COMPUTER VISION BASED ON EYE CLOSURE & YAWN DETECTION FOR ROAD SAFETY

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Abstract— Driver fatigue and drowsiness are problems that cause a lot of road accidents all over the world. This is especially true when people are driving for a time or at night. When a driver gets sleepy they do not pay attention well it takes them longer to react and they do not make good decisions. This makes it more likely that they will be in an accident.To deal with this issue a system is being proposed that uses computer vision to monitor how alert the Driver fatigue and drowsiness system is. This system looks for signs of fatigue like how the driver blinks and yawns.It checks how often the driver blinks and It checks how often the driver yawns.The system uses a webcam to get a video of the Driver fatigue and drowsiness system face. It uses tools like OpenCV and Haar Cascade classifiers to find the Driver fatigue and drowsiness system face, eyes and mouth in the video. It looks at how long the Driver fatigue and drowsiness system eyesre closed and how often they yawn to figure out how tired they are.A score is given based on these things. If the score is too high the system warns the Driver fatigue and drowsiness system.The Driver fatigue and drowsiness system also keeps track of data about the Driver fatigue and drowsiness system fatigue. It shows how it changes over time.

This system is a way to detect when a Driver fatigue and drowsiness system is getting sleepy. It is also cheap.The idea behind this system is to help make the roads safer by warning Driver fatigue and drowsiness system when they are getting tired and reducing the number of accidents caused by Driver fatigue and drowsiness.The Driver fatigue and drowsiness system is important, for road safety. Driver fatigue and drowsiness are causes of road accidents. The Driver fatigue and drowsiness system helps to prevent these accidents.

Keywords— Driver Drowsiness Detection, Computer Vision, Eye Closure Detection, Yawn Detection, Driver Monitoring System, OpenCV, Haar Cascade Classifier, Real-Time Monitoring, Fatigue Detection, Road Safety.

1.INTRODUCTION

Driver drowsiness is a problem that causes many road accidents all over the world. When drivers get tired they do not react quickly. Driver drowsiness makes them do things like making poor decisions. This means driver drowsiness makes them more likely to have an accident.Many accidents happen because of driver drowsiness.This happens when drivers fall asleep or doze off for a seconds while driving.It is not a problem for the driver.Driver drowsiness is also very dangerous for the people in the car and others, on the road.So it is really important to make systems that can watch the driver and find out if they are getting tired.A lot of people are working on driver drowsiness to make roads safer [1].

Drowsiness detection systems have been studied a lot. They use technologies.Traditional methods use body signals like brain activity and heart rate.They also use wearable devices to check how tired a driver is.These methods can give results.They need special equipment.This can be a hassle, for drivers.Modern systems use computer vision.They look at a persons face andThey check eye movements and blinking.They also check how often a person yawns.These signs tell us if a driver is alert or not.This way we can check on the driver without bothering them.Drowsiness detection systems are helpful.They use computer vision to keep drivers safe.The systems check for drowsiness.They help prevent accidents caused by drowsy drivers[2].

However machine learning and image processing have gotten better. That has made driver monitoring systems more accurate.Most studies have used algorithms like Convolutional

Neural Networks, Support Vector Machines and techniques that detect face landmarks.They use these to analyze video from cameras inside the vehicle.These systems usually focus on detecting when a drivers eyes close their head moves or their mouth opens to see if they are tired.Using just one method to detect tiredness might not be accurate because of things like weather, lighting and how the driver behaves.So using factors to detect tiredness is more helpful, in making systems that detect if a driver is drowsy more accurate.This approach helps the system detect drowsy drivers effectively which makes roads safer.[3]

Recent advances in intelligent transportation systems have motivated researchers to automate the surveillance of driving performance and fatigue prevention. Driver monitoring systems based on vision have attracted significant interest because they provide non-intrusive and low-cost means to detect drowsiness. Most of these systems will feature cameras placed within the cabin to pick up facial features and look for behavioral cues like eye closure, blinking rate, or yawning frequency. The system can utilize image processing and machine learning techniques to accurately monitor the condition of the driver, identify other indications of fatigue, and ensure that it is up to date. Until that drowsiness is detected, an alert mechanism can be triggered to warn the driver and prevent accidents. These technologies serve as a foundation for road safety enhancement and can facilitate the creation of smart, self-driving systems. [4]

Driver fatigue is considered one of the leading causes of accidents on the road globally. Long hours of driving, lack of rest, and dull driving conditions can lead drivers to feel drowsy that impairs their speed/reaction time drastically. With the growing transportation systems and more vehicle use, driver safety is one of the significant research issues. Through this problem in mind, researchers recommend a driver drowsiness detection system that analyzes driver's physical and behavioral markers: eye movement, blinking signals and yawning. Computer vision based approaches have received intense interest as they non-invasively observe the driver via a camera and image processing algorithms. Using technologies such as OpenCV and deep learning frameworks, facial features are analyzed from the video stream in real-time to detect fatigue alerts before accidents. As a result, integrating efficient and accurate drowsiness detection systems can significantly increase road safety and minimize accidents caused by fatigue.[5]

2. RELATED WORK / LITERATURE SURVEY:

Several research studies have been carried out to design effective systems for detecting drowsiness in drivers and reducing the number of accidents due to driver fatigue. These systems generally utilize physiological signal-based methods, vehicle behavior analysis, or computer vision-based techniques to detect the level of alertness in the driver.

Eddie E. Galarza and Fabricio D. Egas have proposed a real-time driver drowsiness detection system based on the behavior of facial images by implementing a human-computer interaction system in a smartphone device. The main focus of the proposed driver drowsiness detection system is to analyze the driver's fatigue level based on the visual symptoms of drowsiness such as closing of eyes and yawning. The proposed driver drowsiness detection system utilizes facial feature detection techniques to monitor the driver's condition in natural lighting conditions and also when the driver is wearing different accessories such as glasses and caps.

Another research on driver drowsiness detection using machine learning methods was conducted by Swati Gade and Kshitija Kamble. This research article discusses various machine learning models, where driver behavior patterns are analyzed to detect driver drowsiness. The research paper focuses on various algorithms and also discusses the selection of appropriate features to achieve accurate results. The results of the research prove that efficient solutions can be achieved using machine learning methods to detect driver alertness.

In the work done by Ismail Nasri, Kamal Kassmi, and Mohammed Karrouchi, the authors discussed the various driver drowsiness detection systems. They discussed the different techniques, advantages, and disadvantages. They discussed the different techniques used to detect driver drowsiness. They concluded that the hybrid techniques used to detect driver drowsiness are much more reliable and accurate compared to the single techniques used.

Another research done by K. G. Walke, Harshvardhan Shete, and Darshan Asknani carried out a survey on the detection of driver drowsiness by using optical information and artificial intelligence. The research carried out by these authors used the analysis of the driver's facial features, such as the movement and blinking of the eyes, to determine the level of fatigue by using the percentage of eye closure (PERCLOS).

The driver drowsiness detection system based on Convolutional Neural Networks (CNN) has been proposed by Aishwarya Biju and Anitha Edison. In this proposed system, deep learning techniques have been used to classify the driver's state, which can be either drowsy or alert, based on the facial images captured in real-time. The proposed system consists of face detection and classification using a CNN model.

Analysis of the results of the Arterial Blood Gas (ABG) is an important part of the care of patients in the ICU. However, overuse of this procedure may lead to an increase in costs and discomfort for the patients. The proposed research work utilizes Support Vector Machine-based Machine Learning with SMOTE balancing for accurate classification of acid-base disorders, thereby increasing the accuracy of the results (93.02%) and the efficiency of the diagnostic procedures.

The diagnosis of ALF, Methanol Toxicity, Alcohol Poisoning, and DKA is challenging due to the overlapping symptoms of these diseases. A hybrid machine learning approach is proposed for the accurate diagnosis of diseases and for finding the relationships between diseases by utilizing the multilabel classification and association rule learning approaches.

From the analysis of these studies, it can be observed that techniques of computer vision and machine learning are contributing significantly to the development of efficient driver monitoring systems. However, there are certain limitations in terms of light conditions, facial occlusions, and real-time processing, which are affecting these systems. This highlights the significance of efficient detection techniques in driver monitoring systems.

3.PROPOSED SYSTEM / METHODOLOGY:

Computer vision methods are proposed for analyzing facial features like eye closure and yawning behavior in real time so as to detect driver drowsiness. The system processes a continuous video feed originating from a camera from the inside of the vehicle to monitor driver facial movements. For example, the system can detect abnormal patterns like prolonged eye closure or frequent yawning to identify signs of fatigue and generate an alert for the driver.

In the proposed system, there are different steps, including video acquisition, face detection/recognition and feature extraction from faces which is analyzed for fatigue to generate alert. These stages interact to provide reliable driver drowsiness detection in real-time.First, the camera records live video of the driver. Computer vision techniques are applied to each frame captured in the video stream, allowing the driver's face to be detected. After detecting the region of the face, it finds information about critical features of a face like mouth and eyes. The shouted features are monitored to track eye-blinking patterns and mouth movements. It computes indicators like how long your eye stays closed, and how often you yawn. If the driver's eyes are kept closed for a specific threshold of time or if repetitive yawning is detected, this indicates drowsiness to the system. The system enables an alert mechanism when the fatigue level exceeds a defined threshold to warn the driver with audio warning or visual notification

The proposed approach is based on image processing and machine learning, made using OpenCV. Facial regions are detected using Haar Cascade classifiers, and further image processing techniques are employed to keep an eye on the mouth and eyes. The system registers video frames in real time and periodically updates the driver's level of alertness. Hence, the proposed system integrates eye closure detection with yawning analysis to enhance the reliability of driver fatigue detection. Combining these modalities decreases false detections and improves the monitoring performance.

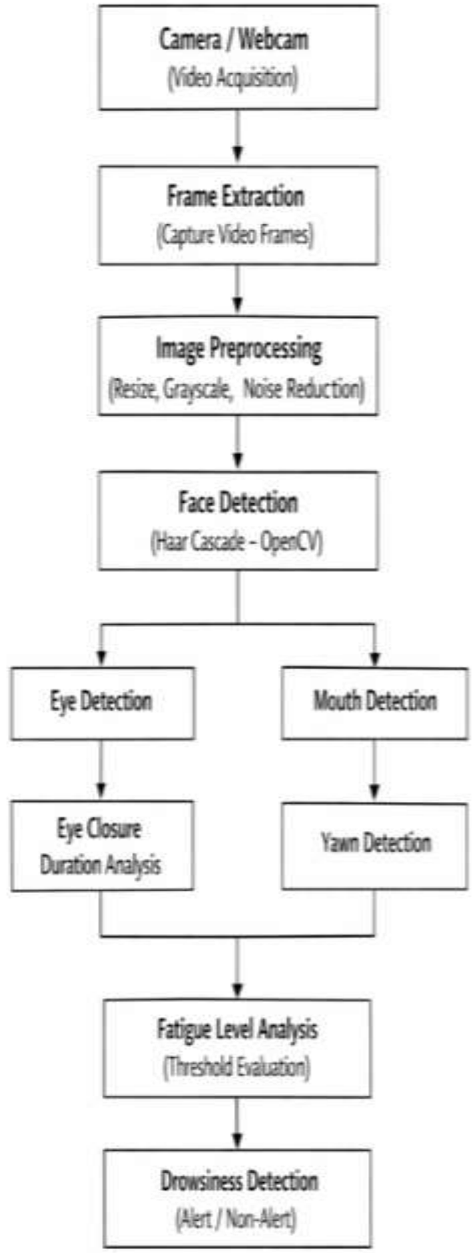

FIG:1 System Architecture of the Proposed Driver Drowsiness Detection System

3.1 Architectural Flow

The proposed system uses a sequential processing pipeline to monitor the behavior of the driver and detect signs of fatigue. The proposed system uses a number of modules to process video frames captured from the driver and detect drowsiness levels.

1.Image/Video Acquisition

The first step of the proposed system is to capture video of the driver using a webcam or a camera. The video is captured in real-time and sent to the processing unit.

2. Frame Extraction

The captured video is divided into individual frames. The video captured by the camera is divided into individual frames, and each frame is extracted and processed separately.

3. Image Preprocessing

This phase involves the pre-processing of the captured images. The pre-processing is carried out to enhance the accuracy of the face detection. The pre-processing includes resizing, conversion of the color of the image to gray-scale, etc.

4. Face Detection

The face of the driver is identified using computer vision techniques. The face of the driver is identified by using the Haar Cascade classifier. The ROI of the face of the driver is identified.

5. Eye Detection

After identifying the face of the driver, the eye of the driver is identified. The eye of the driver is identified by analyzing the patterns of the closing of the eyes. The closing of the eyes is identified by analyzing the patterns of the blinks of the eyes. The closing of the eyes of the driver is identified as one of the major factors of the fatigue of the driver.

6. Yawn Detection

The mouth of the driver is identified to detect the yawning of the driver. The yawning of the driver is identified as one of the major factors of the fatigue.

7. Feature Analysis

The system analyzes the features that are collected, for example, the eye closure period and the frequency of yawning. These features are then used to assess the level of alertness of the driver.

8. Drowsiness Detection

Using the features, the system can then detect whether the driver is alert or drowsy.

9. Alert Generation

If the driver is drowsy, the system can then generate an alert, for example, a sound, to warn the driver and prevent accidents from happening.

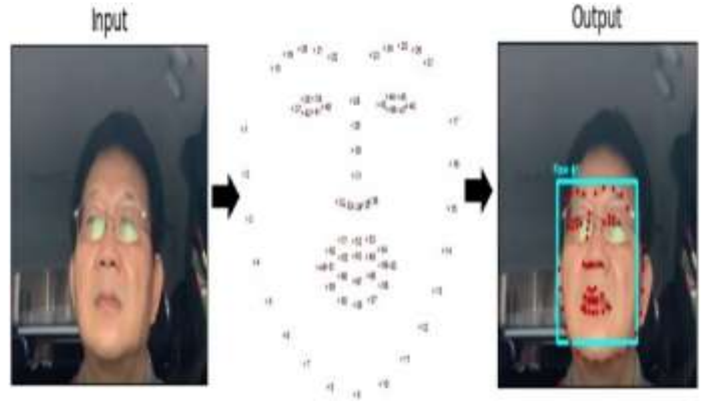

FIG:2 Input–Processing–Output Representation of the Proposed System

4. ALGORITHMS:

1. Haar Cascade Algorithm (Face & Eye Detection)

Haar Cascade Algorithm is a machine learning-based object detection technique used for face and eye detection in images. This technique makes use of Haar features, which are rectangular regions used for face detection by recognizing differences in pixel intensities. This technique works by examining the image at different scale levels, recognizing regions that correspond to patterns of faces. In the driver monitoring system, Haar Cascade Algorithm is used for the detection of the driver's face and eye regions from video streams before further analysis.

2. Eye Aspect Ratio (EAR) Algorithm

The EAR Algorithm is used for eye openness detection, i.e., whether the driver's eyes are closed or not. This algorithm calculates the ratio of vertical and horizontal distance between eye landmarks on the face of the driver. When the driver's eyes are open, the EAR value remains constant, and as the eyes get closed, the EAR value significantly drops. Thus, the EAR value can be used for continuously monitoring whether the driver's eyes are close or not,which can be a sign of drowsiness.

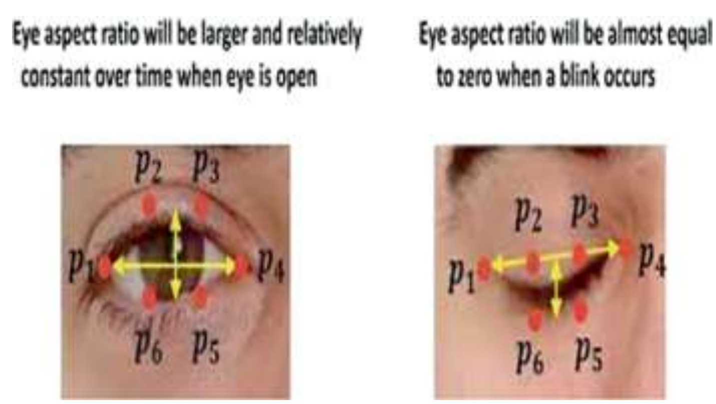

FIG:3 Eye Aspect Ratio (EAR)

3. Yawn Detection Algorithm

The Yawn Detection Algorithm tracks the driver's mouth region to detect the behavior of yawning. The system detects the facial landmarks around the mouth region and calculates the distance between the upper and lower lips. When the mouth is widely open for a certain period of time, it is considered a yawn. Yawning for a long period of time can be a symptom of fatigue, which can be used as a detection criterion for driver drowsiness.

(a) (b) (c)

FIG:4 Yawn Detection

4. Convolutional Neural Network (CNN)

A Convolutional Neural Network (CNN) is a deep learning model used for image classification and feature extraction. CNN is able to learn important features from images with the help of convolutional layers and pooling layers. CNN models can be used to classify whether a driver is drowsy or not by using images of their face obtained from the camera.

5. Threshold-Based Fatigue Detection Algorithm

The Threshold-Based Detection Algorithm is a method for determining whether the driver is drowsy or not by comparing the values with a threshold. The system compares the values for the driver's eye closure and yawn frequencies. When the values exceed the threshold limit, the system identifies the driver as drowsy and activates an alert system. This method reduces the false detection and enhances the reliability of the system….

5. EXPERIMENTAL RESULTS AND OUTPUT ANALYSIS:

The proposed driver drowsiness detection system was implemented using OpenCV, a computer vision library, and was tested by feeding a real-time video stream from a webcam. The system is designed to monitor the facial features of the driver and detect drowsiness, which is indicated by the closure of the eyes and yawning. When the program is executed, it processes video frames in real-time and carries out face detection, eye detection, and mouth detection using pre-trained Haar cascade classifiers.

Real-Time Detection Output

As the system starts running, the camera will capture the face of the driver and indicate the detected face region by a bounding box. The face region will be detected first, followed by the eye and mouth region to assess the condition of the driver.

If the eyes are found to be open, the system will assume the driver to be awake.

If the eyes are found to be closed for a certain number of frames (threshold = 20), the system will assume a drowsiness condition.

As soon as the drowsiness condition is detected, the system will display a message "DROWSINESS ALERT" on the screen and an alarm sound will be produced.

The system can also detect the yawn condition by analyzing the mouth region. As soon as the yawn condition is detected, a message "YAWNING DETECTED" will be displayed on the screen, and the score for the driver's fatigue will be increased accordingly.

Fatigue Score Monitoring

The program also keeps a track of the fatigue level, which increases if drowsiness symptoms such as closing the eyes for a long time or yawning are observed.

Depending on the fatigue level obtained after the session, the driver’s condition is classified into three states:

- Safe: If the fatigue score is less than 20
- Moderate Risk: If the fatigue score is between 20 and 40
- High Risk: If the fatigue score is greater than 40

This classification gives a clear indication of the level of the driver’s alertness during the session.

Snapshot Capture and Logging

Upon the detection of a drowsiness event, the system takes a snapshot of the driver's face automatically and stores it in a directory for further analysis. The system also records important information, such as the time, eye status, and fatigue scores, in a CSV file for further analysis of the driver's behavior and improvement of the detection system.

Performance Metrics

In addition, the system also shows the value of Frames Per Second (FPS) on the screen, which represents the rate at which the algorithm is processed in the system. A higher FPS ensures that the system can operate in real-time environments without experiencing any delay in its operations.

Fatigue Trend Visualization

Finally, the system produces a graph illustrating the change in the fatigue score over a period of time at the end of the monitoring session. This gives a visualization of the change in the driver’s fatigue level over the course of the driving session.

The graph illustrating the fatigue can provide insights into the behavior of the driver.

OUTPUTS:

In order to assess the performance of the proposed system for driver drowsiness detection, some experiments were performed on the system. The experiments used real-time webcam video feed.

The system processes the video frames received from the webcam feed. The system then detects the facial features such as the face, eyes, and mouth of the driver. The system then determines the state of the driver, such as normal alert state, yawning, or eye closure. The following figures show the system's output during execution with different states of the driver.

Figure 5: Yawning Detection Output

This output demonstrates the detection of yawning by the system in real time. The face and eyes are detected by the Haar Cascade classifier. When the mouth is open wide, the system will display the message "Yawning Detected" and will also increase the fatigue level.

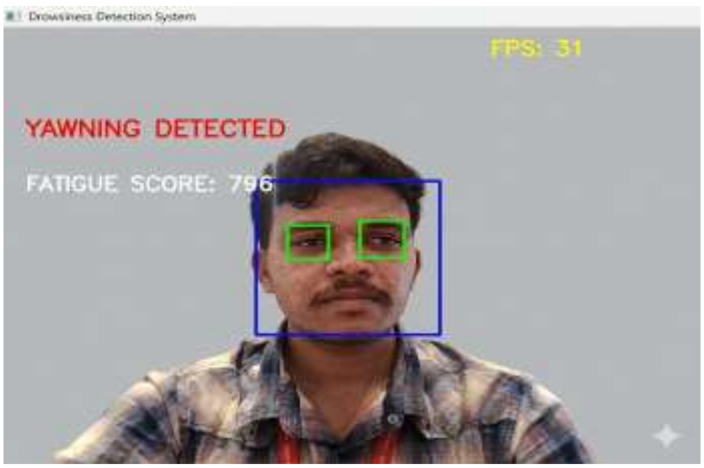

FIG:5 Yawning Detection

Figure 6: Eye Closure Detection

This frame shows the frame for the detection of closed eyes. After identifying the situation where the driver's eyes remain closed, the system will generate an alert message, "Drowsiness Alert."

FIG:6 Eye Closure Detection

Figure 7: Face and Eye Detection

This output represents the initial stage of the system, in which the face and eyes of the driver have been detected by Haar Cascade classifiers. The rectangular bounding boxes indicate the detected facial region used to monitor the eyes and fatigue level.

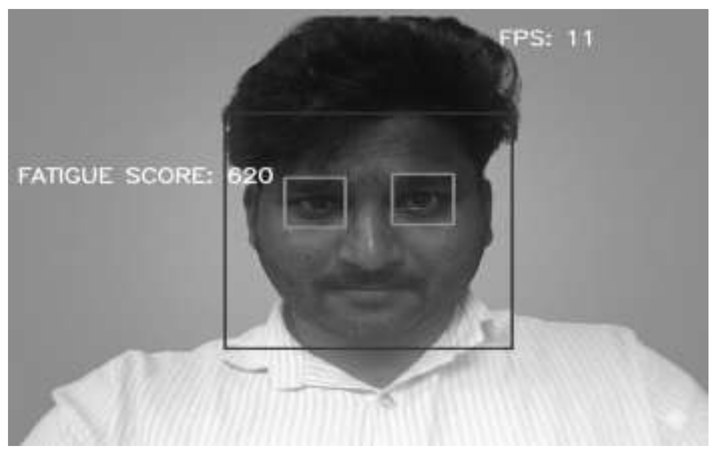

FIG:7 Face and Eye Detection

Figure 8: Drowsiness Alert Detection

This output shows that the system is successfully generating a drowsiness warning message for prolonged eye closure. The system draws a box on the detected face region and displays a warning message.

FIG:8 Drowsiness Alert Detection

6.CONCLUSION:

Driver fatigue is one of the main reasons for road accidents around the world; hence, the need for a reliable driver monitoring system is crucial for enhancing road safety. In this work, a computer vision-based driver drowsiness detection system was designed to monitor the driver's facial features in real time and detect the symptoms of drowsiness, such as long periods of eyes closed and yawning. The proposed system employs Haar Cascade classifiers for face, eyes, and mouth detection from the video frames captured through a webcam.

The system continuously monitors the eyes and mouth to detect the driver's state of alertness. When the eyes are found to be closed for a certain period of time or a yawn is detected, the system increments the score for driver fatigue and triggers a warning message to the driver. In addition, the system records the driver fatigue data, captures images during drowsiness events, and plots a graphical representation of the fatigue levels for further analysis.

The experimental results prove that the system can effectively detect early symptoms of driver fatigue. The system can be implemented in driver fatigue detection because of its real-time processing capability and low computational cost. The system can prevent accidents resulting from driver fatigue and improve road safety. The system can improve road safety by detecting early symptoms of drowsiness. The system can be improved in the future using deep learning algorithms, improving accuracy under low light, and developing embedded systems.

7.FEATURE SCOPE:

Although the proposed driver drowsiness detection system proves the effectiveness of the real-time monitoring system for driver drowsiness using computer vision techniques, various modifications and extensions can be considered for further improvement. One such improvement can be the use of advanced computer vision techniques involving the application of Deep Learning methods such as Convolutional Neural Networks (CNN) and Recurrent Neural Networks (RNN) for the reliability of the facial feature detection system.

Another improvement can be the ability to work under difficult conditions such as low-light environments, different lighting conditions, and the presence of glasses, masks, and head movements. This can be achieved by the use of infrared sensors and the reliability of the facial landmark detection system.

The system can be extended by incorporating additional physiological and behavioral measures like head pose estimation, steering behavior, and heart rate measurement to offer a comprehensive driver monitoring system. This would improve the accuracy of fatigue detection by considering various indicators.

In addition to this, the proposed system has the potential to be used in embedded systems and/or integrated with various vehicle systems to be used in real-world scenarios. With the advent of intelligent transportation systems and self-driving cars, driver monitoring systems like this have tremendous potential to contribute to road safety and avoid fatigue-related accidents.

Future research may also focus on developing mobile or cloud-based driver monitoring applications that allow real-time monitoring and data analysis for fleet management or transportation safety systems.

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