REAL TIME DRIVER DROWSINESS DETECTION And ALERT SYSTEM

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Abstract

In the realm of driver safety, the prevalence of drowsy driving poses a significant challenge, contributing substantially to traffic accidents globally. This research contributes to the ongoing efforts to enhance road safety by providing a robust solution to the critical issue of drowsy driving.

This paper presents a novel approach to driver drowsiness detection using computer vision techniques, specifically leveraging Python and OpenCV libraries. The key features such as eye closure, yawning, and head tilt are detected in real time..

Our approach involves webcam feed analysis and sophisticated algorithms implemented through OpenCV for real-time facial feature extraction and eye movement tracking. Accurate facial landmark detection and tracking are achieved using Python libraries, notably Dlib. The system employs an alarm triggered by prolonged eye closure, excessive head tilt, or frequent yawning. Additionally, a built-in escalation protocol initiates text message alerts to designated family members if the driver remains unresponsive following multiple warnings. The integration of OpenCV-based techniques for eye and facial feature extraction, coupled with innovative methods for head tilt and yawning detection, enhances the precision and effectiveness of the drowsiness detection system. Due to integration of three features the accuracy of drowsiness detection increased significantly and reduced false positives.

Keywords: OpenCV, Python, Webcam feed analysis, Alert system, Facial Feature Extraction, Escalation protocol

1. INTRODUCTION

In the contemporary era, the increasing prevalence of road accidents remains a significant global concern, posing a serious threat to public safety. A major contributing factor to these incidents is driver drowsiness, a pervasive issue that compromises the cognitive and physical capabilities of individuals behind the wheel. With transportation being so crucial in our lives, it's more important than ever to find effective ways to deal with the dangers of drowsy driving. This research paper aims to explore and evaluate the efficacy of Real-time Driver Drowsiness Detection Systems as a proactive means to address the hazards posed by drowsy driving.

A driver drowsiness detection system is meticulously crafted to elevate road safety through the vigilant monitoring of a driver's facial expressions, eye movements, and head gestures in real-time utilising a camera. By harnessing the advancements in computer vision, specifically utilising OpenCV (Open-Source Computer Vision Library) and incorporating pre-trained models, this system presents a compelling approach for real-time monitoring and prompt intervention. OpenCV, a versatile open-source library, serves as a key component in visual data processing. It facilitates tasks such as image and video analysis, enabling the extraction of valuable insights from visual information. The overarching goal is to not only enhance road safety but also contribute to the broader discourse on intelligent transportation systems that prioritise the well-being of both drivers and passengers.

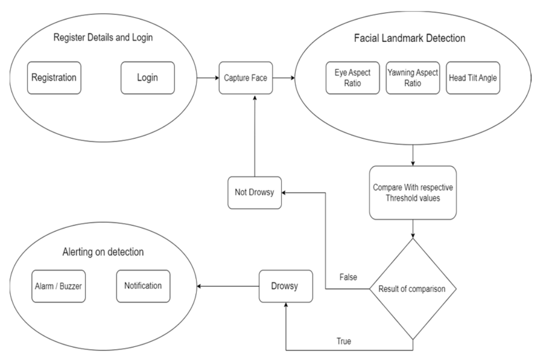
This paper contributes to the ongoing efforts to enhance road safety by presenting a novel approach to driver drowsiness detection using computer vision techniques. The key features such as eye closure, yawning, and head tilt are detected in real time. Our approach involves webcam feed analysis. Accurate facial landmark detection and tracking are achieved using Python libraries, notably Dlib. The system employs an alarm triggered by prolonged eye closure, excessive head tilt, or frequent yawning. Additionally, a built-in escalation protocol initiates text message alerts to designated family members if the driver remains unresponsive following multiple warnings. The integration of OpenCV-based techniques for eye and facial feature extraction, coupled with innovative methods for head tilt and yawning detection, enhances the precision and effectiveness of the drowsiness detection system. Due to integration of three features, the accuracy of drowsiness detection increased significantly and reduced false positives.

2. RELATED WORK

In the dynamic field of real-time driver drowsiness detection, a synthesis of methodologies across different research papers is evident. Deep learning takes precedence in Paper [2], introducing two systems that amalgamate Convolutional Neural Network (CNN), Recurrent Neural Network (RNN), fuzzy logic, and AI preprocessing. Despite achieving modest accuracy, challenges persist, particularly in precise drowsiness detection, especially when dealing with a significantly tilted face. Simultaneously, both Papers [3] and [4] leverage the Eye Aspect Ratio (EAR) as a crucial parameter for drowsiness detection. In Paper [3], EAR calculations are employed in conjunction with facial landmark detection and shape prediction methods, showcasing high accuracy under optimal face alignment conditions. However, potential challenges arise, including accuracy degradation with reflective eyewear and limitations in scenarios where the driver is not facing the camera directly. Paper [4], on the other hand, utilises EAR thresholds in machine learning-based facial landmark detection to achieve an 80% accuracy rate. The system triggers alerts based on EAR thresholds, providing an early warning to prevent accidents caused by driver fatigue. Challenges surface during night driving scenarios, emphasising the ongoing need for refinements to broaden the system's applicability. Paper [5] introduces a real-time visionary approach, emphasising eye blinking speed through Histograms of Oriented Gradients and Linear Support Vector Machines. While promising, challenges emerge in instances of significant head tilting, prompting considerations for further refinements and future iterations. Innovation through OpenCV algorithms characterises Paper [6], achieving an 80% accuracy rate in drowsiness detection based on blink patterns and eye aspect ratios. Limitations, such as reduced accuracy for individuals with dark skin, underscore the necessity for enhancements like automatic camera adjustments and adaptive binarization. Finally, Paper [7] focuses on a non-intrusive system that integrates the "shape predictor algorithm" and eye blink rate for successful drowsiness detection based on eye-related features. Despite its merits, the study highlights the need for further exploration of yawning frequency as a reliable indicator.

This comprehensive overview showcases the synergy and diversity in methodologies, emphasising the significance of ongoing research and refinements to ensure the robustness and applicability of these systems in real-world driving scenarios.

3. SYSTEM DESIGN



(Fig.1A System Design)

4. FEATURES DETECTION

Algorithm for Driver Drowsiness Detection System:
Start Algorithm

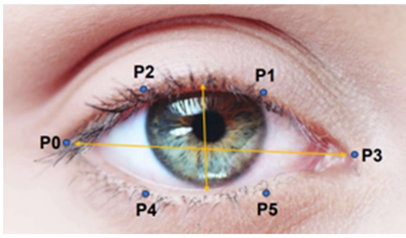
- Initialization:

Initialise necessary libraries, modules, and parameters.
Load the facial landmark predictor and set up the video stream.

- User Authentication:

Implement user registration and login system.
Collect user details during registration, including at least one family member's information.

- Image Capture:
  Capture images from the camera for facial analysis.
- Facial Landmark Detection:
  Use dlib's face detection to identify faces in the grayscale frame.
  Employ facial landmark detection to locate key points on the face.



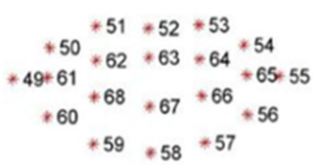
(Fig 2A Eye Aspect ratio)

- Eye Aspect Ratio (EAR) Calculation:
  Calculate the Eye Aspect Ratio (EAR) using the formula:
  EAR = (A+B) / (2 * C).

  Where A = | p2 - p4 | B = | p1 - p5 | & C = | p0 - p3 |

  $$EAR = \frac{|\square 2 - \square 4| + |\square 1 - \square 5|}{2 * |\square 0 - \square 3|}$$

  Set a predefined threshold for EAR.
  If EAR falls below the threshold, increment blink counter.
  Trigger an alert and sound an alarm if the blink counter reaches a certain limit.



(Fig.2B Mouth Aspect ratio)

- Mouth Aspect Ratio (MAR) Calculation:
  Calculate the Mouth Aspect Ratio (MAR) using the formula:
  MAR = (A+B+C) / (3 * D).
  Where A = | p51 - p59 | B = | p52 - p58 | C = | p53 - p57 | &D = | p49 - p55 |

$$MAR = \frac{|\square 51 - \square 59| + |\square 52 - \square 58| + |\square 53 - \square 57|}{3 * |\square 49 - \square 55|}$$

Set a predefined threshold for MAR.
If MAR is above the threshold, indicate that the driver is yawning.

- Head Tilt Angle Measurement:

Utilise 3D model points and solvePnP to estimate the camera's posture.
Convert the rotation vector to a rotation matrix.
Use the rotationMatrixToEulerAngles function to obtain Euler angles representing head tilt.

$$\Theta = \frac{\square_{21}}{\square_{22}}$$

Here, $\square_{21}$ and $\square_{21}$ are the elements of the rotation matrix corresponding to the second row and first column, and the second row and second column, respectively. The arctangent function (arctan) is used to calculate the angle in radians.
This expression captures the head-tilt angle based on the rotation matrix, and the resulting angle can be used as a feature for driver drowsiness detection.

- Drowsiness Detection:

Compare EAR, MAR, and head tilt angle with their respective threshold values.
If any of the ratios fall below the threshold, detect drowsiness.

- Alert Generation:

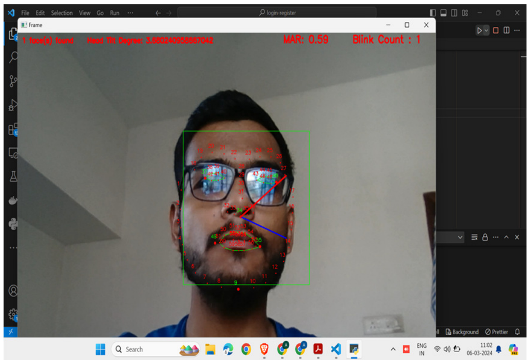
If drowsiness is detected, trigger an alert and display a warning on the frame.
Count the number of blinks, and if the count reaches a certain limit, sound an alarm. Notify family members if the driver fails to respond to alerts.

- Display and Cleanup:

Display the processed frame with annotations.
Continue processing frames until the user decides to quit (press 'q').
Release resources and close windows.

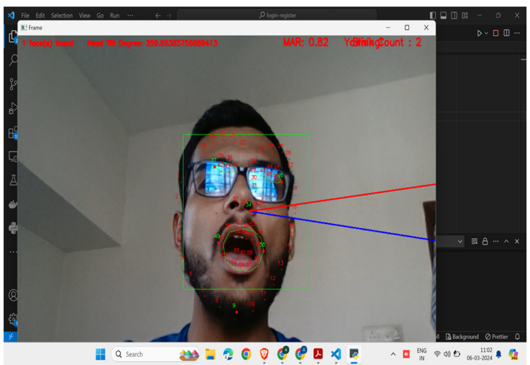
End Algorithm

5. RESULT



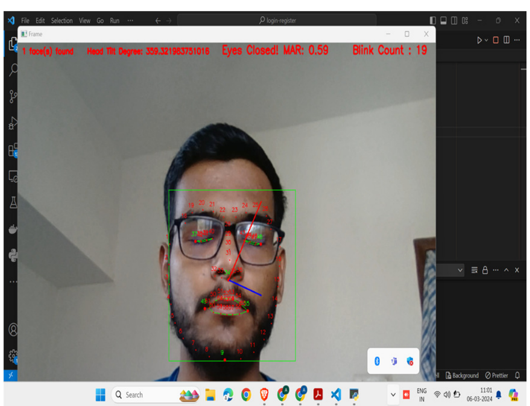
(Fig.3A Face Detected)

Above image shows the face is detected along with the eyes and mouth with the help of OpenCV.



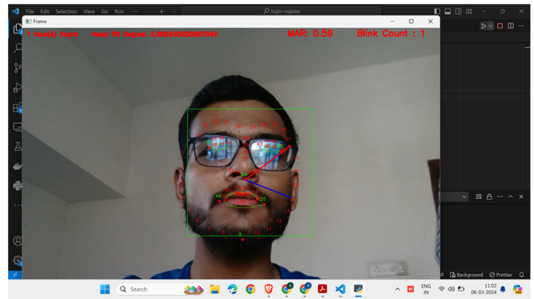
(Fig.3B Yawning)

Above image shows that yawning is detected.



(Fig.3C Eye Closed)

Above image shows that closed eyes are detected.



(Fig.3D Head Tilt)

Above image shows that the head angle is calculated.

6. CONCLUSION

In conclusion, the integration of eye, yawning, and head tilt monitoring in driver drowsiness detection systems offers a promising solution to mitigate fatigue-related accidents. By analysing these indicators, the system can promptly alert drivers, potentially preventing collisions and saving lives. Leveraging machine learning, these systems adapt to real-time data for optimal responsiveness. However, challenges like false alarms and environmental factors require further refinement. Overall, these integrated systems represent a significant advancement in driver safety technology, enhancing awareness and reducing the risks of drowsy driving accidents for safer roads.

7. FUTURE SCOPE

We as a Driver Drowsiness Detection System can have various modifications and additions in future which can include the following

1. Integration of Advanced Sensors : Future systems could integrate additional sensors such as EEG (Electroencephalography) or ECG (Electrocardiography) to monitor brain activity or heart rate variability, providing more comprehensive data for detecting drowsiness accurately.

2. Machine Learning Algorithms : Enhance the system's accuracy by employing advanced machine learning algorithms, including deep learning techniques like convolutional neural networks (CNNs) or recurrent neural networks (RNNs). These algorithms can continuously learn and

3. adapt to individual variations in facial expressions and movements associated with drowsiness.

4. Multi-modal Approach : Combine multiple modalities beyond facial features, such as steering wheel dynamics, vehicle speed, lane deviation, and biometric signals like skin conductance or temperature, for a more robust drowsiness detection system. Integrating these modalities can provide redundant safety measures and improve the system's reliability in real-world scenarios.

5. Personalised Drowsiness Detection : Implement personalised drowsiness detection algorithms that account for individual differences in facial expressions, physiology, and driving behaviour. By continuously adapting to the driver's characteristics and behaviours, the system can alter its alerts and intervention strategies accordingly, reducing the false positives and increasing accuracy.

8. REFERENCES

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