International Journal of Electrical, Electronics and Computer Engineering **14**(1&2): 32-35(2025)

ISSN No. (Online): 2277-2626

A Comprehensive Literature Review on Driver Drowsiness Detection and Alert System

Sangam Kaundal*, Karan Chauhan and Aviral Rana
School of Computer Science Engineering and Technology,
Government College Dharamshala (H.P.), India.

(Corresponding author: Sangam Kaundal)*
(Received: 17 February 2025, Accepted: 26 March 2025)
(Published by Research Trend, Website: www.researchtrend.net)

ABSTRACT: Car crashes are a major reason people get hurt or die. Every year, about a million people worldwide lose their lives in these accidents, according to the World Health Organization. One of the biggest dangers is drivers being too tired. When people don't get enough sleep or are just really worn out, they can fall asleep while driving, putting themselves and others at risk. Studies have shown that being sleepy is a main cause of serious car accidents. These days, it seems like driving when you're tired is the biggest reason drivers get sleepy. And this sleepiness is causing more and more accidents. This is a big problem that we need to solve quickly. Many people are trying to create devices that can tell when a driver is getting sleepy, right when it is happening. These devices use different kinds of artificial intelligence. Our research is also about finding ways to tell when a driver is sleepy. We are building a system that looks at the driver's face and tracks their eyes. It takes pictures of the driver's eyes and compares them to a set of example pictures. If the system sees that the driver's eyes are closed for too long, it sounds an alarm to wake them up. If the driver opens their eyes, the system keeps watching. We have a score that goes up when the eyes are closed and down when they are open. In this paper, we will explain how we built a system that can detect drowsiness with 80% accuracy. Our goal is to help make roads safer by reducing accidents caused by tired drivers.

Keywords: Face Detection, Euclidean Eye Aspect Ratio, Electrooculography, CNN, Alarm, Eye blinking.

INTRODUCTION

Drowsiness, or feeling sleepy, can be very dangerous when driving. Even short moments of sleepiness can lead to serious accidents. The main reason people get sleepy while driving is being tired. This makes it hard to focus and pay attention. Other things, like not concentrating, taking certain medicines, having sleep problems, drinking alcohol, or working night shifts, can also cause drowsiness. It is hard to know when sleepiness will hit. Even if you do not actually fall asleep, being tired makes it much harder to drive safely. It is estimated that one in twenty drivers has fallen asleep at the wheel. People who drive for long hours, like truck and bus drivers, are at a higher risk. Driving for 10 to 12 hours can make them very tired, and this puts other drivers in danger. Driving for long distances when you are already tired, or driving when you should be sleeping, can also leads to accidents caused by drowsiness (Deng and Wu 2019).

The National Highway Traffic Safety Administration (NHTSA) says that drowsy driving causes about 100,000 crashes and over 1,500 deaths each year. Drowsiness is thought to be responsible for around 1,550 deaths, 71,000 injuries, and $12.5 billion in financial losses. In 2019, 697 deaths involved a sleepy driver. The NHTSA also says that these numbers are likely lower than the actual number of accidents caused by drowsy driving, because it is hard to know for sure.

Luckily, we are getting better at detecting when someone is too tired to drive safely. Drowsy drivers show signs like yawning a lot, keeping their eyes closed for too long, and drifting between lanes. Researchers have been working on ways to detect drowsiness for some time now.

To help prevent accidents, we're developing a system that detects drowsiness. First, it finds the driver's face, then it looks at their eyes and how they blink. We use a "Shape predictor with 68 landmarks" to find key points on the face. A camera, like a webcam, helps us find the driver's face and eyes. We use computer programs to analyse the images and see if the eyes are open or closed, and how often they blink. If the eyes are closed for too long, an alarm sounds to warn the driver. We use a scoring system: the score goes up when the eyes are closed and down when they are open. If the score gets too high, the alarm goes off to alert the driver (Mehta *et al.*, 2019).

RELATED WORK

Detecting driver drowsiness using facial features has been a key focus in research. One early approach analyzed multiple facial cues to assess a driver's alertness. Presented at the 5th International Congress on Image and Signal Processing (CISP, 2012), this study set the stage for non-intrusive fatigue monitoring using image-based techniques (Wang and Shen 2012).

Building on this foundation, another study introduced a real-time drowsiness detection system that relied on Eye Aspect Ratio (EAR) and Eye Closure Ratio (ECR). By closely monitoring eye movement patterns, the researchers demonstrated how these parameters could effectively identify fatigue and prevent accidents caused by drowsy driving (Mehta *et al.*, 2019).

Similarly, facial feature analysis has proven to be a valuable tool for detecting early signs of drowsiness. A study published in IEEE Access leveraged deep learning to process real-time facial data, enhancing the accuracy of non-intrusive driver monitoring. This method showed promising results in identifying fatigue at an early stage (Deng and Wu 2019).

Another research effort took a different approach by incorporating artificial neural networks (ANN) with image processing techniques. By analyzing specific facial features and classifying signs of drowsiness, the study highlighted the potential of ANN-based systems in making drowsiness detection more reliable and efficient (Vesselenyi *et al.*, 2017).

Machine learning has also played a significant role in advancing driver fatigue detection. One study explored the use of ensemble machine learning techniques alongside hybrid sensing methods, combining physiological and behavioural data for more accurate results. Their findings demonstrated how integrating multiple sensing methods could minimize false alarms and improve overall detection performance (Gwak *et al*., 2020).

Beyond machine learning, some researchers have focused on real-time driver monitoring systems. A study published in Traffic Injury Prevention investigated how these systems could effectively detect drowsiness and alert drivers before accidents occur. By analyzing both behavioural and physiological signals, the research contributed to the development of more advanced driver assistance systems (ADAS) (Schwarz *et al.*, 2019).

Table 1.

Sr. No.	Problem	Need	Technique Used	Parameters	Solution	Environment	Future Direction
1.	Detecting yawning, eye closure duration, and blinking using video images.	Detect driver drowsiness with more accuracy.	Optimizes KCF algorithm with Multi Convolutional Neural Network.	Detect eyes and mouth movements using the Dlib Library.	Developed facial region detection with 92% accuracy.	Dataset generated from vehicle camera in similar conditions.	Dataset should be based on different public conditions.
2.	Develop a system to track eye movement for driver drowsiness.	Provide more accuracy in different conditions.	Eye Closure Ratio and Eye Aspect Ratio to detect drowsiness.	Face detection using linear SVM and histogram.	System works with similar accuracy, even with spectacles.	Works with an application installed in the driver's car.	Adaptive thresholding varies between individuals.
3.	Detection system based on vehicle, physiological indicators, and behavioural factors.	Early detection of drowsy state.	Combination of ECG, EEG, driving simulators, and vehicle sensors.	Physiological signals: EEG and ECG, driving simulators for behavioural data.	System operates in all fields with 82.4% accuracy.	Driver is covered with body and surrounding sensors.	System must be adaptable for everyone; expensive.
4.	Detecting driver drowsiness using EEG, EOG, and image analysis.	Better detection of driver drowsiness.	EEG and EOG sensors for brain and eye activity, ANN for image analysis.	Sensors for EEG and EOG, ANN for analyzing images.	Works efficiently in bad conditions.	EEG and EOG sensors for physiological signals, camera for images.	Handling EEG and EOG devices is challenging.
5.	Detecting drowsiness using eye and mouth geometric features.	Better accuracy using eye and mouth state.	Two methods: PTMIO (mouth state) and PATECP (eye closure).	AdaBoost algorithm for face detection with edge and line features.	Accuracy of 84% achieved.	Image captured using camera.	Accuracy is lower in bad conditions and with different people.
6.	Detecting driver drowsiness using vehicle sensors.	Analyse drowsiness level from low to high.	NADS and vehicle sensor data integrated with the driver monitoring system.	Detection of vehicle activities such as handle movement and distractions.	Models identify mild to severe drowsiness effectively.	Sensors placed at various locations in the vehicle.	Blinks predict microsleeps.

RESEARCH GAP

Struggles with Different Lighting Conditions: Driving happens in all kinds of lighting—bright sunlight, dim streetlights, total darkness—yet most systems still struggle outside of controlled environments. Infrared cameras offer a solution, but they're expensive and impractical for widespread use. Developing models that can adapt to varying lighting conditions without costly hardware is a necessary step forward.

Difficulty Detecting Eyes Through Glasses and Sunglasses: Many drivers wear prescription glasses or sunglasses, but most detection systems rely on clear visibility of the eyes. This makes them unreliable when eyes are obscured. Future research needs to explore alternative approaches, such as analyzing head movement patterns or using infrared-based tracking to maintain accuracy regardless of eyewear.

Sensitivity to Head Movements and Obstructions: In real-world driving, people don't always sit still. They check mirrors, shift positions, or briefly look away from the road. Current detection models often fail when the driver's face is partially obscured or angled differently. Improving AI to recognize drowsiness despite these natural movements is essential for practical use.

One-Size-Fits-All Approach Reduces Accuracy: Drowsiness looks different for everyone—some blink frequently, while others yawn more often. Yet, most detection systems apply the same thresholds to all drivers, leading to false alarms or missed detections. A more personalized system that learns from individual drivers over time could significantly improve reliability.

High False Alarm Rates: Frequent false alarms can be frustrating and even dangerous if they cause distractions. Some systems mistake normal blinking or facial expressions for drowsiness, reducing driver confidence in the alerts. Smarter AI that considers additional factors—such as driving patterns, time of day, and physiological signals—could make these warnings more accurate and meaningful.

Lack of Multi-Sensor Integration: Relying solely on facial tracking has its limitations. Combining eye tracking with other data—such as heart rate monitoring, steering behaviour, or even brain activity—could provide a more comprehensive and early-warning system for detecting drowsiness. Yet, many existing models do not take advantage of these additional insights.

Challenges in Real-Time Processing: Most high-accuracy drowsiness detection models require significant computing power, making them difficult to run in real-time on standard vehicles or mobile devices. Future advancements should focus on lightweight, optimized algorithms that can function efficiently on low-cost hardware without sacrificing performance.

Limited and Non-Diverse Datasets: Many existing drowsiness detection models are trained on datasets that lack diversity in driver demographics, including variations in age, gender, and ethnicity. This can lead to biases, making the technology less effective for some individuals. Expanding datasets to better represent the real-world driving population is crucial for fairness and accuracy.

FINDING SUGGESTIONS

To make driver drowsiness detection systems more effective and user-friendly, several improvements are necessary. One of the biggest challenges is ensuring the system works well in different lighting conditions, whether it's bright sunlight, dim streetlights, or complete darkness. Integrating infrared cameras or adaptive brightness adjustments can help maintain accuracy regardless of the environment. Another issue is detecting drowsiness in drivers who wear glasses or sunglasses, as many current systems struggle to track their eye movements. By incorporating thermal imaging or analyzing head movements and facial expressions, we can make the system more reliable for all users. Additionally, since drowsiness looks different for everyone, the system should learn and adapt over time to individual drivers rather than relying on one-size-fits-all thresholds. Reducing false alarms by refining facial tracking algorithms will also improve the overall experience, preventing unnecessary distractions caused by normal head movements like checking mirrors or adjusting posture.

Instead of relying only on eye tracking, a more advanced approach would combine multiple indicators, such as heart rate monitoring, steering behaviour, and lane position changes, to provide a more complete picture of driver fatigue. Making the system lightweight and optimized for real-time processing will also allow it to function smoothly in any vehicle without requiring expensive hardware. Expanding training datasets to include drivers of different ages, ethnicities, and driving conditions will help make the system more inclusive and effective for everyone.

When it comes to alerts, a mix of warning methods such as seat vibrations, increasing alarm intensity, or steering wheel feedback can ensure the driver notices and responds appropriately. Personalization options should also be available, allowing drivers to adjust the system's sensitivity to match their needs. Finally, integrating cloud-based monitoring could enable real-time notifications to family members or fleet managers if a driver ignores repeated warnings. By implementing these improvements, we can create a smarter, more adaptable system that not only reduces fatigue-related accidents but also makes roads safer for everyone.

CONCLUSIONS

In summary, driver drowsiness detection systems represent a crucial vehicle safety technology designed to mitigate injuries caused by fatigued driving. The timely detection and alerting of drivers experiencing drowsiness are paramount in preventing potentially fatal accidents. The proposed system utilizes image processing techniques to assess driver drowsiness levels by quantifying the Eye Aspect Ratio (EAR), effectively measuring the driver's eye aperture. To establish a reliable drowsiness threshold, comprehensive EAR data collection is essential. An auditory alarm system serves as a vital component, aiming to reduce the incidence and severity of accidents attributed to driver fatigue, thereby contributing to a decrease in annual vehicle crash fatalities.

The current system demonstrates consistent drowsiness detection for individual drivers with minimal limitations. The alarm mechanism functions effectively, providing timely alerts. However, the threshold for triggering the alarm, based on EAR, may vary significantly across individuals. Future research should focus on developing an adaptive threshold determination mechanism that eliminates the need for individual calibration. This would enable the system to automatically establish personalized drowsiness thresholds based on real-time driver behaviour. Furthermore, some drivers may prefer a more sensitive and frequent alarm system due to heightened awareness of road safety. Integrating user-adjustable sensitivity settings could address this variability in driver preferences.

REFERENCES

Deng, W. & Wu, R. (2019) Real-Time Driver-Drowsiness Detection System Using Facial Features, 118727–118738.

Gwak, J., Hirao, A., & Shino, M. (2020). An investigation of early detection of driver drowsiness using ensemble machine learning based on hybrid sensing. *Applied Sciences*, *10*(8), 2890.

Mehta, S., Dadhich, S., Gumber, S., & Jadhav Bhatt, A. (2019). Real-time driver drowsiness detection system using eye aspect ratio and eye closure ratio. In *Proceedings of international conference on sustainable computing in science, technology and management (SUSCOM), Amity University Rajasthan, Jaipur-India*.

Schwarz, C., Gaspar, J., Miller, T. & Yousefian, R. (2019). The detection of drowsiness using a driver monitoring system. *Traffic injury prevention*, *20*(sup1), S157-S161.

Vesselenyi, T., Moca, S., Rus, A., Mitran, T., & Tătaru, B. (2017). Driver drowsiness detection using ANN image processing. In *IOP conference series: materials science and engineering*, *252*(1), pp 012097). IOP Publishing.

Wang, P. & Shen, L. (2012). A method of detecting driver drowsiness state based on multi-features of face, 1171–1175.