A REVIEW: DRIVER DROWSINESS DETECTION SYSTEM

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Abstract: Driver drowsiness is a significant factor contributing to road accidents worldwide, leading to pressing need for effective driver drowsiness detection systems. This review paper offers a comprehensive examination of the state-of-the-art in driver drowsiness detection technologies, their underlying principles, and the challenges they face. We present an extensive survey of the various sensing modalities used in these systems, including vision-based, and vehicular data-driven approaches. We also discuss the critical algorithms and machine learning techniques employed for drowsiness detection. The paper highlights the real-world applicability and limitations of existing systems, emphasizing the need for reliable and non-intrusive solutions. Challenges related to the accuracy of detection, adaptability to diverse driving conditions, and the avoidance of false positives are addressed. In conclusion, this review paper not only synthesizes the existing body of knowledge on driver drowsiness detection but also identifies promising directions for future research and development.

Keywords: Open CV, Python , Drowsiness Detection, Eye Closure & Eye Blinking, Yawning, Fatigue

I. INTRODUCTION

Driver Drowsiness and sleep deprivation is one of the major causes for a lot of road accidents. Driver in drowsy state are a danger to road safety and can cause serious injuries sometimes, resulting in death of the victim and also economical loss. Drowsiness means a state where person feels lethargic, has difficulty concentrating and tiredness in eyes of the drivers while he's driving vehicles.

Most of the accidents happen in India due to the lack of concentration of the driver. Driving ability of the driver deteriorates with time owing to drowsiness. To avoid these situations, we developed a system which will detect the drowsiness nature of the driver and will also alert him immediately.

Lot of people drive on the highways all day and all night. This includes bus drivers, truck drivers, taximen and people who are traveling long-distance, they suffer from lack of sleep. Because of sleep deprivation, it becomes very dangerous to drive when feeling fatigued.

Background and Motivation: Driving is a common and essential activity for many people around the world. However, it is well-known that prolonged or monotonous driving can lead to driver fatigue, drowsiness, and even impaired alertness. One of the key indicators of driver drowsiness is the manifestation of specific facial expressions, such as excessive eye blinking, prolonged eye closure, or frequent yawning. These signs not only reflect the driver's state but also increase the risk of accidents due to delayed reactions and compromised attention. In recent years, deep learning-based systems have emerged as a promising solution for recognizing these drowsiness-related facial expressions in real-time. These systems leverage advances in computer vision and neural network technology to analyse and interpret the driver's facial cues, thereby enhancing road safety by issuing timely warnings or implementing corrective actions.

Objectives of the System: The primary objective of a deep learning-based driver dizziness recognition system focused on facial expression analysis is to: Detect early signs of driver drowsiness or impairment by monitoring facial expressions. Provide real-time alerts to the driver to prevent accidents. Mitigate the risks associated with driver fatigue and in attention. Enhance overall road safety and driving experience.

Scope of the System: This system's scope encompasses the utilization of in-car cameras and deep learning algorithms to analyse the driver's facial expressions. Specifically, it targets the recognition of three key facial expressions associated with driver drowsiness: Excessive Eye Blinking: Frequent and prolonged eye blinking, often indicative of drowsiness or fatigue. Eye Closure: Prolonged eye closure or drooping eyelids, a clear sign of impaired attentiveness. Yawning: Frequent yawning, which may signify drowsiness and fatigue.

LITERATURE REVIEW

This paper aims to propose a drowsy driver warning system that detects the real-time driver’s eye closure. In this system, if the driver’s eye classifies as the close class for successive frames, it is a sign of drowsiness, and an alert will be sent to the driver early enough to avoid an accident. The proposed work of this article includes four contributions.[2]

The frames enter to preprocessing unit to detect the eyes and crop them. Then this unit applies the grayscale function and normalizes the histogram of the eye. The authors used low-resolution images to have real-time detection and histogram equalizer to overcome the bad illumination condition.

The authors proposed three neural networks regarding the parameter of fastness, high accuracy, and small dataset.

There is a proposed algorithm to evaluates the result of network detection; if it detects as a close eye, the system adds one to the counter, and if the number of the counter reaches more than 12 successive frames, that eye is close, send an alarm for the driver. Otherwise, it keeps the counter for the next frame, whenever an open eye categorizes, counter restart. In other words, the task of this counter is counting successive close frames for distinguishing blinking from falling sleep.

Collecting a new dataset that considers a new position of the eye, named oblique view of the driver.[3]

For eye classification to the classes of open and close, three networks considered. The first network is the fully designed neural network, the second is a deep neural network with

transfer learning, and it uses a pre-trained VGG16 network, which uses the low-level features on the ImageNet dataset and high-level features to learn. The third network is similar to the second network, but it uses VGG19 with the same goal as the third network. The results show high accuracy and short computational time in the proposed methodology of this article[6].

Road crashes and related forms of accidents are a common cause of injury and death among the human population. According to 2015 data from the World Health Organization, road traffic injuries resulted in approximately 1.25 million deaths worldwide, i.e. approximately every 25 seconds an individual will experience a fatal crash While the cost of traffic accidents in Europe is estimated at around 160 billion Euros, driver drowsiness accounts for approximately 100,000 accidents per year in the United States alone as reported by The American National Highway Traffic Safety Administration (NHTSA). In this paper, a novel approach towards real-time drowsiness detection is proposed. This approach is based on a deep learning method that can be implemented on Android applications with high accuracy. The main contribution of this work is the compression of heavy baseline model to a lightweight model. Moreover, minimal network structure is designed based on facial landmark key point detection to recognize whether the driver is drowsy. The proposed model is able to achieve an accuracy of more than 80%.[13][14]

Among works that focus on the analysis of the vehicle state and its relation to fatigue,

the most common measures that are studied are steering wheel behaviors or lane departures [11–13]. In [14], other parameters of the car are used, such as the vehicle position or the steering wheel angle, and they perform data fusion on multiple measures to achieve a more reliable system. However, even if the diminishing performance over skill-based tasks by the driver can actually be a consequence of drowsiness, it appears at a later stage and it cannot be used to detect the early symptoms of fatigue [15].

There are many works that follow this approach, which use numerous and varied parameters and techniques for their detection. For example, in [17], the landmarks of the driver's face (that is, a group of points that locate the most important elements of the face: eyes, eyebrows, nose, mouth, and facial shape) are obtained, and then, using these landmarks, some parameters, such as the percentage of eye closure (PERCLOS), are calculated. Afterwards, these features are introduced on a support vector machine (SVM) that classifies whether the driver is tired or not. In [18], a combination of depth videos and deep learning is used for fatigue detection. In particular, it uses two CNNs: a spatial CNN, which detects object's positions, and a temporal CNN, which looks for information between two neighboring frames. By using these two CNNs, the system is able to calculate motion vectors from one frame to another, which allows to detect yawns, even when the driver uses a hand to cover his or her mouth.[18]

This system will cover the driver's eyes using camera and by developing a algorithm we can detect symptoms of driver fatigue early enough to avoid unanticipated incidents. So need to detect driver fatigue in advance will be helpful and will give an alert warning which will be in form of sound and seat belt vibration who has frequency which variable between 100 to 300 HZs. The warning cannot be deactivated automatically it can be done by manually [22]

Sukrit et al. in [6] have used the most commonly used technique which is the Eye Aspect Ratio (EAR) and Eye Closure Ratio (ECR). Same accuracy for people wearing spectacles. Useful in conditions when drivers drive for longer distances. Adaptive thresholding varies greatly from person to person. So, In [6] Deng and Wu in [7] have used video Images that were used to detect Blinking, yawning and duration of eye closure. They drafted an identification technique for facial regions which is based on the Golden Ratio of 68 main points. There were not any publicly available image-based driver sleepiness recognition datasets. algorithm works with an accuracy reaching 95% when the Euclidean distance is within 20 pixels. Average accuracy regardless of environmental conditions is approximately 92%. The limitation is that it requires a high-performance machine with heavy processors and good RAM.[7]

In these algorithms, a counter starts counting during the time the eyes are closed and when it exceeds a certain threshold value, the alarm system is activated. When the eye is opened, the number in the counter decreases and the alarm system is disabled because it falls below the threshold value. In another study, a method that is close to the method described in this thesis has been proposed. In this study [6], eye and face detection are considered as an object detection approach. Eyes are labeled and trained as open and closed. Fatigue decision is determined by determining a threshold value, as mentioned in previous studies, and depending on whether the duration of eye closure exceeds this threshold value. This threshold value is determined as 40% of the frame rate of the image captured from the camera. For example, if camera is 30 FPS, the threshold value is 12. If blindfold is detected in at least 12 of the 30 frames, the alarm is activated.[17]

The ultimate aim of our work is to activate an alarm when the system detects that the driver is drowsy, which means that the alarm activation module will follow a binary behavior (on/off, depending on the fatigue level of the driver). Because of this, only the "awake" and "drowsy" classes are used to train and test the system (60 awake videos, 62 drowsy videos).[9] The database provides the videos divided in 5 folds (or subsets of data), so in this work, we use 5-fold cross-validation to test the data. These videos were recorded with different cameras (web, mobile phone, etc.) which we have to specify the type of webcam used, resulting in a pool of videos with different qualities and resolution. This is very interesting to emulate real situations in a car, where there are light changes, but the results obtained can be moderate, as would correspond to this situation.[8]

Continuous advancements in computing technology and artificial intelligence in the past decade have led to improvements in driver monitoring systems. Numerous experimental studies have collected real driver drowsiness data and applied various artificial intelligence algorithms and feature combinations with the goal of significantly enhancing the performance of these systems in real-time. This paper presents an up-to-date review of the driver drowsiness detection systems implemented over the last decade. The paper illustrates and reviews recent systems using different measures to track and detect drowsiness. Each system falls under one of four possible categories, based on the information used. Each system presented in this paper is associated with a detailed description of the features, classification algorithms, and used datasets. In addition, an evaluation of these systems is presented, in terms of the final classification accuracy, sensitivity, and precision. Furthermore, the paper highlights the recent challenges in the area of driver drowsiness detection, discusses the practicality and reliability of each of the four system types, and presents some of the future trends in the field.[21]

Khan et al. [30] proposed a real-time DDD system based on eyelid closure. The system was implemented on hardware that used surveillance videos to detect whether the drivers' eyes were open or closed. The system started by detecting the face of the driver. Then, using an extended Sobel operator, the eyes were localized and filtered to detect the eyelids' curvature. After that, the curvature's concavity was measured. Based on the measured concavity value, the eyelid was classified as open (concave up) or closed (concave down). If the eyes were deemed closed for a certain period, a sound alarm is initiated. The system used three datasets. The authors generated two of them, and the third was acquired from.[31] The first dataset, which contained simple images, with a homogenous background, showed an accuracy of 95%. The second set, which included a complex benchmark image dataset, achieved an accuracy of 70%; the third one, which used two real-time surveillance videos, showed an accuracy that exceeded 95%.[31]

Some of the image-based measures.

Blink frequency [25]	The number of times an eye closes over a specific period of time.
Maximum closure duration of the eyes [25]	The maximum time the eye was closed. However, it can be risky to delay detecting an extended eye closure that indicates a drowsy driver.
Percentage of eyelid closure (PERCLOS) [26]	The percentage of time (per minute) in which the eye is 80% closed or more.
Eye aspect ratio (EAR) [27]	EAR reflects the eye's openness degree. The EAR value drops down to zero when the eyes are closed. On the other hand, it remains approximately constant when the eye is open. Thus, the EAR detects the eye closure at that time.
Yawning frequency [28]	The number of times the mouth opens over a specific period of time.
Head pose [29]	Is a figure that describes the driver's head movements. It is determined by counting the video segments that show a large deviation of three Euler angles of head poses from their regular positions. These three angles are nodding, shaking, and tilting.

II. CONCLUSION

Thus we have studied the working of Deep Learning-Based Driver Dizziness Recognition System targeting facial expressions like eye blinking, eye closure, and yawning shows great promise for enhancing road safety. By detecting early signs of driver drowsiness and issuing timely alerts, it can significantly reduce the risks associated with impaired driving. While challenges remain, ongoing research and development in this field point towards a safer and more efficient future for transportation.

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