e-ISSN: 2455-7013
Asian Journal of Management, Engineering & Computer Sciences (AJMECS)
Vol. 9(1), Jan. 2024: 6-13
URL: http://www.crsdindia.com/ajmecs.html
Email: crsdindia@gmail.com

RESEARCH PAPER

Technology to Detect Drowsiness in Drivers through Wide-Open Eyes

Shruti Gupta, Aarushi Saxena, Atulya Shree Sharma and Arpana Maheshwari
Department of Comp. Eng., Poornima Institute of Eng. & Tech., Jaipur, Rajasthan
Email: shruti.gupta@poornima.org

ABSTRACT

This study incorporates an efficient sound alert system together with a thorough method for facial analysis drowsiness detection. In order to accurately identify facial characteristics, the first component uses a pre-trained shape prediction model for face detection and landmark extraction. The quality of the gathered frames is improved by applying image improvement techniques, such as gamma correction and histogram equalization, which are essential for further computations. In order to identify blinks and contribute to the overall drowsiness detection system, the Eye Aspect Ratio (EAR) is presented as a crucial parameter. Because the EAR is calculated using precise distances between face landmarks, the algorithm can reliably recognize blinks. A separate thread is used to control a sound alert system that sounds an alarm when it senses tiredness. To ensure prompt and accurate notifications, the system uses a communication channel between the main thread and the sound alert thread. When drowsiness is identified, integration with drowsiness detection triggers the sound alert system and displays visual alerts on the frame.

Keywords: *Algorithm, Face Detection, Landmark Extraction, Eye Aspect Ratio (EAR), Blink Detection, Drowsiness Detection, Sound Alert System, Thread Management, Integration*

Received: 8th Nov. 2023, Revised: 4th Dec. 2023, Accepted: 14th Dec. 2023

How to cite this article:
Shruti Gupta, Aarushi Saxena, Atulya Shree Sharma and Arpana Maheshwari (2024): Technology to Detect Drowsiness in Drivers through Wide-Open Eyes. AJMECS, Vol. 9(1): Jan., 2024: 6-13.

INTRODUCTION

The symptoms of drowsiness, which include decreased alertness, compromised cognitive function, and sleep deprivation episodes, are extremely dangerous for road safety. Drowsiness, in contrast to other impairments like intoxication from alcohol or distraction, frequently goes unnoticed until it is too late. Conventional strategies to prevent sleepy driving, like drinking coffee or opening windows, are frequently ineffectual and don't deal with the underlying cause of the issue.

The rising number of accidents on the road caused by sleepy drivers has drawn significant attention from around the world in recent years. The World Health Organization (WHO) estimates that road traffic crashes claim the lives of 1.35 million people annually, and that sleepy driving plays a major role in these deaths. In addition to causing fatalities, the effects of drunk driving place a heavy financial and social burden on society. Therefore, researchers, technicians, and policymakers have all placed a great deal of emphasis on the development of efficient drowsiness detection systems.

The main causes of driver fatigue, coupled with succinct explanations:

Lack of Sleep: Sleep deprivation or inadequate sleep duration can cause fatigue. Sleep disorders, erratic sleep habits, or just not allotting enough time for sufficient rest could be the cause of this.

Extended Driving Hours: Driving for extended periods of time, especially without breaks, might make you tired and drowsy. This is especially typical for people who drive for a living or for extended road trips.

Drugs and Alcohol: Both alcohol and some drugs, including illegal narcotics and some prescription medications, can cause sleepiness and impair cognitive performance. In addition to being dangerous, driving while under the influence of certain substances is prohibited.

Medications: Drowsiness can result from side effects of several medications, including certain prescription and over-the-counter pharmaceuticals. It's critical that drivers understand these possible adverse effects and abstain from operating a vehicle if they feel sleepy after taking medicine.

Emotional and Stress Factors: Anxiety, tension, and emotional turmoil can impair the quality of sleep and cause weariness during the day, especially when driving.

Medical Illnesses: Excessive daytime sleepiness and an increased risk of sleepy driving can result from certain medical illnesses, such as sleep disorders like narcolepsy or sleep apnea.

These elements have the potential to seriously hinder a driver's capacity to maintain awareness and focus while driving, which raises the possibility of collisions.
Researchers have been looking into cutting-edge technological solutions to this problem that aim to identify and mitigate driver drowsiness in in real time. These remedies include physiological monitoring devices as well as computer vision-based algorithms that can read driver emotions and behaviour. The incorporation of such technologies into automobiles has the potential to avert collisions by notifying drivers or initiating safety protocols upon detecting indications of fatigue.

RELATED WORK

Research on drowsiness detection is essential to the effort to reduce fatigue-related accidents, especially when driving or operating heavy machinery. Technological developments have resulted in the creation of complex systems with three essential parts: alarm systems, eye blink detection, and eye detection.
Drowsiness detection systems rely heavily on eye detection since it offers important information about a person's attentiveness and alertness. Convolutional Neural Networks (CNNs), a more sophisticated approach than Haar cascades, have replaced traditional computer vision algorithms and greatly increased the accuracy of real-time eye identification. These improvements allow stable performance even in difficult situations such as changing lighting and head angles. Eye blink detection is a vital component that supports eye detection in identifying sleepiness indicators. The frequency and duration of blinks can be used as markers of different cognitive processes. The temporal patterns of blinks have been analysed using a variety of methodologies, ranging from template matching to sophisticated deep learning techniques like Recurrent Neural Networks (RNNs) and Long Short-Term Memory (LSTM) networks. By differentiating between patterns linked to tiredness and regular blinking, the aim is to increase the overall effectiveness of the drowsiness detection system.
As the last line of defence, alert systems notify those who are at danger of fatigue-related impairment in a timely manner. These systems try to get the person's attention again and stop any accidents by using haptic, visual, or aural alerts. Alert systems come in a variety of levels of complexity; basic sirens and flashing lights are among them, but they can also include more complex features like vibrating seats or vibrations in the steering wheel. Alert systems that adapt their intensity according to the degree of detected drowsiness are becoming more and more common. The personalization of alerting strategies through

the integration of machine learning models into alert systems increases their efficacy in reducing the dangers associated with driving while intoxicated.

Several modalities are taken into account in a holistic way to improve detection accuracy. Changes in facial expressions serve as extra markers of tiredness, in addition to facial recognition and expression analysis, which help to understand a driver's emotional state. Comprehensive sleepiness detection frameworks combine head movements, physiological signals like heart rate, and even steering behavior and lane departure tendencies. Due to the multimodal integration, it is possible to measure a person's cognitive state in a more sophisticated manner, taking into account individual variances and different lighting circumstances.

The enormous datasets produced by drowsiness detection systems are processed and interpreted in large part through the use of machine learning and artificial intelligence (AI). Data from various sensors has been analyzed using a variety of techniques, from support vector machines to decision trees and neural networks. Convolutional neural networks (CNNs) and recurrent neural networks (RNNs) are two examples of deep learning approaches that have shown encouraging results in increasing the accuracy of drowsiness detection models, permitting adaption to various driving circumstances. Even with the advancements, there are still difficulties in implementing sleepiness detection systems in practical settings. Obstacles include changing driving circumstances, user preferences, and environmental influences are still present. The goal of current research is to address these issues by creating algorithms that are more reliable, using new technologies, and investigating additional sleepiness signs. To make it easier to validate and compare various sleepiness detection systems, standardized evaluation criteria and testing methodologies are also being actively developed. In conclusion, sleepiness detection has evolved through a multidisciplinary approach that combines knowledge from computer vision, machine learning, physiology, psychology, and other fields to produce more precise, flexible, and user-friendly systems that improve road safety.

METHODOLOGY

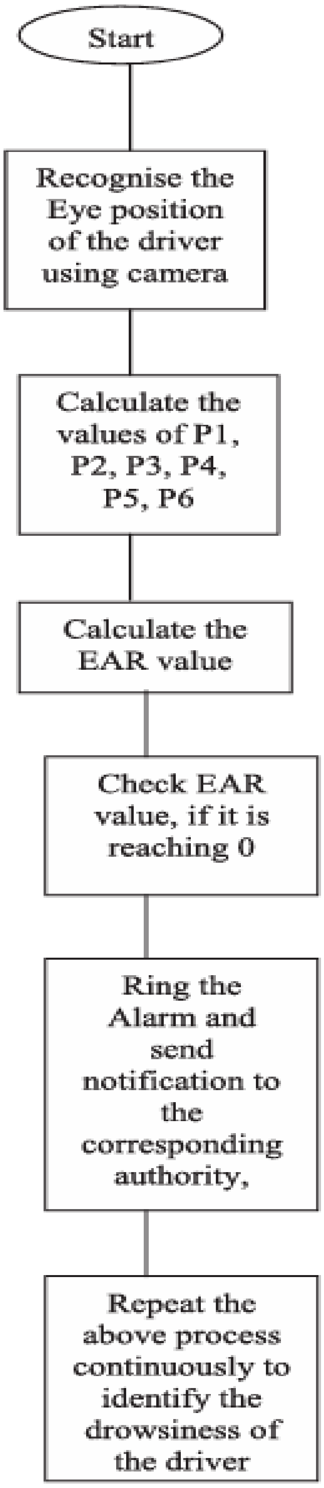
Blinking is the quick closing and opening of one's eyes. It varies from person to person in terms of blink time (around 100–400 ms), blink speed, and degree of squeezing. This paper suggests a technique for localizing the shapes of the eyes and eyelids by utilizing sophisticated facial landmark detectors. The eye opening stage is indicated by the Eye Aspect Ratio (EAR), which is calculated from the landmarks that have been identified. When the eye is open, EAR, which is calculated as the ratio of the eye's height to width, provides a constant value; when the eye is closed, EAR approaches zero. A classifier is trained to take into account a wider temporal window of frames in order to improve accuracy and eliminate potential per-frame EAR recognition issues.

Eye landmarks are identified for every video frame, and EAR is calculated using a formula incorporating the locations of 2D landmarks. When the eye is open, the EAR is relatively constant, and when it closes, it approaches zero, indicating a partial insensitivity to head attitude and person fluctuations. The open eye's aspect ratio is completely independent of face rotation and image scaling, and it varies very little between people. Since both eyes usually blink simultaneously, the average EAR of the two eyes is used. The provided figures show an example of an EAR signal across a video sequence.

Although a prior study based on eye segmentation in a binary image provided a similar feature, this work improves the method by integrating EAR calculation with facial landmarks and demonstrates its efficacy in detecting eye blinks.

Process Flow of the System:

The mouth, nose, and corners of the eyes are examples of important facial features that provide useful cues for identifying activities related to the eyes. The shifts and positions of all these landmarks can be tracked over time, making it possible to precisely detect and describe eye blinks. This method offers a non-invasive and effective way to track blink patterns, allowing for a variety of uses, such as the evaluation of driver fatigue and the identification of neurological conditions.



$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}, \qquad (1)$$

where $p_1, \ldots, p_6$ are the 2D landmark locations, depicted in Fig. 1.

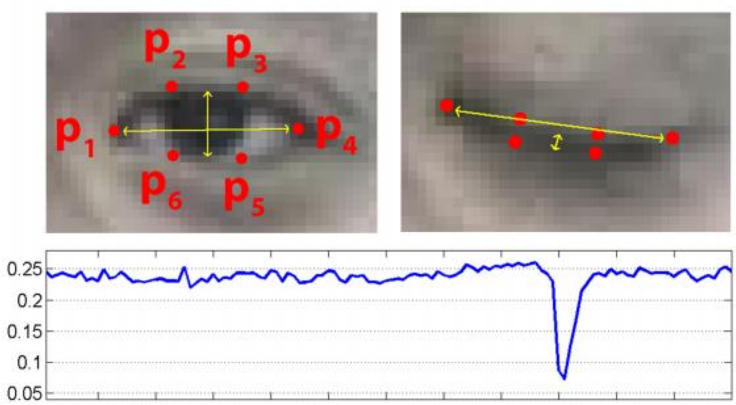


Figure 1: Open and closed eyes with landmarks p_i automatically detected by [1]. The eye aspect ratio EAR in Eq. (1) plotted for several frames of a video sequence. A single blink is present.

Eye Blink Detection using Facial Landmarks:

Fig. 2: Facial Landmarks

Moreover, issues like robustness to head movements, occlusions, and facial expressions are discussed in relation to the practical application of eye blink detection systems. The discussion of approaches like augmenting data, landmark the normalization process, and methods for ensemble learning offers an understanding of how to address these issues and enhance the dependability and precision of blink detection algorithms.

Due to its numerous applications in a variety of fields, such as driver tracking systems, healthcare, and interaction between humans and machines, the detection of eye blinks using facial landmarks has attracted a lot of fascination in recent years. Knowing human behaviour, cognitive states, and physiological conditions is fundamentally dependent on the ability to detect eye blinks. Thanks to developments in methods for computer vision and deep learning algorithms, using facial landmarks for blink detection has become a promising method.

A facial landmark is the location of specific feature-exhibiting areas on an individual's face. The most common facial landmarks are the corners of the eyes, the nose tip, the nostril tips, the mouth corners, the end point of the brow arch, the ears, lobes, and the chin. Its feature is frequently applied to the following:-

1. Expression analysis: One can determine the emotions on someone's face by tracking the movement of key locations on their face when they express themselves.
2. Face identification: A person's face can be identified by measuring the distances and angles between landmark points on their face, which can provide geometric data regarding the subject's face. Because every person has a different point location, the region surrounding the eyes is advantageous.
3. Face tracking: Faces in a video frame can be tracked by tracking the movement of landmark areas on the face, particularly when a person turns their head or moves their face.

FACE DETECTION AND LANDMARK EXTRACTION

The components that deal with face identification and landmark extraction are essential for recognizing facial features. 68 facial landmarks are extracted using a pre-trained shape prediction model, and frontal face detection is accomplished using the dlib library. Points surrounding the mouth, nose, eyes, and other facial parts are among these landmarks. For the computation of the eye aspect ratio and the consequent detection of blinks, precise recognition of face landmarks is necessary.

The detector object is responsible for identifying faces in the captured frames, while the predictor object extracts facial landmarks based on the detected faces.

IMAGE ENHANCEMENT TECHNIQUES

The code applies histogram equalization and gamma correction, two picture improvement techniques, to enhance the quality of the collected frames. By modifying the brightness and contrast of the frames, these strategies improve the precision of the calculations made for the eye aspect ratio later on.

The gamma_correction function applies gamma correction to the input image, while the histogram_equalization function performs histogram equalization on the grayscale version of the image.

A. Eye Aspect Ratio (EAR):

Computer vision systems frequently use the Eye Aspect Ratio (EAR) characteristic, especially for tasks like facial emotion identification and drowsiness detection. It entails calculating the ratio of different distances between the eye region's facial markers. When it comes to sleepiness detection, EAR is used to track changes in an individual's eye appearance that happen when they get sleepy or drowsy.

1. eye is a list of coordinates representing the landmarks of an eye.
2. dist. euclidean(a,b) computes the Euclidean distance between points a and b.
3. A, B, and C represent specific distances between landmarks on the eye.

The formula (A + B) / (2.0 * C) computes the ratio of the sum of distances A and B to twice the distance C. This ratio is the EAR.

B. Blink Detection:

The EAR is used in the check Blink Status function to determine if a blink has occurred. The function updates the global state, blink Count, and drowsy variables based on predefined thresholds and the current eye status.

This algorithm helps identify blinks and contributes to the overall drowsiness detection system implemented in the code. If the EAR falls below a certain threshold (thresh), it indicates that the eyes are closed, and the blink count is updated accordingly.

In summary, the EAR is a crucial parameter for blink detection, providing insights into eye behavior and enabling the system to recognize signs of drowsiness.

SOUND ALERT SYSTEM

The sound alert system is implemented as a separate thread, managed by the sound alert function. This function continuously checks a thread StatusQ queue to determine whether it should continue running or exit. The thread StatusQ serves as a communication channel between the main thread and the sound alert thread.

- The soundAlert function is defined to take two parameters: the path to the sound file path and the thread status queue thread StatusQ.
- Inside the function, there's an infinite loop while True that continuously checks the status of the thread StatusQ.
- If the queue is not empty, it retrieves the status FINESHED from the queue. If FINESHED is True, it breaks out of the loop, effectively terminating the thread.
- If the queue is empty or FINESHED is False, it continues playing the sound alert using the playsound (path) function.

INTEGERATION WITH DROWSINESS DETECTION

The sound alert system is triggered in the main loop of the code when drowsiness is detected. Here's the relevant part of the code:

- If drowsy is True, indicating the detection of drowsiness, the code displays a visual alert on the frame.
- It then checks whether the alarm is already on (ALARM_ON). If not, it sets ALARM_ON to True, puts the opposite value (not ALARM_ON) into the thread StatusQ to signal the sound alert thread to start, and starts a new thread (thread) to execute the soundAlert function.
- The thread.setDaemon(True) line makes the thread a daemon thread, meaning it will automatically exit when the main program stops.

CONCLUSION

To sum up, this thorough investigation tackles the important problem of fatigued driving and how it affects traffic safety. Drowsiness's symptoms, which include lowered attentiveness and impaired cognitive function, are extremely dangerous when driving. The inefficiency of many traditional techniques, such as drinking coffee or opening windows, highlights the necessity for cutting-edge solutions.

The research pinpoints a number of factors that contribute to driver weariness, including inadequate sleep, long driving days, drug abuse, side effects from medications, psychological issues, and underlying medical disorders. These elements greatly impair a driver's capacity to maintain attention and alertness, which raises the risk of collisions.

The process flow is explained in depth in the technique section, with particular attention to the eye blink detection utilizing facial landmarks. The Eye Aspect Ratio (EAR), which is determined by accurately extracting face landmarks, is presented in the paper as a crucial component for blink detection. The total efficacy of the sleepiness detection system is enhanced by the integration of EAR computation, facial landmark extraction, and picture enhancement techniques.

The suggested system gains another layer with the addition of a sound alarm system, which increases user awareness when drowsiness is identified. The code implementation demonstrates a comprehensive approach to drowsiness detection by utilizing ear, sound alarm, and facial markers.

In conclusion, the study offers a robust and versatile drowsiness detection system that integrates blink detection, facial landmark extraction, and a sound alert system. The creation of a comprehensive strategy to manage the risks associated with sleepy driving is aided by the integration of cutting-edge technology, machine learning, and real-time monitoring.

REFERENCES

1. Arefnezhad S., Eichberger A., Frühwirth M., Kaufmann C. and Moser M. (2020): Driver Drowsiness Classification Using Data Fusion of Vehicle-based Measures and ECG Signals. In Proceedings of the 2020 IEEE International Conference on Systems, Man, and Cybernetics (SMC), Toronto, ON, Canada, 451-456.
2. Awais M., Badruddin N. and Drieberg M. (2017): A hybrid approach to detect driver drowsiness utilizing physiological signals to improve system performance and wearability. Sensors 17(9).
3. Bakheet S. and Al-Hamadi A. (2021): A Framework for Instantaneous Driver Drowsiness Detection Based on Improved HOG Features and Naïve Bayesian Classification. Brain Sci. 11, 240.
4. Barua S., Ahmed M.U., Ahlstr¨ om C. and Begum S. (2019): Automatic driver sleepiness detection using EEG, EOG and contextual information. Expert Syst. Appl. 115, 121-135.
5. Becerra-S´anchez E., Reyes A. and Guerrero-Iba˜nez J. (2019): Wearable Sensors for Evaluating Driver Drowsiness and High Stress. IEEE Lat. Am. Trans. 17 (3): 418-425.