

Drowsiness Detection System Using Face Recognition Camera and Euclidean Distance Algorithm in Python

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Abstract

Ensuring road safety is a critical priority in modern transportation systems, and advanced driver assistance technologies have become integral to reducing accidents caused by driver fatigue. With continuous advancements in artificial intelligence, image processing, and sensor technology, contemporary vehicles are now equipped with intelligent systems that can monitor a driver's physiological and behavioural cues to enhance driving safety. This paper presents a comprehensive review of existing research on driver drowsiness detection and alert mechanisms, with a focus on enhancing accuracy and reliability.

Our study employs the Euclidean distance method to analyse eye and facial movements using real-time data from camera sensors. By continuously tracking key indicators such as blink rate, eye closure, and yawning frequency, the system effectively identifies early signs of fatigue. Recent developments in video processing and machine learning algorithms have significantly improved the precision of image analysis, enabling more accurate detection of drowsiness. The Driver Drowsiness Detection System plays a crucial role in mitigating sleep-related traffic accidents, particularly in regions where fatigue-related crashes are prevalent.

In this research, we propose an optimized feature extraction method that accurately assesses driver fatigue by analyzing the relative positions and movements of the eyes and mouth. By integrating advanced image processing techniques with real-time monitoring, this system aims to provide timely alerts, thereby improving driver awareness and reducing the risk of accidents.

Keywords— Euclidean distance, Driver drowsiness detection, Facial Detection using Open CV's Haar Cascade, Sound Alert.

1. INTRODUCTION

Road accidents remain a leading cause of fatalities worldwide. In recent years, changes in lifestyle and time management have significantly impacted regular sleep patterns. Individuals struggling to maintain a healthy work-life balance often face difficulties performing daily tasks, such as driving, which requires both mental and physical alertness. Sleeplessness, often triggered by microsleeps, is a major contributor to accidents, leading to severe injuries, financial losses, and even fatalities due to fatigue or drowsiness.

Traffic accidents are more prevalent during nighttime compared to daytime. To address the high number of fatigue-related incidents, various methods have been developed to detect driver drowsiness and issue timely alerts. While each technique has its own advantages and limitations, there is considerable potential for future improvements in this field. According to recent data, road accidents result in approximately 1,200 fatalities and 76,000 injuries annually. Additionally, around 2,400 accidents occur every year, with an average of one fatality every four hours.

Studies have shown that driver fatigue accounts for about 20% of car accidents. Distracted driving, often caused by tiredness, significantly increases the likelihood of road mishaps. Innovations in accident prevention technology can play a crucial role in detecting and mitigating driver fatigue. Given the risks associated with drowsy driving, it is essential to develop effective strategies and preventive measures to reduce the impact of such hazards on road safety.

2. RELATED STUDY

According to a survey conducted by the National Highway Traffic Safety Administration, there were 56,000 sleep-related incidents reported in the United States in 1996. In this context, the term "drowsy" refers to the ability to identify drivers experiencing fatigue based on their eye blink patterns. Unfortunately, drivers often struggle to prevent such accidents.

One effective method to assess a driver's fatigue level involves monitoring the vehicle's movements. However, this technique can produce inconsistent results influenced by factors such as the type of vehicle and road conditions. Another approach is the use of electrocardiograms (ECG) to analyze the driver's physiological signals. This method also has limitations, as ECG sensors must be continuously attached to the driver, which may cause discomfort.

Some research relies on classifiers like the Support Vector Machine (SVM) to detect drowsiness. The SVM classifier is used to identify the driver's eye state by extracting eye-related features with the help of the Garbo filter. However, the conditions applied in these methods make it challenging to accurately determine the eye's status.

In this study, we focus on employing Euclidean distance calculations to measure the spatial relationships between a driver's eyes, mouth, and other key facial landmarks to identify signs of drowsiness. This technique is implemented using Python, an open-source programming language known for its flexibility and robust libraries, and is integrated with camera sensors to facilitate continuous monitoring of the driver's facial expressions in real time.

3. PROPOSED METHODOLOGY

Step 1: Capturing Real-Time Video Data

The system begins by capturing live video streams through camera sensors installed within the vehicle. These sensors continuously record the driver's facial movements, providing the raw data needed for further analysis. The high-resolution feed ensures that even subtle changes in facial expressions are detectable.

Step 2: Facial Landmark Detection

Once the video feed is captured, the system applies facial landmark detection algorithms to identify key points on the driver's face. These landmarks typically include the corners of the eyes, edges of the mouth, and points around the eyebrows and nose. This step is critical as it sets the foundation for accurate distance measurement.

Step 3: Calculating Euclidean Distances

After identifying the facial landmarks, the system calculates the Euclidean distance between these critical points. This mathematical method helps determine the spatial relationships between facial features. For example, the distance between the upper and lower eyelids can indicate whether the eyes are closing frequently, and the distance between the upper and lower lips can help detect yawning.

Step 4: Analyzing Facial Metrics for Drowsiness

With the Euclidean distances calculated, the system analyzes these metrics to identify patterns associated with drowsiness. Indicators such as prolonged eye closure, frequent blinking, and yawning are monitored closely. The algorithm is designed to recognize these signs even when changes are subtle, ensuring early detection of fatigue.

Step 5: Triggering the Alarm System

When the system detects signs of drowsiness, it triggers an alarm sound through the car's speaker system. This immediate auditory alert is intended to capture the driver's attention and prompt them to take corrective actions, such as resting or pulling over safely. The alarm continues to sound until the driver acknowledges it.

Step 6: Continuous Monitoring and System Termination

The program operates in a continuous loop, constantly analysing the driver's facial features without interruption. This ensures real-time monitoring and immediate responses to signs of drowsiness. The system remains active throughout the driving session and can only be manually terminated by the driver, ensuring consistent safety support. By incorporating this technology, the system aims to enhance road safety by providing timely alerts that can prevent potential accidents caused by driver fatigue.

METHODOLOGY

Face Detection: Uses OpenCV's Haar Cascades for real-time face tracking.

Eye Detection: Employs Dlib's facial landmark detector to locate eye regions.

Eye Aspect Ratio (EAR): Utilizes Euclidean distance to measure eye openness.

Alert Mechanism: Sounds an alarm if the EAR drops below a threshold, indicating drowsiness.

4. EUCLIDEAN DISTANCE FORMULA

The Euclidean distance – (x_1, y_1) and (x_2, y_2) – is calculated as:

$$D = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

This formula measures distances between eye landmarks to compute the EAR.

5. CONCLUSION

One of the most important things in any firm is determining which personnel are capable of taking on difficult duties or developing projects. This driver drowsiness detection system is designed to enhance road safety by continuously monitoring a driver's facial expressions in real time. It utilizes advanced computer vision techniques, leveraging Euclidean distance calculations to measure subtle changes in key facial landmarks, such as the eyes and mouth. By analyzing these micro-expressions, the system can detect early signs of fatigue, such as slow blinking, prolonged eye closure, or frequent yawning.

Developed using Python and seamlessly integrated with camera sensors, this system operates without interfering with the driver's natural behavior. The camera continuously captures and processes facial data, identifying patterns that indicate drowsiness. When signs of fatigue are detected, the system can trigger immediate alerts—such as an audible alarm or a vibration in the steering wheel—to prompt the driver to take a break before their drowsiness leads to dangerous situations.

This real-time detection approach is particularly useful for long-haul truck drivers, late-night commuters, or anyone susceptible to fatigue behind the wheel. By proactively addressing drowsiness, the system plays a crucial role in reducing the risk of accidents and making roads safer for everyone.

6. References

1. V B Navya Kiran, Raksha R, Anisoor Rahman, Varsha K N, Dr. Nagamani N P, 2020, Driver Drowsiness Detection, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) NCAIT – 2020 (Volume 8 – Issue 15).
2. Radhika, K., Rao, N. K., Shalini, N., Vani, V. D., & Geetavani, B. (2023). Driver Drowsiness Detection Using OpenCV and Machine Learning Techniques. In *Microelectronics, Circuits and Systems: Select Proceedings of Micro2021* (pp. 413-422). Singapore: Springer Nature Singapore.
3. Sanjay, S., Banupriya, N., & Sathish, M. (2021, August). Drowsiness detection with OpenCV. In *2021 Second International Conference on Electronics and Sustainable Communication Systems (ICESC)* (pp. 1421-1425). IEEE.
4. Satish, K., Lalitesh, A., Bhargavi, K., Prem, M. S., & Anjali, T. (2020, July). Driver drowsiness detection. In *2020 international conference on communication and signal processing (ICCSP)* (pp. 0380-0384). IEEE.
5. V B Navya Kiran, Raksha R, Anisoor Rahman, Varsha K N, Dr. Nagamani N P, 2020, Driver Drowsiness Detection, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) NCAIT – 2020 (Volume 8 – Issue 15),
6. Akash, A., Kishan, K., Shyam, S., & Subramanian, B. (2024, February). Monitoring of drowsiness using OpenCV and python. In *AIP Conference Proceedings* (Vol. 2742, No. 1). AIP Publishing.