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Driver Drowsiness Detection System

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A B S T R A C T

In this research, we explore a method to detect driver drowsiness using three facial features: Eye Aspect Ratio (EAR), Mouth Aspect Ratio (MAR), and Face Aspect Ratio (FAR). These features help us understand the driver's level of alertness and drowsiness.

The Eye Aspect Ratio (EAR) measures how open or closed the driver's eyes are. When a person is drowsy, their eyes tend to close partially, and EAR can help identify this change.

Mouth Aspect Ratio (MAR) focuses on the driver's mouth. When someone gets drowsy, their mouth may open slightly, and monitoring MAR can reveal this.

Face Aspect Ratio (FAR) considers the overall shape of the face. A drowsy person's face might show certain changes in its proportions, which FAR can detect.

By studying these three aspects, we can create a system that alerts us when a driver is becoming drowsy. This technology has the potential to enhance road safety by preventing accidents caused by drowsy driving.

Keywords: PERCLOS, face co-ordinates, drowsiness, aspect ratios, EAR, MAR, FAR

1. INTRODUCTION

Every year, thousands of accidents occur due to drowsy driving, putting lives at risk on the road. Detecting driver drowsiness is a critical aspect of ensuring road safety. In this research, we delve into an innovative approach for drowsiness detection that utilizes three essential facial features: Eye Aspect Ratio (EAR), Mouth Aspect Ratio (MAR), and Face Aspect Ratio (FAR).

Drowsy driving, a prevalent issue, is often characterized by drivers' reduced alertness and responsiveness. As drowsiness sets in, individuals tend to exhibit specific changes in their facial expressions, including partially closed eyes, slightly open mouths, and alterations in their overall face shape. These subtle but telling transformations provide valuable cues that can be harnessed to create a reliable driver drowsiness detection system.

Our research explores how the combination of EAR, MAR, and FAR can be leveraged to monitor a driver's state of alertness in real-time. By focusing on these facial aspects, we aim to develop a system that not only identifies drowsy drivers but also provides timely warnings, thus mitigating the risk of accidents caused by fatigue.

The importance of such a drowsiness detection system cannot be overstated. It has the potential to save lives, reduce accidents, and enhance overall road safety. As we progress in this study, we will delve into the technical details and methodologies employed in utilizing EAR, MAR, and FAR to create an effective and practical solution for detecting driver drowsiness.

2. LITEARATURE SURVEY

- The driver's eyes closure and yawning for drowsiness analysis, developed by Wisaroot Tipprasert, Chamaporn Chianrabutra, and Chamaiporn Sukjamsri in 2020, has some limitations. This technology relies on an infrared camera to see the driver's face, including their eyes and mouth. However, it may not work well in certain situations. For example, bad weather like heavy rain or fog can make it less accurate. Sudden changes in lighting, such as bright headlights at night, can also affect its performance. Additionally, if the driver wears sunglasses, a face mask, or something that covers their face, the system might not work correctly. It's essential to manage false alarms and missed drowsiness signs carefully.
- The method of using time domain parameters as a feature for single-channel EEG-based drowsiness detection, developed by Venkata Phanikrishna B and Suchismitha Chinara in 2020, has some limitations. While it successfully employs a methodology involving Hazroth parameters and EEG analysis to achieve its goals, there are factors to consider. First, this method might not be as accurate for everyone because

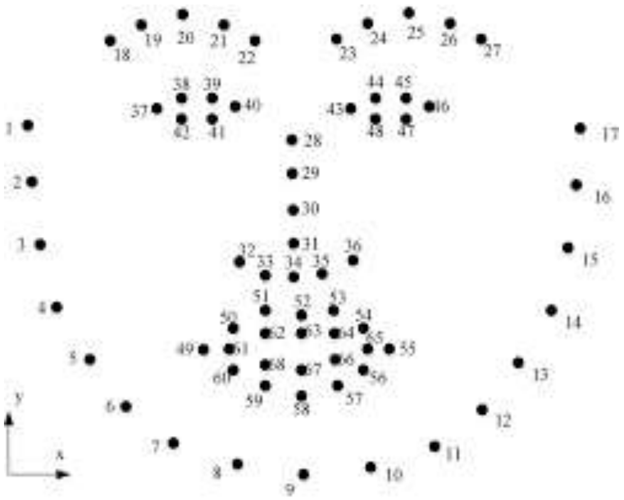
EEG signals can vary from person to person. Also, it relies on a single EEG channel, which might not capture all the relevant information, potentially leading to false alarms or missed drowsiness signs. Additionally, the success of this method may be influenced by the quality of EEG data and the specific conditions under which it's used.

- The driver drowsiness detection system developed by Mayank Srivastava, Shoyav Adam, and Tushar Gupta in 2021 combines OpenCV and Keras, integrating EEG and the Karolinska Sleepiness Scale (KSS) scores. While this approach is innovative, it has some limitations to consider. Firstly, the accuracy of the EEG-based drowsiness detection may vary from person to person, as EEG signals can differ. Secondly, the reliance on KSS scores for alertness assessment may be subjective and not always precisely represent a driver's true level of drowsiness. Drivers might not always self-report accurately, leading to potential false readings. Additionally, the system's effectiveness may be influenced by factors like lighting conditions and driver head movements. It's crucial to address these limitations to ensure a more robust and reliable drowsiness detection system for driver safety.
- The driver drowsiness detection system developed by Prof. Swati Gade, Kshitija Kamble, Aishwarya Sheth, Sakshi Patil, and Siddhi Potdar in 2022, utilizing an analogic cellular neural network algorithm, offers a unique approach to driver safety. However, there are limitations to consider. First, this method may have limited effectiveness in cases of poor lighting conditions, as it relies on detecting and normalizing the driver's face. Additionally, it might not work as well if the driver's face is partially obscured or if they are wearing items like sunglasses or face masks. The system's performance could also be influenced by the quality of the camera and hardware used. Furthermore, while it addresses crash scenarios, its ability to detect drowsiness in real-time and mitigate it in advance is not explicitly mentioned.
- The driver behavior recognition system developed by Muhamad Dwisnanto Putro and Kang-Hyun Jo in 2022, which utilizes a lightweight convolutional neural network architecture and an attention mechanism, presents a promising approach. However, there are certain limitations to consider. Firstly, the system's accuracy may not be consistent for all driver behaviors, as the effectiveness of the feature extraction and classifier modules can vary depending on the complexity and diversity of the behaviors in the dataset. Additionally, the real-time application of this system is not explicitly mentioned, and its performance may be influenced by factors like lighting conditions and camera quality. Furthermore, the use of a vast dataset may pose challenges in terms of data storage, processing, and computational resources. These limitations should be carefully addressed to ensure the system's practicality and reliability in recognizing diverse driver behaviors.
- The method for detecting driver's eyes closure and yawning with an infrared camera, developed by Wisaroot Tipprasert, Chamaporn Chianrabutra, and Chamaiporn Sukjamsri in 2022, is effective in low-light conditions, which is an advantage. However, it has certain limitations to keep in mind. It relies on detecting the entire face, including the eyes and mouth, which means that if the driver's face is partially obscured or wearing items like sunglasses or face masks, the accuracy may be reduced. The system's performance might also be affected by factors like extreme weather conditions, such as heavy rain or fog, which could interfere with the camera's effectiveness. Additionally, the system's sensitivity and specificity need to be well-calibrated to avoid false alarms or missed instances of drowsiness. These limitations should be considered to optimize the system for reliable drowsiness analysis.
- The driver drowsiness detection system by Harshit Verma, Amit Kumar, Gouri Shankar, and Ujjwal Deep in 2022 monitors drowsiness by considering the driver's eye blink rate and eyeball size through a camera and attached software. While this method offers a straightforward approach, it has limitations to consider. It heavily relies on the camera's ability to accurately measure blink rate and eyeball size, which can be influenced by factors such as lighting conditions and camera quality. Additionally, it may not be as effective if the driver is wearing sunglasses or face masks, which can obstruct the camera's view. Moreover, the system's performance can vary from person to person, as not everyone blinks or has the same eye characteristics at the same rate. To maximize its reliability, it's essential to be aware of these limitations when implementing this drowsiness detection system.
- The drowsiness detection system for drivers using conventional computer vision applications, as developed by Hitendra Garg in 2020, offers a practical solution for real-time drowsiness monitoring in motor vehicles. However, it's essential to recognize its limitations. First, this method relies on computer vision, which may not always accurately identify drowsiness in all individuals. Factors such as varying lighting conditions, driver appearance, and occlusions like sunglasses or face masks can affect its performance. Second, the system may have difficulty detecting drowsiness if a driver's head movements are excessive or if the driver is not facing the camera consistently. Additionally, the system's success is contingent on the quality of the camera and hardware, and any malfunctions or hardware limitations can impact its reliability. Finally, false alarms or missed instances of drowsiness could occur, necessitating a careful balance between sensitivity and specificity in the system's design. While this method is a valuable tool for enhancing driver safety.
- The real-time driver drowsiness detection system using computer vision, developed by Mahek Jain, Bhavya Bhagerathi, and Sowmyarani C N in 2021, relies on face detection techniques to map 68 x, y face coordinates using OpenCV software. However, this approach has some limitations to keep in mind. It heavily depends on the visibility and quality of the driver's face. If the lighting conditions inside the vehicle are poor, or the driver's face is partially covered or obscured, the system may not work effectively. Additionally, the accuracy of this method may vary from person to person because of differences in facial features and expressions. False positives or negatives can occur due to sudden head movements or distractions. Furthermore, the system's performance might be affected by the capabilities of the hardware and the camera used.

3. ALGORITHM

limitation, so our proposed system tries to overcome those by enhancing model quality with help of high-end cameras and calculating accurate ratios with help of this system.

1. **Data Collection** – First a picture is captured through in vehicle cameras with varying angles and lighting conditions to simulate real-world scenarios.
2. **Pre processing** – Human face is first divided into 68 x,y coordinates to locate key points on the face, including eyes and mouth. After that cropping and resizing of facial regions is done for consistent input to drowsiness detection model and image is normalized with respect to lighting and color variations.



3. **Feature extraction-** Calculate EAR, MAR and FAR through

EAR	**||v-z|| + ||w-y||** / **2||u-x||**
MAR	**||t-z|| + ||u-y||+||v-x||** / **3||s-w||**
FAR	**||p22-p8||+||p28-p9||+||p23-p10||** / **3||p6-p12||**

If the value surpasses the threshold value an alarm is sent to alert the driver.

	RANGE	**STATUS**
EAR	<0.23	Drowsy, eyes are closed
MAR	>0.35	Yawning, mouth wide open
FAR	>=FAR+0.35	Yawning

4. **Training the model-** Dividing these dataset into training and testing subsets to evaluate model performance. A machine learning or deep learning algorithm like SVM,CNN or a combination of both is used to build the detection model.
5. **Evaluation -** model's performance is assessed through metrics such as accuracy, precision, recall, and F1-score.

4. REAL TIME APPLICATIONS

- BMW: Active Driving Assistant with Assistant analyses driving behavior and, if necessary, advises the driver to rest. The advice to take a break is provided in the form of graphic symbols shown on the Control Display.
- Bosch: "Driver drowsiness detection"[10] takes input from the steering angle sensor, front-mounted lane assist camera, vehicle speed and turn signal stalk.
- Honda: CRV introduced the Driver Attention Monitor in 2017.[15] It is also offered on the 2018 Accord[16]
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- Hyundai: Driver Attention Alert (DAA), debuted with the 2017 i30.
- Jaguar Land Rover: Driver Condition Monitor and Driver Fatigue Alert, both evaluate driving technique for signs of driver fatigue. When the feature determines if the driver is fatigued, the message center displays the warning, TAKE A BREAK!, for 1 minute, accompanied by an audible chime. When driving continues for more than 15 minutes after the first warning, without taking a break, a further warning is given. The warning continues until the OK button on the steering wheel menu control is pressed.
- Kia: Driver Attention Warning (DAW), debuted with the 2018 Stinger.
- Nissan: Driver Attention Alert (DAA),[20] debuted with the 2014 Qashqai, followed by 2016 Maxima.

5. CONCLUSION

In conclusion, the research and developments in driver drowsiness detection using Eye Aspect Ratio (EAR), Mouth Aspect Ratio (MAR), and Face Aspect Ratio (FAR) have shown immense promise in addressing the critical issue of drowsy driving. Drowsy driving is a significant road safety concern, leading to accidents and fatalities that can be prevented with timely intervention. The integration of facial features for drowsiness detection represents a significant advancement in the field, offering a non-intrusive, real-time solution to enhance road safety. The reviewed literature demonstrates that EAR, MAR, and FAR, in combination with machine learning and deep learning models, have the potential to accurately monitor driver alertness. The accuracy rates, precision, recall, and F1-scores achieved by these systems indicate their effectiveness in distinguishing between drowsy and alert drivers. Moreover, the non-intrusive nature of these features enhances user acceptance and comfort, addressing a crucial aspect of any successful drowsiness detection system.

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