time video using webcam.
- Detects face and extracts eye landmarks.
- Calculates EAR from landmarks and analyzes over time.
- Detects prolonged eye closure (drowsiness).
- Triggers visual and audible alerts to warn the driver.

SYSTEM ARCHITECTURE

1. INPUT — Webcam Capture

→ **2. DETECTION** — Face Detection & Eye Landmark Extraction

→ **3. ANALYSIS** — EAR Calculation & Temporal Analysis

→ **4. DECISION** — Drowsiness Detection Logic (Threshold + Consecutive Frames)

→ **5. OUTPUT** — Alert Generation (Visual & Audible)

TECHNOLOGIES USED

- **OpenCV** — For image processing and computer vision
- **dlib** — For face detection and facial landmark extraction
- **Python** — For implementation and system integration

Real-time & Efficient

Optimized for real-time performance with minimal computational cost.

Accurate & Reliable

EAR-based detection with temporal analysis ensures high accuracy.

Lightweight & Scalable

Works on standard hardware and can be scaled for various applications.

Enhances Safety

Helps prevent accidents and promotes safer driving habits.

EYE METRICS: EAR & MAR

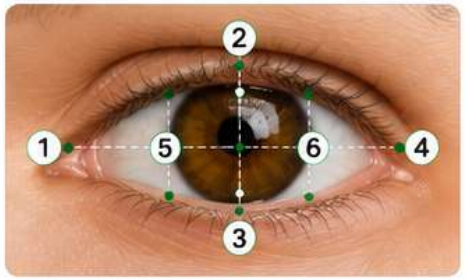
Quantifying Eye and Mouth States for Drowsiness Detection

To reliably detect drowsiness, the system uses two key metrics:
Eye Aspect Ratio (EAR) to measure eye openness and
Mouth Aspect Ratio (MAR) to measure mouth opening (yawning).
These simple geometric ratios are computed using facial landmarks.

WHY USE EAR & MAR?

- **EAR drops when eyes close**
  Helps detect drowsiness
- **MAR increases during yawning**
  Strong indicator of fatigue
- **Lightweight & real-time**
  Works efficiently on standard hardware
- **Robust & reliable**
  Less affected by lighting and head movement

1. EYE ASPECT RATIO (EAR)

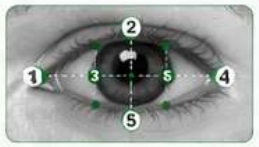


Formula

$$EAR = \frac{||p2 - p6|| + ||p3 - p5||}{2 \times ||p1 - p4||}$$

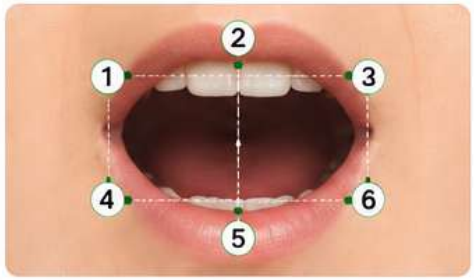
Where:
p1–p6 are 2D landmarks around the eye.

Eye Open
EAR ≈ 0.25 – 0.35
(Higher Value)



Eye Closed
EAR ≈ 0.10 or less
(Lower Value)

2. MOUTH ASPECT RATIO (MAR)

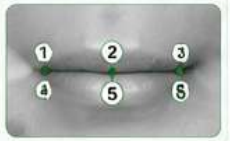


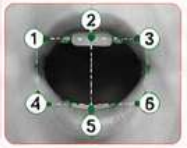
Formula

$$MAR = \frac{||p2 - p5||}{||p1 - p3||}$$

Where:
p1–p6 are 2D landmarks around the mouth.

Mouth Closed
MAR ≈ 0.15 – 0.25
(Lower Value)





Yawning (Mouth Open)
MAR > 0.60
(Higher Value)

HOW THEY WORK TOGETHER

Drowsiness is detected when EAR remains low for a certain duration (eyes closed) and/or MAR becomes high (yawning). Using both metrics improves detection accuracy and reduces false alarms.

Compute EAR (Eye Openness) + **Compute MAR** (Mouth Opening) → **Temporal Analysis** (Over Consecutive Frames) → **Drowsiness Detected**

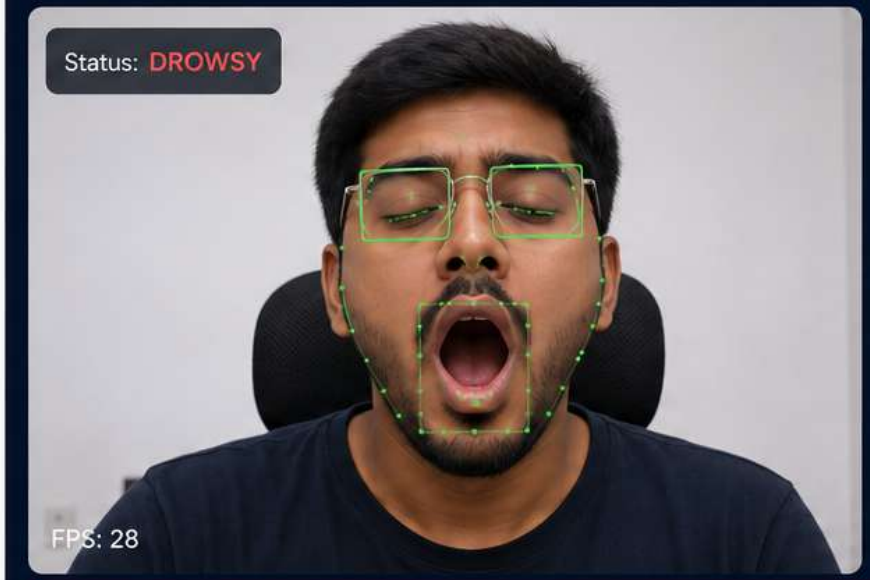
- **Simple & Efficient**
  Based on geometric distances between facial landmarks.
- **Real-time Capable**
  Low computational cost enables smooth real-time performance.
- **Reliable Indicator**
  EAR and MAR are proven indicators of drowsiness and fatigue.
- **Improved Accuracy**
  Combining EAR and MAR reduces false alarms and improves robustness.

PRODUCT DEMO / OUTPUT RESULTS

Real-time Drowsiness Detection in Action

DROWSINESS DETECTION SYSTEM

● LIVE



EYE ASPECT RATIO (EAR)

Left EAR : 0.16

Right EAR : 0.15

Avg EAR : 0.16

0.00 0.10 0.20 0.30 0.40

Threshold: 0.18

MOUTH ASPECT RATIO (MAR)

MAR : 0.68

0.00 0.20 0.40 0.60 0.80 1.00

Threshold: 0.60

ALERT! DROWSINESS DETECTED

Please take a break and stay safe.

WHAT YOU SEE

Eye Landmarks
Tracks eye openness using 6 facial landmarks and computes EAR.

Mouth Landmarks
Tracks mouth opening using 6 facial landmarks and computes MAR.

Metric Values
Real-time EAR and MAR values are displayed with thresholds.

Alert System
When EAR goes below threshold and/or MAR goes above threshold, an alert is triggered.

SYSTEM STATUS (EXAMPLE)

Driver State	Drowsy (Yawning)
Avg EAR	0.16 (Below 0.18)
MAR	0.68 (Above 0.60)
Alert	ON
FPS	28 (Real-time)

Real-time Detection
Processes video frames in real-time using webcam.

Accurate Tracking
Uses facial landmarks for precise measurement.

Instant Alerts
Triggers audio-visual alerts on drowsiness detection.

Lightweight & Efficient
Optimized for real-time performance on standard hardware.

Driver Safety
Helps in preventing accidents and promotes safe driving.

The system continuously monitors EAR and MAR to detect drowsiness and provides timely alerts for safer journeys.

CONCLUSION

Building Safer Journeys with Intelligent Detection

KEY TAKEAWAYS

Real-time Detection

The system detects drowsiness in real-time using EAR and MAR from facial landmarks.

Effective Indicators

EAR and MAR are proven to be strong, reliable indicators for identifying drowsiness and yawning.

High Performance

Achieved high accuracy with low false alarms and smooth real-time performance.

Optimized Workflow

A well-structured workflow ensures efficient detection, alert generation and user notification.

Impact & Potential

The system enhances driver safety and provides a scalable foundation for future intelligent solutions.

This project successfully delivers a robust, efficient and real-time driver drowsiness detection system using EAR and MAR.

The project provides a scalable foundation for intelligent driver safety systems.

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THANK YOU!

For Your Attention

"Towards Safer Journeys with Intelligent Drowsiness Detection."

Real-time
Detection

Reliable
Performance

Instant
Alerts

Enhanced
Driver Safety