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Real Time Driver Drowsiness Detection with Alert Sound Using Image Processing

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ABSTRACT

Drowsy driving is one of the major causes of accident and death. Most of the conventional methods are either vehicle based, behavioral based or psychological based. Major studies have suggested that around 20% of all road accidents are fatigue related. Drowsy Driving can be extremely dangerous, a lot of road accidents are related to the driver falling asleep while driving and subsequently losing control of the vehicle. However, initial signs of fatigue and drowsiness can be detected before a critical situation arises. A direct way of measuring driver fatigue is measuring the state of the driver drowsiness. So it is very important to detect the drowsiness of the driver to save life and property. A low-cost, real-time Driver's Drowsiness Detection System is developed with high accuracy. The Video and image are extracted using the webcam. In this work, Facial Landmarks are used to detect the eye closure yawn and head. HaarCascade Algorithm is used in the proposed work to detect objects in images, irrespective of their scale in image and location. This helps to find the status of the closed eyes or opened mouth like yawning, and any frame finds that has hand gestures like nodding or covering opened mouth with hand as innate nature of humans when trying to control the sleepiness.

Keywords: Drowsy Driving, Facial landmarks, Haar cascade algorithm, Drowsiness Detection system, Real time.

1 Introduction

Drowsy driving is the dangerous combination of driving when sleepy. This usually happens when a driver has not slept enough, but it can also happen because of untreated sleep disorders or shift work. Drowsiness may occur due to lack of sleep or continuous driving at night or both, ultimately making the vehicle driver tired and diverted from the concentration on driving. In the transportation industry, where the bus and truck drivers drive overnight, it is very common for them to fall asleep. The two main causes of drowsy driving are lack of quality/quantity of sleep and driving at times of the day when you would normally be sleeping. The World Health Organization (WHO) has published an article that pointed out that the risk factors leading to accidents are speeding, intoxicated driver, distracted driving, etc. This detection system is a real time system which captures image continuously and measures the state of the eye, mouth and head according to the specified algorithm using OpenCV and dlib library in python Integrated Development Environment (IDE). In this paper



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facial landmarks are used to detect the eye closure, yawn and head tilt. Facial landmarks works by extracting the key facial features. The complete face is mapped into 68 co-ordinates. Eye closure is detected by estimating the EAR value. When EAR value goes below a particular threshold eye closure will be detected. The yawn is detected by estimating the MAR value. When the MAR value goes above the threshold value, yawn will be detected and proposes one such algorithm, known as the Haar Cascade algorithm, which is combined with the various libraries in Python to capture and detect drowsiness in real-time. The development of technologies required to implement the driver drowsiness tools becomes a tedious task in the area of accident prevention or accident-avoidance systems.

2 Recent Works

- [1] A Survey On State-Of-The-Art Drowsiness Detection Techniques, M. Ramzan, H. U. Khan, S. M. Awan, A. Ismail, M. Ilyas, And A. Mahmood [2019].**

Drowsiness or fatigue is a major cause of road accidents and has significant implications for road safety. Several deadly accidents can be prevented if the drowsy drivers are warned in time. A variety of drowsiness detection methods exist that monitor the drivers' drowsiness state while driving and alarm the drivers if they are not concentrating on driving. The relevant features can be extracted from facial expressions such as yawning, eye closure, and head movements for inferring the level of drowsiness. The biological condition of the drivers' body, as well as vehicle behavior, is analyzed for driver drowsiness detection. This paper presents a comprehensive analysis of the existing methods of driver drowsiness detection and presents a detailed analysis of widely used classification techniques in this regard. First, in this paper, we classify the existing techniques into three categories: behavioral, vehicular, and physiological parameters-based techniques. Second, top supervised learning techniques used for drowsiness detection are reviewed. Third, the pros and cons and comparative study of the diverse method are discussed. In addition, the research frameworks are elaborated in diagrams for better understanding. In the end, overall research findings based on the extensive survey are concluded which will help young researchers for finding potential future work in the relevant field.

- [2] A Smartphone-Based Drowsiness Detection and Warning System for Automotive Drivers, A. Dasgupta, D. Rahman, and A. Routray, [2019].**

This paper presents a smart phone-based system for the detection of drowsiness in automotive drivers. The proposed framework uses three-stage drowsiness detection. The first stage uses the percentage of eyelid closure (PERCLOS) obtained through images captured by the front camera with a modified eye state classification method. The system uses near infrared lighting for illuminating the face of the driver during night-driving. The second step uses the voiced to the unvoiced ratio obtained from the speech data from the microphone, in the event PERCLOS crosses the threshold. A final verification stage is used as a touch



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response within a stipulated time to declare the driver as drowsy and subsequently sound an alarm. The device maintains a log file of the periodic events of the metrics along with the corresponding GPS coordinates. The system has three advantages over existing drowsiness detection systems. First, the three-stage verification process makes the system more reliable. The second advantage is its implementation on an Android smart-phone, which is readily available to most drivers or cab owners as compared to other general purpose embedded platforms. The third advantage is the use of SMS service to inform the control room as well as the passenger regarding the loss of attention of the driver. The framework provides 93.33% drowsiness state classification as compared to a single stage which gives 86.66%.

[3] Eeg-Based Driver Drowsiness Estimation Using Feature Weighted Episodic Training, Y. Cui, Y. Xu, And D. Wu. [2019].

Drowsy driving is pervasive, and also a major cause of traffic accidents. Estimating a driver's drowsiness level by monitoring the electroencephalogram (EEG) signal and taking preventative actions accordingly may improve driving safety. However, individual differences among different drivers make this task very challenging. A calibration session is usually required to collect some subject- specific data and tune the model parameters before applying it to a new subject, which is very inconvenient and not user-friendly. Many approaches have been proposed to reduce the calibration effort, but few can completely eliminate it. This paper proposes a novel approach, feature weighted episodic training (FWET), to completely eliminate the calibration requirement. It integrates two techniques: feature weighting to learn the importance of different features, and episodic training for domain generalization. Experiments on EEG-based driver drowsiness estimation demonstrated that both feature weighting and episodic training are effective, and their integration can further improve the generalization performance. FWET does not need any labelled or unlabeled calibration data from the new subject, and hence could be very useful in plug-and-play brain- computer interfaces.

[4] EEG-based driver drowsiness estimation using an online multi-view and transfer TSK fuzzy system. Jiang, Y. Zhang, C. Lin, D. Wu, and C.T. Lin [2021].

In the field of intelligent transportation, transfer learning (TL) is often used to recognize EEG-based drowsy driving for a new subject with few subject-specific calibration data. However, most of existing TL-based models are offline, non- transparent, and in which features are only represented from one view (usually only one algorithm is used to extract features). In this paper, we consider an online multi-view regression model with high interpretability. By taking the 1-order TSK fuzzy system as the basic regression component and injecting the nature of the multi-view settings into the existing transfer learning framework and enforcing the consistencies across different views, we propose an online multi- view & transfer TSK fuzzy system for driver drowsiness estimation. In this novel



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model, features in both the source domain and the target domain are represented from multi-view perspectives such that more pattern information can be utilized during model training. Also, comparing with offline training, the proposed online fuzzy system meets the practical requirements more competently. An experiment on a driving dataset demonstrates that the proposed fuzzy system has smaller drowsiness estimation errors and higher interpretability than introduced benchmarking models.

[5] Effective driver fatigue monitoring through pupil detection and yawing analysis in low light level environments, Shen, Weijie [2012].

Monitoring driver fatigue is an important method to improving transportation safety. The statistics shows that a number of transportation accidents are caused by driver fatigue. A system which can monitor driver fatigue and issue warning timely will help in preventing many accidents, and consequently reduce personal suffering and save money greatly. Driver fatigue detection are the subject of intense research today. However, effective driver fatigue monitoring in low light level environments has been challenging since it is difficult to get the exactly state of the driver. This paper has made an attempt to design a system that uses video camera that points directly towards the driver's pupil and yawning in order to detect fatigue. With IR illuminator, the system works robustly in low light level environments. If the fatigue is detected, a warning signal is issued to alert the driver.

3 Proposed Work Explanation

In this proposed work, initially captured the frontal image of driver from input video stream. Afterward identified the face via drawing the bounding box around the face. Here, for creating bounding box, next imported the inbuilt face detection library that is available in dlib facial feature tracker based on 68 facial landmarks. Further, here localized the eye region of interest (ROI) from the coordinates of predefined landmarks present in dlib. Haar cascade algorithm is used here to detect objects in images, irrespective of their scale in image and location. This algorithm is not so complex and can run in real-time. Once the Landmarks are predicted, the eye landmarks are used and the mouth landmarks are used to determine the Eye Aspect Ratio(EAR) and Mouth Aspect Ratio(MAR) to check if a person is drowsy the alert sound will play.



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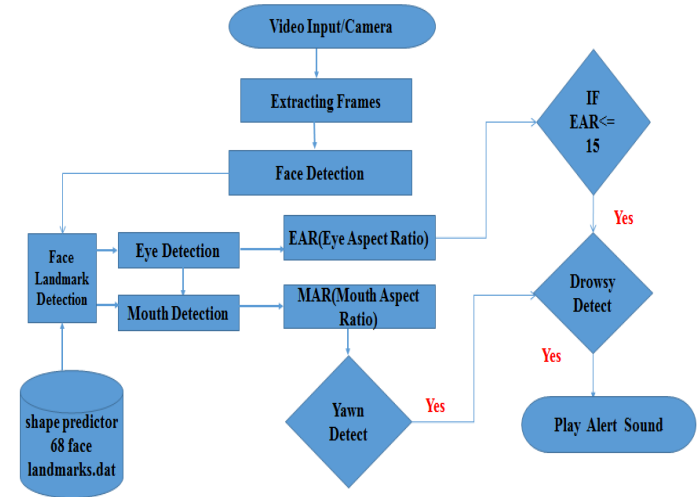


Figure 1: Proposed block diagram

3.1 System Modules

Face Detection

In this designed framework, the dlib facial feature tracker library to detect the face from image of driver. Since dlib libraries based on Histogram of Oriented Gradient (HOG) feature descriptor for face detection and Linear Support Vector Machine (SVM) as classifier.

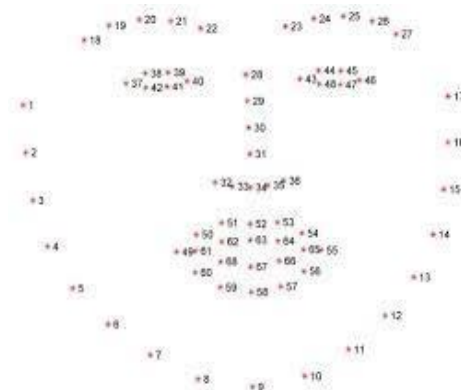


Figure 2: Visualization of the 68 facial landmark co-ordinates

Eye Aspect Ratio

EAR refers to the aspect ratio of the eye region, which is often used to calculate the temporal consistency and speed of left and right eye blinks and in fatigue detection. These co-ordinates are used to estimate the value of EAR. Landmark indices for right eye → [36,37,38,39,40,41] Landmark indices for left eye → [42,43,44,45,46,47]



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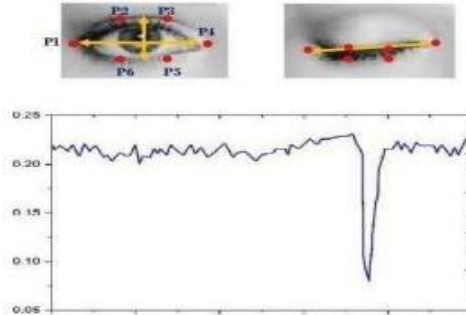


Figure 3: Eye Aspect Ratio

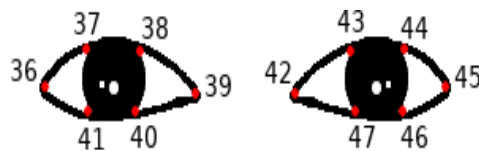


Figure 4: Landmark indices of eyes

The formula to estimate the Eye Aspect Ratio (EAR) is given by as:

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

The numerator of this equation computes the distance between the vertical eye landmarks while the denominator computes the distance between horizontal eye landmarks, weighting the denominator appropriately since there is only one set of horizontal points but two sets of vertical point.

C. Mouth Aspect Ratio

Mouth Aspect Ratio (MAR) is used to detect whether a person is Yawning or not. MAR is the ratio of vertical distance of mouth to the horizontal distance of the mouth. The three vertical distances and one horizontal distance are considered in MAR estimation. When driver yawns, the vertical distances will start increasing and the horizontal distance will decrease slightly. MAR value for yawning person is assumed to be greater than 0.43 for faithful detection while the other values of MAR less than threshold are omitted.



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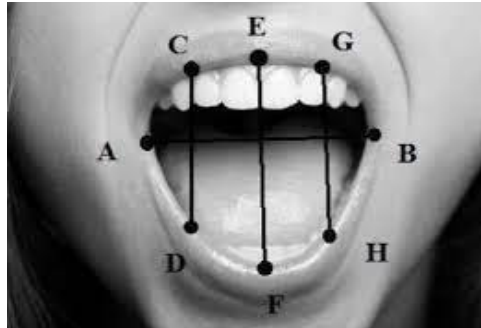


Figure 5: Landmark indices when mouth is opened.

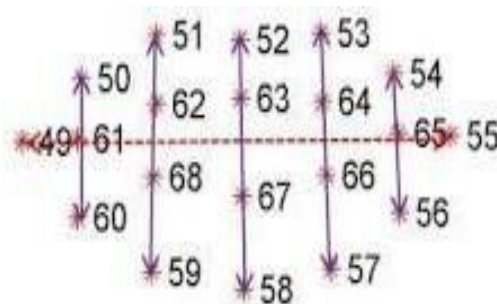


Figure 6: Mouth Aspect Ratio

The formula for estimating the Mouth Aspect Ratio (MAR) is given by as:

$$\text{MAR} = \frac{|CD| + |EF| + |GH|}{3 * |AB|}$$

When the mouth is opened the three vertical distances will be greater and the horizontal distance will be lesser. So as a result, MAR value will increase upon yawning.

D. Drowsy Detection

Drowsy Detection Method is used to determine how long a given person's Eyes have been closed for. If their eyes have been closed for a certain amount of time, then assume that they are starting to doze off and play an alarm to wake them up and grab their attention.

4 Results and Discussion

4.1 Eye Detection

The value of EAR will be higher when eyes are opened as shown in the When eye is closed the value EAR will start decreasing. The threshold value of EAR is set as 0.14. When EAR goes below 0.14, it is understood that the eyes are closed. It can be either eye blink or mild sleep. The EAR value has to be lower than the threshold for 20 consecutive frames to confirm



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the drowsiness of the driver. When the drowsiness is detected the system will give alert as shown in the Figure 4.1.

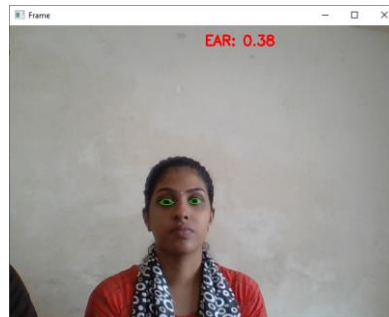


Figure 7: Eye Detection

4.2 Mouth Detection

When the mouth is closed, the value of MAR will be lesser. When mouth is opened MAR value will increase. The threshold value of MAR is set as 0.5. When MAR goes above this threshold, yawning is confirmed and alert is given to drowsy driver. The outputs when mouth is closed and opened are shown in the Figure 4.2.

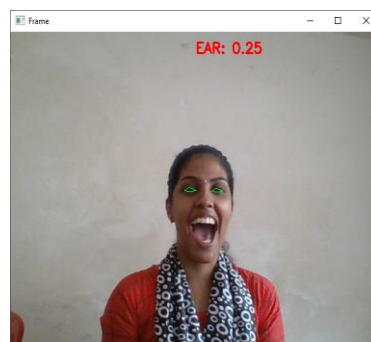


Figure 8: Mouth Detection

4.3 Drowsy Detection

If the eye aspect ratio indicates that the eyes have been closed for a sufficiently long enough amount of time the sound an alarm to wake up the driver are shown in the Figure 4.3.

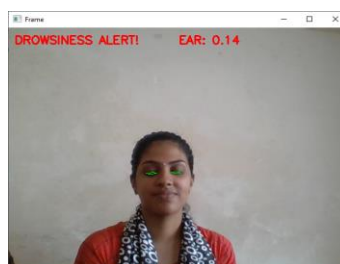


Figure 9: Drowsy Detection



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5 Conclusions

The major issue in the framework is extracting the efficient features from the images that have been cropped and cut from the video sequence. The proposed work has detected the driver's drowsiness based on various aspects such as closed eyes, opened mouth, nodding with hand, and putting hand on mouth while yawning. The methods such as EAR, MAR, and the proposed novel FAR were used for feature extraction. Also, orientation of the faces was identified and gradient based patterns were used to identify the various scenarios created by different states of face parts and hands. This developed framework gives the better result in recognizing driver's state of drowsiness. The framework has reached a stable state in which all bugs have been eliminated. The results are discussed in testing section and are found satisfactory. Image processing achieves highly accurate and reliable detection of drowsiness. Image processing offers a non-intrusive approach to detecting drowsiness without the annoyance and interference. This paper provides a way through which a number of road accidents might be avoided if an alert is sent to a driver that is deemed drowsy. This paper is not only useful to the person who will install it in their vehicle but also for the other cars, trucks, buses and humans moving around it. The system is fast and once it starts capturing frames it continuously detects the face and perform detection till it is stopped.

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