IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Real-Time Deep Learning-Based Drowsiness Detection Using Computer Vision and Eye-Blink Analysis

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Abstract:

Driver drowsiness is a major cause of road accidents worldwide, leading to significant loss of life and property. This project presents an AI-Based Driver Drowsiness Detection and Alert System that continuously monitors a driver's facial expressions using a webcam and computer vision techniques. The system utilizes MediaPipe Face Mesh to detect facial landmarks and calculates the Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) to identify signs of fatigue such as prolonged eye closure and yawning. Based on the detected condition, the system generates different audio alerts using Pygame to immediately warn the driver. In critical situations, where eye closure exceeds a predefined threshold, the system captures an image of the driver and automatically sends an email notification with the captured image as evidence. The proposed solution is non-intrusive, cost-effective, and capable of real-time operation using standard hardware. Experimental results demonstrate that the system can effectively detect driver fatigue and provide timely alerts, thereby enhancing road safety and reducing the risk of accidents caused by drowsiness.

Index: Artificial Intelligence (AI), Computer Vision, Driver Drowsiness Detection, MediaPipe Face Mesh, Eye Aspect Ratio (EAR), Mouth Aspect Ratio (MAR), Fatigue Detection, Yawn Detection, Real-Time Monitoring, Alert System, Road Safety, Webcam-Based Detection.

I. INTRODUCTION

Road transportation is one of the most widely used modes of travel, but driver fatigue and drowsiness remain major contributors to road accidents worldwide. Long driving hours, insufficient sleep, stress, and monotonous driving conditions can significantly reduce a driver's alertness, leading to delayed reaction times and poor decision-making. According to various traffic safety studies, a considerable percentage of road accidents occur due to driver drowsiness, resulting in injuries, fatalities, and economic losses.To address this issue, intelligent driver monitoring systems have gained significant attention in recent years. Advances in Artificial Intelligence (AI), Computer Vision, and Machine Learning have enabled the development of real-time systems capable of detecting signs of fatigue through facial analysis. Unlike traditional methods that rely on physiological sensors, vision-based approaches are non-intrusive, cost-effective, and easier to deploy in vehicles.This project presents an **AI-Based Driver Drowsiness Detection and Alert System** that utilizes a webcam and **MediaPipe**

Face Mesh technology to continuously monitor the driver's facial landmarks. The system analyzes eye and mouth movements by calculating the **Eye Aspect Ratio (EAR)** and **Mouth Aspect Ratio (MAR)** to detect prolonged eye closure and yawning, which are key indicators of drowsiness. Based on the detected fatigue level, the system generates appropriate audio alerts to warn the driver. In critical situations, the system captures an image of the driver and automatically sends an email notification to a predefined recipient for additional safety.The proposed system provides a low-cost, real-time, and efficient solution for reducing fatigue-related accidents and improving overall road safety. By integrating facial landmark detection, alert mechanisms, and automated notification services, the system serves as an intelligent driver assistance tool capable of enhancing driver awareness and preventing potential accidents.

OBJECTIVES

To develop an AI-based real-time driver drowsiness detection system that monitors driver alertness using facial landmark analysis and generates warning alerts to prevent fatigue-related accidents.

Specific Objectives

- To capture live video of the driver using a webcam.
- To detect facial landmarks using MediaPipe Face Mesh technology.
- To calculate Eye Aspect Ratio (EAR) for detecting eye closure.
- To calculate Mouth Aspect Ratio (MAR) for detecting yawning behavior.
- To identify different levels of driver fatigue based on facial features.
- To generate distinct audio alerts for eye closure, yawning, and critical drowsiness conditions.
- To capture the driver's image during severe drowsiness events.
- To automatically send email notifications with the captured image to a predefined recipient.
- To provide a low-cost and non-intrusive driver safety solution.
- To improve road safety by reducing accidents caused by driver fatigue.

II. PROBLEM STATEMENT

Driver drowsiness is a significant factor contributing to road accidents and fatalities worldwide. Fatigue caused by long driving hours, lack of sleep, and continuous vehicle operation reduces driver concentration and reaction time, increasing the risk of accidents. Traditional drowsiness detection systems often require expensive sensors and specialized equipment, making them unsuitable for widespread adoption. Therefore, there is a need for a cost-effective, real-time, and non-intrusive driver monitoring system that can accurately detect signs of fatigue, such as prolonged eye closure and yawning, and provide timely alerts to prevent accidents and enhance road safety.

III. PROPOSED SYSTEM

The proposed system is an intelligent driver monitoring solution that uses computer vision and artificial intelligence techniques to detect drowsiness in real time. A webcam continuously captures video frames of the driver, which are processed using MediaPipe Face Mesh to extract facial landmarks. The system identifies key points around the eyes and mouth and calculates the Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR).When the EAR value falls below a predefined threshold for a certain duration, the system interprets it as prolonged eye closure, indicating drowsiness. Similarly, when the MAR value exceeds a predefined threshold, the system detects yawning behavior. Based on these measurements, the system classifies the driver's condition into normal, eyes closed, yawning, or critical drowsiness states.To ensure immediate response, different audio alerts are generated for each detected condition using the Pygame library. If the driver's eyes remain closed for an extended period, indicating severe drowsiness, the system captures an image and automatically sends an email alert with the captured image attached to a predefined emergency contact. This multi-level alert mechanism enhances driver safety by providing both local and remote notifications.

The proposed system is cost-effective, easy to implement, and capable of operating in real time using standard hardware such as a laptop and webcam, making it suitable for various transportation and driver monitoring applications.

IV. LITERATURE SURVEY

[1] Sankaran, K. S., Vasudevan, N., & Nagarajan, V. (2020) proposed a driver drowsiness detection system based on the Percentage Eye Closure (PERCLOS) method. The system continuously monitors the driver's eye state using image processing techniques and calculates the percentage of time the eyes remain closed over a specific period. When the eye closure exceeds a predefined threshold, the system identifies the driver as drowsy and generates an alert. The study demonstrated that PERCLOS is a reliable indicator of fatigue and can be effectively implemented in real-time driver monitoring applications. The proposed approach offers a cost-effective solution for reducing accidents caused by driver fatigue.

[2] Talukder, M. M. A., Islam, M. S., Ahmed, I., & Raihan, M. A. (2013) investigated the major causes of fatigue among truck and cargo drivers in Bangladesh. Through surveys and field studies, the authors identified prolonged driving hours, inadequate rest periods, poor road conditions, and stressful working environments as the primary contributors to driver fatigue. The study emphasized that fatigue significantly impairs reaction time, decision-making ability, and overall driving performance. The findings highlighted the urgent need for fatigue monitoring systems and stricter regulations regarding driver working hours to improve road safety.

[3] Tribune Desk (2023) reported a tragic road accident in Madaripur, Bangladesh, where driver exhaustion resulting from continuous driving for approximately 33 hours was identified as the primary cause. The incident demonstrated the severe consequences of fatigue on driving performance and reinforced the necessity of implementing real-time drowsiness detection systems in commercial vehicles. The report serves as practical evidence supporting the development of intelligent monitoring technologies to prevent fatigue-related accidents.

[4] Martin, L. M. (2023) discussed the growing problem of drivers falling asleep at the wheel and its impact on road safety. According to the National Safety Council, drowsy driving significantly increases the risk of crashes due to reduced attention, slower reaction times, and impaired judgment. The article emphasized that fatigue-related accidents are often underreported, making them a critical public safety issue. The study recommended technological interventions, including driver monitoring systems and alert mechanisms, as effective measures to mitigate risks associated with drowsy driving.

[5] Baul, S., Rana, M. R., & Alam, F. (2024) developed a lightweight computer vision-based driver drowsiness detection application capable of operating in real time on low-resource devices. The system utilized facial landmark detection techniques to monitor eye closure and facial expressions associated with fatigue. The proposed model achieved high detection accuracy while maintaining low computational complexity, making it suitable for deployment on embedded systems and portable devices. The research demonstrated the effectiveness of lightweight artificial intelligence models in improving driver safety without requiring expensive hardware.

[6] TBS Report (2024) highlighted that more than 35,000 lives were lost in road accidents in Bangladesh over a period of 5.5 years. The report, based on data from the Road Safety Foundation, identified driver fatigue as one of the major contributing factors to road crashes. The alarming statistics underscore the importance of adopting advanced driver assistance technologies, including drowsiness detection systems, to reduce accident rates and improve transportation safety.

[7] TBS Report (2024) analyzed the economic impact of road accidents in Bangladesh and reported losses exceeding Tk 21,000 crore. The report attributed a substantial portion of these losses to accidents caused by human errors, including fatigue and inattentiveness. The findings highlighted that preventing fatigue-related incidents through intelligent monitoring systems could not only save lives but also significantly reduce economic losses associated with road accidents.

[8] Mohanty, S., Hegde, S. V., Prasad, S., & Manikandan, J. (2019) designed a real-time drowsiness detection system using the Dlib facial landmark detection framework. The system extracted facial landmarks from live video streams and monitored Eye Aspect Ratio (EAR) values to determine eye closure patterns. When prolonged eye closure was detected, an alarm was triggered to alert the driver. Experimental results demonstrated that the system could effectively detect drowsiness under varying lighting conditions, making it suitable for real-world applications.

[9] Rana, M. R., & Baul, S. (2024) presented an overview of microkernel-based operating systems and their essential components. Although not directly related to driver drowsiness detection, the study provided valuable insights into lightweight and efficient operating system architectures suitable for embedded applications. Such operating systems can support real-time execution of computer vision algorithms and sensor data processing required in intelligent driver monitoring systems.

[10] Ahamed, J., Baul, S., Ali, M., & Nandi, D. (2024) explored advanced artificial intelligence mechanisms for breast cancer classification and prediction. The study demonstrated the effectiveness of machine learning and deep learning techniques in medical image analysis. The methodologies discussed, including feature extraction and classification algorithms, can be adapted to driver drowsiness detection systems for enhancing fatigue recognition accuracy through AI-based approaches.

V. IMPLEMENTATION

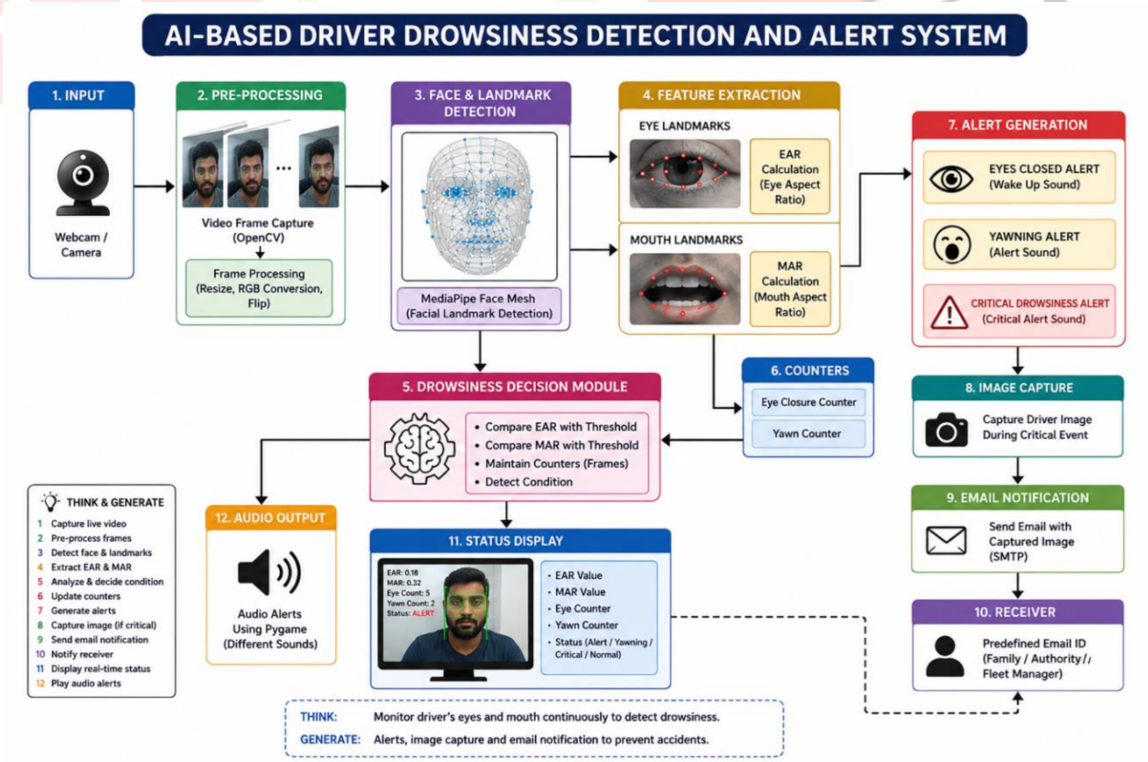

Fig. 6.1 : Explanation of AI-Based Driver Drowsiness Detection and Alert System Block Diagram

The Driver Drowsiness Detection System operates by continuously monitoring the driver's facial expressions through a webcam and analyzing eye and mouth movements in real time. Initially, the webcam captures live video frames of the driver, which are processed using the MediaPipe Face Mesh framework to detect and track facial landmarks accurately. The detected landmarks corresponding to the eyes and mouth are extracted for further analysis.

The system calculates the **Eye Aspect Ratio (EAR)** using specific eye landmark points. The EAR value decreases when the eyes begin to close and remains low when the eyes are fully closed. If the EAR value falls below a predefined threshold for a continuous number of frames, the system identifies the condition as eye closure, which is a strong indicator of driver drowsiness. Simultaneously, the **Mouth Aspect Ratio (MAR)** is calculated using mouth landmarks. A higher MAR value indicates a wide mouth opening, which is associated with yawning. When the MAR exceeds a predefined threshold for several consecutive frames, the system recognizes a yawning event.

Based on the calculated EAR and MAR values, the system continuously evaluates the driver's alertness level. If only eye closure is detected, an "Eyes Closed" warning is generated. If only yawning is detected, a "Yawning" alert is activated. When both prolonged eye closure and yawning occur simultaneously, the system classifies the condition as **Critical Drowsiness** and triggers a more urgent warning. Different audio alerts are played through the speaker using the Pygame library to immediately notify the driver and encourage corrective action.

In severe drowsiness situations, where the eye closure counter exceeds the critical threshold, the system automatically captures an image of the driver and stores it with a timestamp. The captured image is then attached to an email and sent automatically to a predefined recipient using the SMTP email service. This feature provides remote notification and can be used to alert fleet operators, family members, or supervisors about the driver's condition.
Throughout the operation, the system displays real-time information such as EAR value, MAR value, eye closure count, yawn count, and driver status on the screen. The continuous monitoring, alert generation, and email notification mechanisms work together to create an intelligent safety system capable of reducing accidents caused by driver fatigue and drowsiness.
The block diagram illustrates the complete workflow of the proposed Driver Drowsiness Detection and Alert System. The process begins with the **Webcam/Camera**, which continuously captures live video of the driver. The captured video frames are then passed to the **Pre-Processing Module**, where OpenCV performs operations such as frame acquisition, image resizing, RGB color conversion, and frame flipping to prepare the images for analysis.

After preprocessing, the frames are sent to the **MediaPipe Face Mesh Module**, which detects and tracks facial landmarks in real time. This module identifies important facial feature points around the eyes and mouth. The detected landmarks are then forwarded to the **Feature Extraction Module**, where eye landmarks are used to calculate the **Eye Aspect Ratio (EAR)** and mouth landmarks are used to calculate the **Mouth Aspect Ratio (MAR)**. These parameters serve as indicators of eye closure and yawning.The calculated EAR and MAR values are provided to the **Drowsiness Decision Module**, which compares them with predefined threshold values. The system maintains eye closure and yawn counters to monitor the duration of these events. Based on the comparison results, the module determines whether the driver is in a normal state, experiencing eye closure, yawning, or suffering from critical drowsiness.

The **Counters Module** keeps track of the number of consecutive frames in which eye closure or yawning is detected. These counters help avoid false detections caused by blinking or temporary facial movements. When the counter values exceed specified limits, the system confirms the drowsiness condition.Depending on the detected state, the **Alert Generation Module** activates different warning sounds. If eye closure is detected, an eye-closure alert sound is played. If yawning is detected, a yawn alert is generated. When both conditions persist for an extended period, the system triggers a critical drowsiness alarm to immediately warn the driver.

In severe cases, the **Image Capture Module** automatically captures the driver's image and stores it with a timestamp. The captured image is then sent to the **Email Notification Module**, which uses the SMTP protocol to send an email alert containing the image attachment. The email is delivered to a predefined recipient such as a family member, vehicle owner, supervisor, or fleet manager.

The **Status Display Module** continuously presents real-time information on the screen, including EAR value, MAR value, eye count, yawn count, and the current driver status. Simultaneously, the **Audio Output Module** produces warning sounds through the speaker using the Pygame library.

Overall, the system continuously monitors the driver's eyes and mouth, analyzes fatigue-related behaviors, generates real-time alerts, captures evidence during critical situations, and notifies concerned persons through email. This integrated approach enhances driver safety and helps reduce accidents caused by fatigue and drowsiness.

Flowchart Explanation

The flowchart represents the complete operational sequence of the **AI-Based Driver Drowsiness Detection and Alert System**. The process begins with the **Start** block, where all required components such as the webcam, MediaPipe Face Mesh model, audio alert files, counters, and email settings are initialized. Once initialization is complete, the system starts capturing live video frames from the webcam continuously.

Each captured frame undergoes preprocessing operations such as image resizing, RGB color conversion, and frame flipping to improve the accuracy of facial landmark detection. The processed frame is then sent to the MediaPipe Face Mesh module, which detects the driver's face and extracts facial landmark points. If no face is detected, the system displays a "Face Not Detected" message and continues to process the next frame.
When a face is successfully detected, the system extracts eye and mouth landmark coordinates. Using the eye landmarks, the **Eye Aspect Ratio (EAR)** is calculated to determine whether the driver's eyes are open or closed. Similarly, the **Mouth Aspect Ratio (MAR)** is calculated using mouth landmarks to identify yawning behavior.

The system then updates the eye closure counter and yawn counter. If the EAR value falls below the predefined threshold, the eye closure counter increases; otherwise, it is reset. Likewise, if the MAR value exceeds the predefined threshold, the yawn counter increases; otherwise, it is reset. These counters help distinguish actual drowsiness from normal blinking or brief mouth movements.

After updating the counters, the system checks for drowsiness conditions. If the eye closure counter exceeds the specified eye-frame threshold, the system identifies an eye-closure event and plays an eye alert sound. If the yawn counter exceeds the yawn threshold, a yawning alert sound is generated. When both conditions persist for a prolonged duration or the counters exceed critical limits, the system classifies the situation as **Critical Drowsiness**.

During critical drowsiness, the system activates a critical warning alarm, captures an image of the driver, saves the image with a timestamp, and automatically sends an email notification containing the captured image to a predefined recipient using the SMTP protocol. This feature ensures that responsible individuals are informed about the driver's unsafe condition.

Finally, the system displays real-time information such as EAR value, MAR value, eye closure count, yawn count, and current driver status on the screen. After processing the current frame, the system returns to capture the next video frame, and the entire process repeats continuously until the application is terminated.

Overall, the flowchart illustrates how the system continuously monitors the driver's facial behavior, detects signs of fatigue, generates warning alerts, and performs emergency notification actions to enhance road safety and reduce accidents caused by drowsiness.

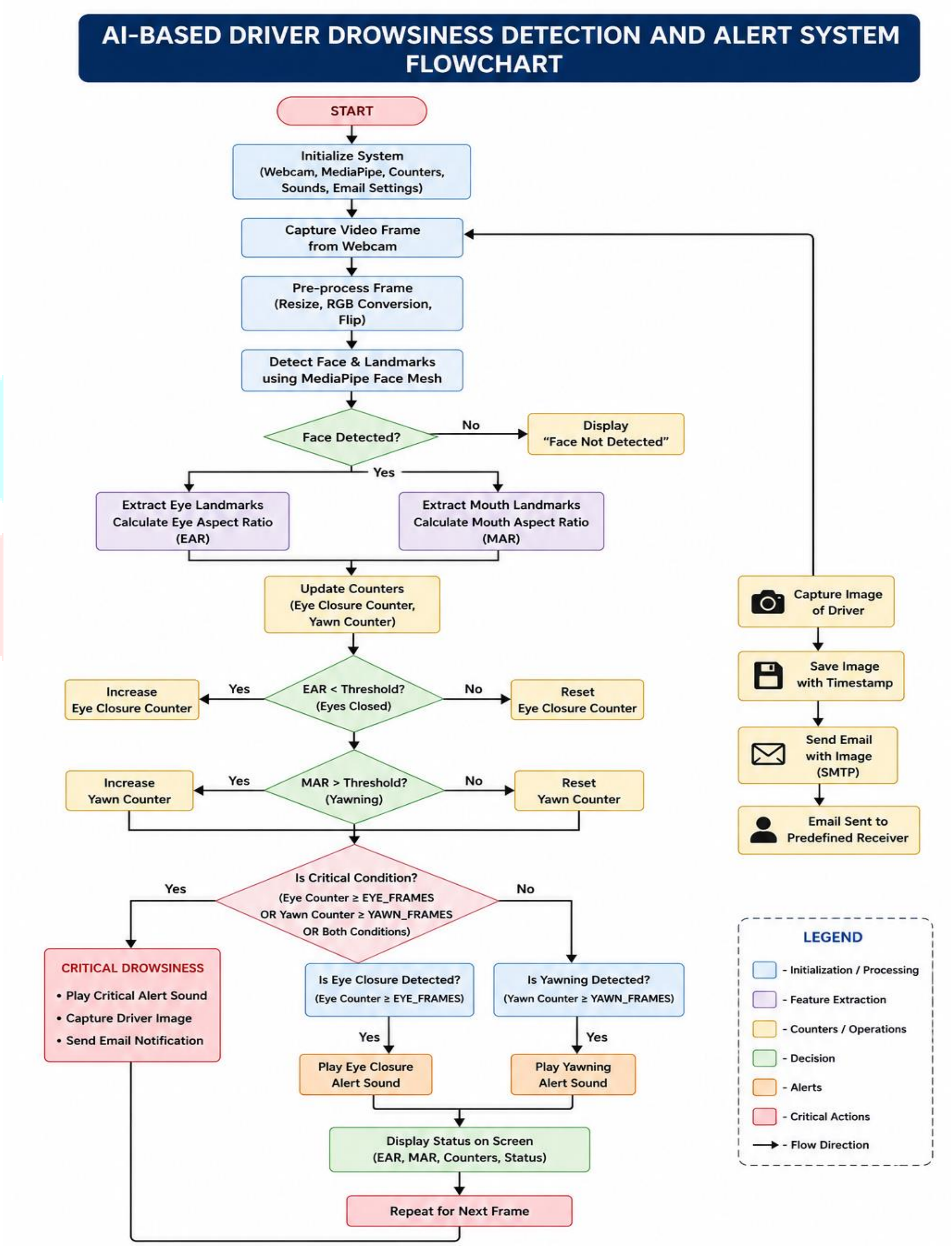

Fig. 6.2 : AI-Based Driver Drowsiness Detection and Alert System

VI. Hardware and Software requirments

Hardware Requirements

The proposed AI-Based Driver Drowsiness Detection and Alert System requires the following hardware components for real-time monitoring and alert generation:

Sl. No.	Hardware Componer	Specification
1	Laptop/Desktop	Intel Core i3/i5/i7 or equival
2	Webcam	Built-in or USB Camera (720p or higher)
3	Speaker	Audio Alert Output
4	Internet Connection	Required for Email Notificat
5	RAM	Minimum 4 GB, Recommen 8 GB
6	Storage	500 MB or More
7	Display Monitor	Standard LCD/LED Monito

Software Requirements

The software requirements include the programming environment, libraries, and tools used to develop and execute the proposed system.

Sl. No	Software/Tool	Function
1	Windows 10/11	Operating System
2	Python 3.10+	Programming Language
3	OpenCV	Image Processing and Video Capture
4	MediaPipe	Facial Landmark Detection
5	Pygame	Audio Alert Generation
6	SMTP	Email Notification Service
7	Math Library	Distance Calculations
8	Datetime Module	Timestamp Generation
9	MIME Libraries	Email Attachment Handling
10	VS Code/PyCharm	Development Environment

VII. Results and Discussion

The developed AI-Based Driver Drowsiness Detection and Alert System was successfully implemented and tested using a laptop webcam under normal indoor lighting conditions. The system continuously monitored the driver's facial expressions and accurately detected eye closure and yawning activities using MediaPipe Face Mesh facial landmark detection. Real-time computation of Eye Aspect Ratio (EAR) and Mouth Aspect Ratio (MAR) enabled effective identification of drowsiness-related behaviors.

During testing, the system successfully classified the driver's condition into four states: Alert, Eyes Closed, Yawning, and Critical Drowsiness. When the EAR value fell below the predefined threshold for a specified number of consecutive frames, the system generated an eye-closure warning. Similarly, when the MAR value exceeded the threshold, a yawning alert was activated. When both conditions persisted for a prolonged duration, the system triggered a critical drowsiness alert. The audio warning mechanism functioned effectively by generating different alert sounds for each condition, enabling immediate driver awareness. Furthermore, when the eye closure counter exceeded the critical threshold, the system automatically captured the driver's image and successfully transmitted an email notification containing the captured image to the predefined recipient through the SMTP email service. This demonstrated the capability of the system to provide both local and remote safety alerts.

The system also displayed real-time information including EAR value, MAR value, eye count, yawn count, and current driver status on the screen, allowing continuous monitoring and verification of system performance. The experimental results confirmed that the proposed system operates efficiently in real time using standard computing hardware without requiring specialized sensors.

REFERENCES

[1] Sankaran, K. S., Vasudevan, N., & Nagarajan, V. (2020, July). Driver drowsiness detection using percentage eye closure method. In 2020 International Conference on Communication and Signal Processing (ICCSP) (pp. 1422-1425). IEEE.

[2] Talukder, M. M. A., Islam, M. S., Ahmed, I., & Raihan, M. A. (2013). Causes of Truck and Cargo Driversâ€™ Fatigue in Bangladesh. Jurnal Teknologi (Sciences & Engineering), 65(3).

[3] Tribune Desk. (2023, March 20). Madaripur crash: Exhaustion from driving 33 hours led to accident. Dhaka Tribune. Retrieved
June 5, 2025, Available at:
https://www.dhakatribune.com/bangladesh/nation/307177/madaripur-crash-exhaustion-fromdriving-33-hours

[4] Martin, L. M. (2023, January 1). Drivers are falling asleep behind the wheel. National Safety Council. Retrieved June 5, 2025,
Available at: https://www.nsc.org/road/safety-topics/fatigued-driver

[5] Baul, S., Rana, M. R., & Alam, F. (2024). A Real-time Light-weight Computer Vision Application for Driver's Drowsiness
Detection. International Journal of Engineering and Manufacturing, 14(2), 23-33.

[6] TBS Report. (2024, October 16). Road accidents claim over 35,000 lives in 5.5 years: Road Safety Foundation, The Business
Standard. Retrieved June 5, 2025, Available at: https://www.tbsnews.net/ bangladesh/road-accidents-claim-over-35000-lives55-years-road-safety-foundation-968206

[7] TBS Report. (2024, January 8). Road accidents cost Bangladesh over Tk21,000cr in 2024: Report, The Business Standard.
Retrieved June 5, 2025, Available at: https://www.tbsnews.net/bangladesh/road-accidents-cost-bangladesh-over-tk21880cr2024-road-safety-foundation-1037621

[8] Mohanty, S., Hegde, S. V., Prasad, S., & Manikandan, J. (2019, November). Design of real-time drowsiness detection system
using dlib. In 2019 IEEE International WIE Conference on Electrical and Computer Engineering (WIECON-ECE) (pp. 1-4).

[9] Rana, M. R., & Baul, S. (2024). An Overview of Operating Systems Based on Microkernel Technology and their Essential
Components. International Journal of Information Engineering and Electronic Business, 16(6), 18-28.

[10] Ahamed, J., Baul, S., Ali, M., & Nandi, D. (2024, December). The Effective AI Mechanisms for Breast Cancer Classification and Prediction. In 7th IEOM Bangladesh International Conference on Industrial Engineering and Operations Management, https://doi.org/10.46254/BA07.20240063.

[11] Trisna, N., Baul, S., Joy, R., & Hasan, K. (2024, December). Advancements in Lung Cancer Detection: Harnessing Machine Learning for Early Diagnosis and Precision Medicine. In 7th IEOM Bangladesh International Conference on Industrial Engineering and Operations Management, https://doi.org/ 10.46254/BA07.20240196.

[12] Dalve, S., Ramdasi, I., Kothawade, G., Khadke, Y., & Wete, M. (2023). Real Time Prevention of Driver Fatigue Using Deep Learning and MediaPipe. International Journal of Innovative Research in Computer Science & Technology (IJIRCST) Volume11, Issue-3.