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Driver Monitoring System

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***Abstract*— Driver monitoring system is an emerging technology which aims at reducing the number of road accidents caused due to a distracted driver and thus increasing the road safety. The system works by monitoring the driver state and behavior by using image processing and computer vision techniques. Our results show that the system is effective and reliable for use in real-world scenario. Providing a viable solution for road accident caused due to distracted driver.**

***Keywords*— Fatigue, Driver drowsiness, Face detection, Dlib, Image Preprocessing, Feature extraction, Eye aspect ratio**

I. Introduction

Road Accidents are a leading cause of death worldwide killing around 1.3 million people each year. Most of these accidents are caused by the driver not paying attention or a distracted driver. Distraction can be of various forms such as drowsy driver or driver not paying attention on the road. A distracted driver has a reduced sense of alertness and concentration on the road which causes him to make slow decision and sometimes not able to take decision. All this ultimately result in the increased chances of the driver getting into an accident. This can be prevented if there was a system which continuously monitors the driver and in driver drowsiness or distraction is detected it raises an alarm.

The Driver Monitoring System aims to provide a low-cost user- friendly solution to the help reduce the accidents caused due to distracted driver. The proposed system aims at using computer vision techniques to continuously monitor the driver and provide an audio output to the driver to alert the driver incase driver distraction is detected. The technology shows promise in reducing a significant number of accidents on the road.

The research paper aims to document the development and evaluation Driver Monitoring System. This paper also aims at
Exploring existing technologies and solutions for Driver monitoring system the computer vision techniques used to develop the proposed system and the usability and effectivity in the real-world scenario. It will also present the user feedback and comparisons with existing systems. The paper will also present the potential for future research in this field.

II. Literature Survey

A. *Overview of current technologies and solutions fordriver monitoring system:*

One commonly used technology in DMS is cameras, which can capture images and analyze the driver behavior and state, including head pose, drowsiness and yawning.

Another technology used in driver monitoring system is biometric sensors such as heart rate monitor and electroencephalography devices, which can detect signs of driver fatigue and stress.

Some companies have also developed specialized driver monitoring system solution which can track eye and detect driver gaze direction and measure the frequency of eye blinks which can be an indicator of drowsiness

Over all there are numerous technologies and solutions available for driver monitoring system each has its own strengths and weakness. The choice of technology depends on the specific requirement and use case of DMS application.

B. *Limitations of existing systems:*

1. ***Cameras:*** Cameras can be affected by poor lighting conditions, reflections and other environmental factors**,** which can impact their accuracy. They can also raise privacy concerns as they capture images of driver face.
2. ***Biometric Sensors:*** Biometric sensors can be costly and require additional hardware to be installed in the vehicle. They may also be affected by external factors such as driver clothing and skin condition
3. ***Machine Learning Algorithms:*** Machine learning algorithms require a significant amount of data to be trained effectively. They can also be impacted by bias in training data, which can affect their accuracy.
4. ***Eye-Tracking technology:*** Eye Tracking technology can be affected by driver's glasses or contact lenses, which can interfere with the accuracy of measurment. It can also be impacted by external factors, such as bright sunlight or reflection on the windshield

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C. Review of relevant computer vision techniques for driver monitoring system:

Computer vision techniques play a crucial role in Driver Monitoring System, as they are used to analyze driver state and behavior. Here are some relevant computer vision techniques for driver monitoring system

1. ***Face Detection and Recognition:*** Face detection and recognition are used to identify the driver and track their facial features such as eye movements and head pose. This can be used to detect the signs of drowsiness or distraction.

2. ***Eye Tracking:*** Eye tracking is used to measure the driver gaze direction and eye movements, which can provide insight into their level of attentiveness and focus. It can also be used to detect the signs of fatigue and signs of fatigue, such as frequent blinking.

3. ***Head Pose Estimation:*** Head Pose estimation is used to track drivers head movements which can provide information about their level of engagement with the road. It can also be used to detect signs of distraction or drowsiness, such as nodding off.

4. ***Facial Expression Analysis:*** Facial expression analysis is used to detect changes in the driver's facial expression such as yawning and frowning. This can be used to detect the signs of fatigue or stress.

III. PROPOSED METHODOLOGY

A. PROPOSED SYSTEM

The system main objective is to detect driver distraction by continuously checking the facial expression of the driver by the method of facial landmark detection.

The Project objectives are:

1. Identification of Driver face from input video feed
2. Detection of eye closure by estimation of eye aspect ratio (EAR)
3. Detection of yawning by estimation of mouth aspect ratio (MAR).
4. To alert the driver if driver distraction is detected.

B. METHODOLOGY

The proposed methodology for the driver monitoring system project involves the following steps:

1. **Facial landmark Detection:** Facial landmark has been applied to a wide variety of computer vision projects some of them are head pose estimation, blink detection. Detecting facial landmark is a two- step process in the first step face region is identified in the captured image then the key features of the face is recognized.

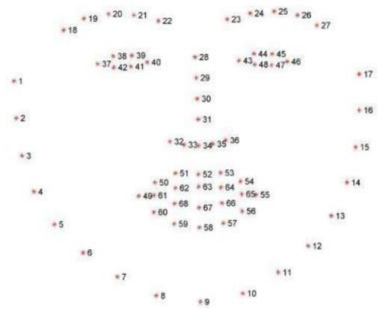

Fig 1. 68 Facial Landmark Visualization.

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68 Facial landmark coordinate detection is achieved through Dlib library.

2. Detection of Closed Eye: Using a web camera

The face is continuously collected, and the captured frames are analyzed in an opencv environment. Using the Dlib facial landmark detector. The face is recognized and important facial features are extracted. Both eye regions

Landmark indices are highlighted in the frame. The eye aspect ratio is continuously calculated and shown in the frame. The EAR value will be high when eyes are opened. The value of EAR will be lower when are closed. The detection of eye closure occurs when EAR value falls below a particular threshold. The alarm is set off to alert the driver when it detects that driver eye is closing

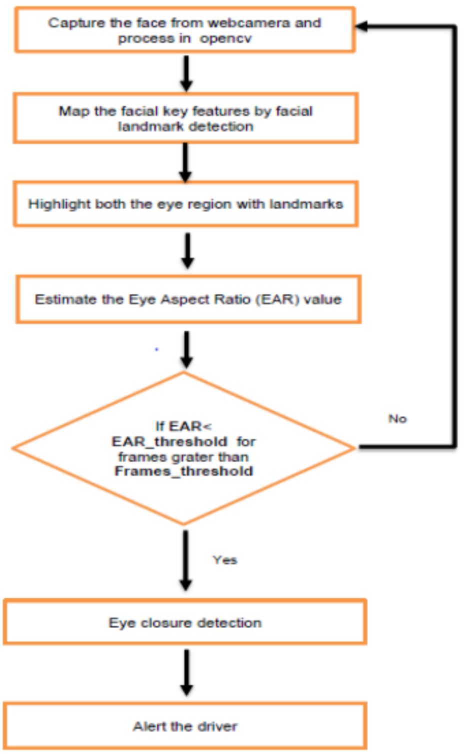

Fig 2: Process Flow of Eye Closure Detection

3. **Eye Aspect Ratio:** The term "EAR" stands for Eye aspect ratio, which is frequently used to determine the timing and rate of left and right eye blinks as well as the detection of weariness.

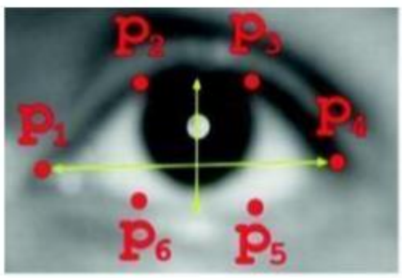

Fig 3: Landmarks when eyes open

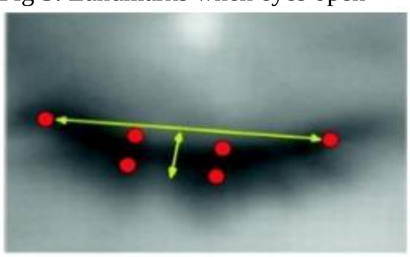

Fig 4: Landmark when eyes closed

The Eye Aspect Ratio (EAR) formula is given by:

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

This equation numerator computes the separation between vertical eye landmark. Weighting the denominator correctly because there is only one, whereas the denominator calculates the distance between horizontal eye landmark there are two sets of vertical point but only one set of horizontal point.

4. **Yawn Detection:** A Webcam is used to capture the face which is then processed in an OpenCV environment. The landmark indices for mouth are found and highlighted. Estimates are made for Mouth Aspect Ratio (MAR) The value for MAR will be lower when mouth is closed. The yawning will be recognized. The alarm function will be triggered when yawning is detected.

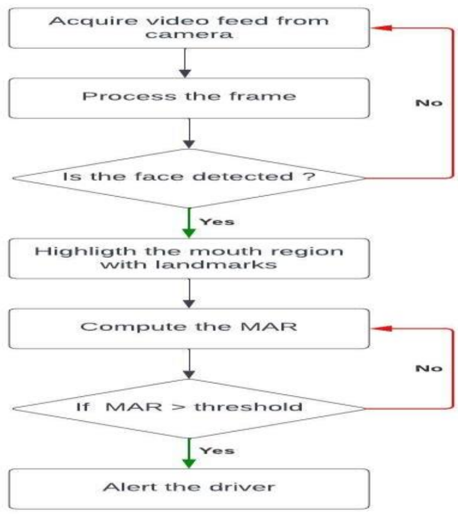

Fig 5. Process of Yawn Detection

5. **Mouth Aspect Ratio:** The vertical to horizontal ratio of mouth distance is known as mouth's distance is known as MAR. The MAR estimation takes into account the one horizontal distance and three vertical distances. Driver yawns, increasing the vertical distance while decreasing the horizontal distance. The MAR value of a person who is yawning is presumed to be greater than 0.43for faithful detection and all other MAR values below threshold are ignored.

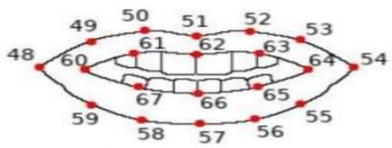

Fig 6. Landmark indices for mouth region

The vertical lengths will increase as the mouth Opens while the horizontal length decreases.

Therefore upon yawning MAR value will Increase.

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IV. RESULTS AND DISCUSSION:

A. *RESULTS*

1. ***Facial Landmark Detection Output:*** The initial stage of the proposed work is to detect facial landmarks on the face. To achieve this the Dlib facial landmark detector is employed to detect the key features of the face. The resulting output is presented in the figure 7 which shows 68 facial landmarks surrounding the eyes and mouth.

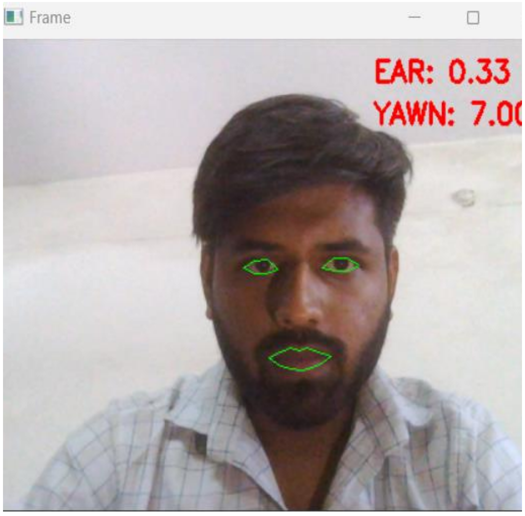

Figure 7. Mouth and Face Region Detection

2. ***Eye Closure Detection Output:*** As illustrated in figure 7 the EAR value is higher when eyes are opened. Conversely when the eyes are closed, the EAR values begin to decrease. To determine drowsiness the threshold EAR value of 0.2 is established when Ear value falls below this threshold it implies that driver eyes is closed due to mild sleep or blinking. If the eyes are closed for more than 20 consecutive frames an alarm is triggered to alert the driver. As shown in figure 8

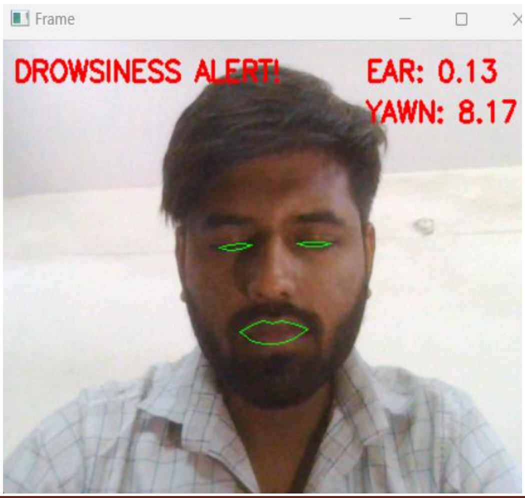

Figure 8: Eyes Closed

3. ***EAR Response:*** A graph is generated using matplotlib library which represent the relationship between the frames and EAR value of respective frames. The graph is displayed in figure 10. To create the graph, an empty list is initialized and EAR value of each frame is appended to the list. As a result the list contain EAR values of all the frame. The distinction between a blink and a mild sleep is shown in the graph. To identify drowsiness the EAR must remain low for at least 20 consecutive frames.

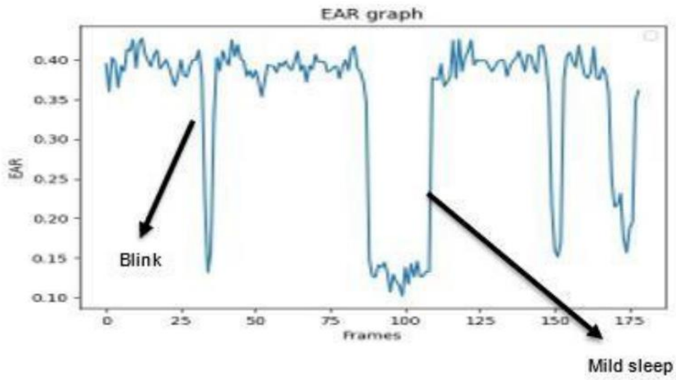

Figure 9: EAR Plot

4. ***Yawn Detection:*** When the mouth is closed the corresponding value of MAR will be lower whereas when mouth is opened the MAR value will increase. To detect yawning a threshold value of is set When MAR value exceed this threshold it is conformed that driver is yawning and an alert is issued to the drowsy driver. The system output when the mouth is opened is displayed below

Figure 10: Yawn Alert

Accuracy for eye and yawn detection: The system is opened and a sample of 4 people are taken to find the accuracy of the eye closure and yawn detection module. Each person is asked to yawn and imitate drowsiness and the corresponding output from the system is noted to calculate the accuracy of the system.

Sample Number	No. of Times Drowsiness imitated	No. of times drowsiness detected	Accuracy
1	30	29	96.66%
2	30	28	93.33%
3	30	29	96.66%
4	30	28	93.33%

Fig 11: Accuracy of drowsiness detection

The drowsiness detection accuracy is calculated by:

$$\text{Accuracy [Eye Closure]} = \frac{\text{no.of blinks detected}}{\text{no.of times blinked}} \times 100\ \%$$

The Accuracy is found out to be: **94.99%**

Sample Number	No. of times yawned	No. of times yawn detected	Accuracy
1	30	29	96.66%
2	30	27	90.00%
3	30	29	96.66%
4	30	28	93.33%

Fig 12: Accuracy of yawn detection

The Yawn Detection accuracy is calculated by:

$$\text{Accuracy [Yawn detection]} = \frac{\text{no.of yawns detected}}{\text{no.of times yawned}}$$

The accuracy of Yawn Detection is**: 94.16%**

B. DISCUSSION

The results of the study shows that the proposed methodology is effective in detecting a distracted driver and give real-time feedback to the driver. The system works by analyzing facial landmark of the driver in real-time using a machine learning model trained on thousands of facial images. The system is capable of preventing accidents caused due to distracted driver.

The study also highlights the importance of considering a methodology and algorithm which can continuously monitor the driver with high frame rate to give the best performance and safety to the driver

Overall, the study demonstrates that the proposed methodology is a promising approach for developing driving monitoring system. Future work could involve including more modules such as head pose detection and gaze detection so as to capture additional parameters for detection of a distracted driver.

V. CONCLUSION

In conclusion the above discussed real-time driver monitoring system shows promise in terms of speed and performance. The system has been tested under various circumstances, and it has demonstrated stable performance under every scenario. However instead of using a threshold distraction level. It is advised to develop a continuous scale driver distraction detection system that can monitor level of distraction continuously. By continuously monitoring the level of distraction, the system can generate trigger a signal to control the hydraulic braking system of the vehicle when distraction level exceeds a certain threshold. This will help in preventing accidents caused due to driver distraction and improve road safety. Further research can be done to increase accuracy and reliability.

The presented system for driver distraction detection using eye blink and yawn has shown promising result in accurately detecting distraction in individuals. The high accuracy rates of 94% for eye blink and 95% for yawn detection as well as system ability to function well in poor lighting condition makes it a reliable option as a driver monitoring system. The continuous detection of face and real-time operation further enhances its practicality for use in various circumstances. Over all the system has potential to contribute significantly to road safety by providing a reliable means of detecting driver distraction and preventing road accidents.

VI. ACKNOWLEDGMENT

We would like to express our gratitude to all those who have contributed to the development and success of this project.

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Last but not least, we would like to thank our families and friends for their unwavering support and encouragement throughout the project, and for always believing in us.

Together, their contributions have made this project a success, and we are grateful for their support and dedication.

VII. FUTURE SCOPE

There are several potential areas for future improvement and expansion of driver monitoring system:

1. **Multi-Person Detection:** The current system is designed to detect distraction of a single person. In future it can be extended to detect multiple persons at the same time.
2. **Integration with other sensors**: The system can be enhanced by integrating it with other sensors such as heart rate monitor and EEG sensors to improve accuracy of driver distraction system.
3. **Machine Learning:** Machine learning algorithms can be incorporated to improve the accuracy of the system. By the training the system with more data. It can learn to detect more subtle signs of distraction. Leading to better detection and prevention of distraction.
4. **Integration with autonomous vehicle:** In future the system can be integrated with autonomous vehicle to provide an additional layer of safety. The system can detect distraction level of passenger and take control if necessary
5. **Facial expression recognition:** The system can be extended to recognize other facial expressions such as anger, sadness and happiness. This can also help us in getting other valuable insights into driver state of mind while he is driving the vehicle.

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