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Identification and Detection of Driver Drowsiness using Machine Learning Techniques

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Abstract

Many people die or are injured in car accidents. According to the World Health Organization, one million people die from traffic accidents every year worldwide. Drowsy, unrested, or drowsy drivers are drowsy drivers who put themselves and other road users at risk. Studies on car accidents show that major train accidents are caused by driver fatigue. In recent years, it has been revealed that driving while drowsy can cause fatigue. Nowadays, the cause of accidents while climbing is hunger. This situation is a serious problem all over the world and needs to be solved as soon as possible. In recent years, driver hijacking has become one of the leading causes of traffic accidents that can lead to death, serious bodily injury, and accidents. Economic losses and disasters. Driver fatigue can be caused by long hours of driving, drowsiness, fatigue, medications, sleep disorders, and illness. An analysis of various studies shows that there is a need for reliable technology that can detect drowsy driving and warn drivers before an accident occurs. Many studies have been conducted to improve the diagnosis and prediction of drowsy driving using different scales to assess drowsy driving. This study identified several measures categorized by the researchers as physiological, automatic, mental, and behavioral measures. This article deals with the main issues of different sleep detection methods and how to use them to detect drowsiness while driving. To warn drivers before they crash, the analysis focuses on what happens while driving, and as technology advances, it is designed to ideally identify and predict drowsy drivers. This comprehensive review provides a better understanding for researchers conducting fundamental evaluations in a field. Continuous advances in technology and artificial intelligence over the past decade have also led to advances in driver monitoring. Extensive research has collected real-world driving data, and various algorithms and combinations of artificial intelligence have been used to improve the immediate performance of these systems. This article provides an up-to-date review of driver drowsiness detection devices used over the past decade. This article describes and reviews modern systems for monitoring and analyzing sleep using various metrics.

Keywords

Real-time detection, Face Detection, Python, Open CV, Eye blinking, Facial landmark detection, Automotive safety systems.

1. Introduction

The automotive industry has undergone a major transformation due to technological advances, especially in the field of driver assistance systems. These systems are designed to improve safety and comfort for drivers, passengers and pedestrians. Among the many challenges that drivers face, one of the most important is sleepiness, which can lead to accidents with serious consequences. According to the National Highway Traffic Safety Administration (NHTSA), in the United States alone, drowsy driving causes nearly 100,000 crashes each year, resulting in 71,000 injuries and 1,550 deaths. These reports highlight the critical need for effective drowsy driver detection.

In today's fast-paced world, road safety is a serious concern. Drowsiness while driving is a serious risk not only for the driver but also for passengers and other road users. To reduce this risk, advanced technology has emerged to detect and prevent drowsy driving accidents. One of these technologies is the integration of computer vision and machine learning algorithms.

Diagnosing driver drowsiness is a complex task that involves monitoring various physiological and behavioral indicators. Traditional methods of sleepiness detection, such as the analysis of driver's eye movements and facial expressions, have limitations in terms of accuracy and reliability. In addition, these methods require extensive manual intervention and can be time-consuming. Therefore, there is a growing demand for automatic and intelligent systems that can accurately and efficiently detect driver drowsiness in real time.

2. Literature Survey

The motive force abnormality tracking machine monitors for drowsiness, fatigue, and other conditions in drivers. It uses a camera to track the face, measuring eye closures to assess the driver's level of alertness. The system works effectively in various conditions, including low light and with drivers wearing glasses [1].

Recent research has made significant strides in drowsiness detection, with a 97.23% accuracy achieved through a deep learning-based Convolutional Neural Network (CNN) model. The superior performance of CNN is attributed to its ability to discern intricate patterns and features in the data. Future advancements may involve exploring synergies between CNN and other neural networks [2].

The Drowsiness Detection System can quickly detect drowsy driving behaviors and alert the driver, even in low light conditions. It uses internal image processing techniques to monitor the driver's head and eye movements and delivers audio warnings when prolonged eyelid closure is detected [3].

The driver drowsiness detection system uses image processing to measure Eye Aspect Ratio and alert the driver when drowsiness is detected. The system has limitations but can help reduce accidents caused by drowsy driving. For future work, the system should automatically determine the threshold for each individual without manual setup [4].

In the blindfolding method, the driver's condition is measured by counting the number of times the driver blinks. The average face-to-face time is between 0.1 seconds and 0.4 seconds. This means that the eye blinks at least 2 or 3 times per second. Watch for a few minutes. When the driver is tired the count will be lower than normal. In this way, we can control the driver's fatigue. In our project, the camera is placed in front of the face to help detect the real face and the flashing face. Initially, the face is detected, and then eye, the closure process is recorded with the help of an open cv which detects the 68 landmarks of the face [5].

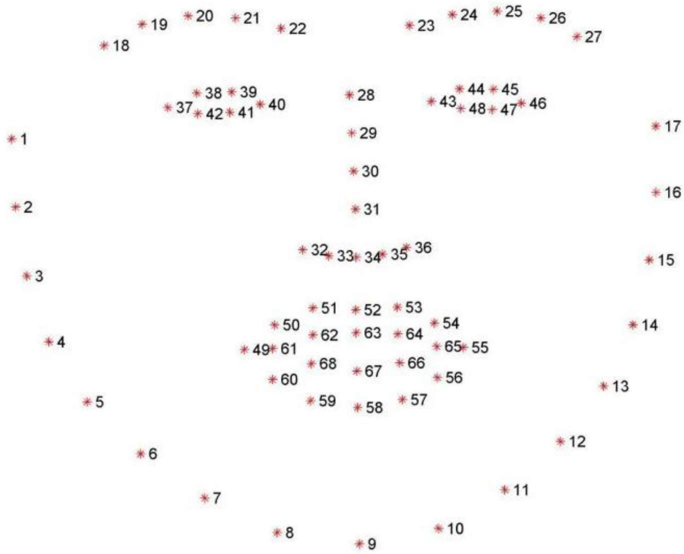

Figure 1. face landmarks detected by open cv

Once the eye is detected, the next system will determine whether the eye is open or not. If the eye is closed, the alarm will sound until the eye is opened when it is checked whether the score exceeds the specified score. The system will continue to follow the driver as long as his eyes are open.

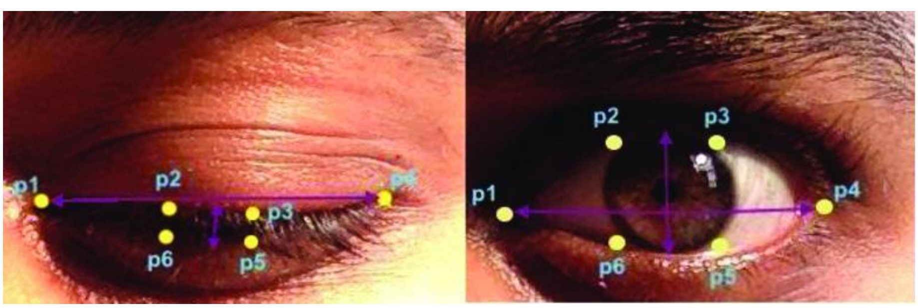

Figure 2. The position of the 6 cardinal points with the eyes open and closed determines the EAR

The system detects drowsiness through eye and mouth monitoring using shape prediction methods. It calculates the Eye Aspect Ratio (EAR) from facial landmarks and utilizes an eSpeak module for voice alerts when drowsiness or yawning is detected. This initiative aims to reduce accident rates and prevent fatalities on roads by leveraging technology [6].

The proposed drowsiness detection gadget enhances road safety by accurately identifying fatigue in drivers through behavioral, physiological, and vehicular parameters, minimizing accidents and alerting drivers when drowsiness is detected. It suggests integrating nonintrusive techniques like contactless electrode placement with physiological measures such as Dlib, alongside behavioral and vehicle-based data, for optimal efficiency in detecting drowsiness. Additionally, considering environmental factors is crucial for achieving optimal results [7].

Two driver drowsiness detection systems proposed: one combining CNN and RNN for drowsiness level estimation, the other utilizing fuzzy logic with preprocessed data. Testing on 122 videos showed moderate accuracy (~65% on training, ~60% on test data), but the second system showed promise, with low false positives (7%) but lower accuracy (36%) in detecting drowsiness. Both systems have potential for improvement in future research to tackle the complex problem of drowsiness detection from driver images [8].

The paper introduces a real-time driver drowsiness detection system using vision-based techniques. It employs skin color model for face detection, Circular Hough transform for eye localization, and a distance logic for eye state estimation, achieving an 80% accuracy in face and eye detection. However, challenges arise in dark backgrounds leading to potential errors in eye detection and false fatigue alarms, yet the system effectively issues warnings upon prolonged eye closure indicative of drowsiness [9].

A fusion-based method intelligently monitors driver drowsiness, enhancing safety by detecting behavioral cues like yawns and eye closures. Its simplicity and independence from subject training make it suitable for commercial use, with experimental results demonstrating high efficiency [10].

A proposed driver drowsiness detection system integrates a touch sensor into the steering wheel and employs a cam-era-based algorithm for facial feature extraction. By assessing hand grip strength on the wheel alongside Eye Aspect Ratio (EAR), it accurately determines the driver's drowsiness status, validated through combined experimental results. The measured amplified voltage correlates with grip strength and EAR, affirming its efficacy in detecting drowsiness accurately [11].

Drowsy driving poses a significant risk to safety, prompting automotive manufacturers to enhance vehicle safety features. Ongoing research aims to develop an effective, non-intrusive driver drowsiness detection system utilizing real-time image processing and warning signals, fostering safer roads [12].

We developed a driver drowsiness detection system using camera analysis for cost-effectiveness, achieving over 92% accuracy with a latency of 0.8 seconds. By integrating PERCLOS, CNN, facial landmarks, Haar cascades, and EAR methods, warnings are issued through a speaker connected to a PYNQ-Z2 board and transmitted over the cloud via Wi-Fi [13].

The study comprehensively examines methods for detecting driver drowsiness, including image-based, biological-based, vehicle-based, and hybrid-based systems, with detailed explanations of features, AI algorithms, datasets, and accuracy. Techniques such as deep CNN models and image processing show promise, with potential to significantly reduce accidents caused by drowsy driving when applied in vehicles. A hybrid approach combining multiple methods holds potential for real-time detection, maximizing effectiveness in preventing accidents [14].

A Machine Learning system detects driver drowsiness using facial landmarks and CNN models. It excels with transparent glasses and night vision, ready for deployment on physical devices. Future plans include integrating facial expressions for enhanced accuracy in addressing drowsiness-related accidents [15].

3. Experimental Setup and Dataset Description

The experimental setup of this work uses various libraries and tools to perform face and eye detection, extract eye features, and calculate the distance between these features using Python. Play the ringtone. The dataset used for training and testing the model consists of images and videos containing human faces labeled with eye features.

After the entire architecture of the model is explained, you will see that it is very easy to use. So, all we do here is take the driver's face with a camera and measure the driver's score. Visually observe the alarm and sound accordingly.

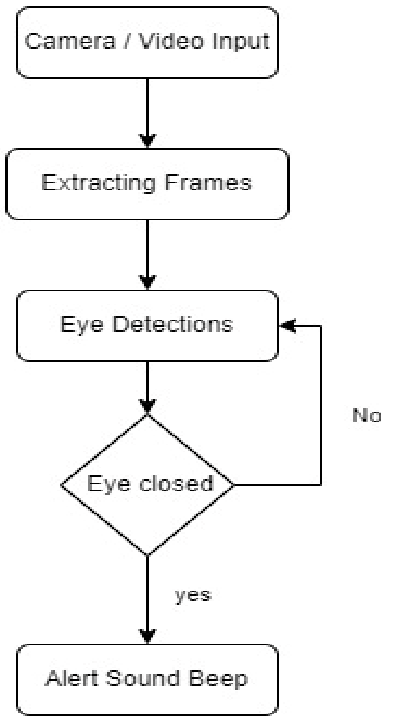

Figure 3. A flowchart illustrating the operational workflow of the model

3.1. Open CV

OpenCV (Open-Source Computer Vision Library) is a powerful open-source computer and machine learning software library. It is widely used for photo and video work. Use the pip install opencv-python command to install OpenCV.

This work uses OpenCV for face and eye detection, which is the basis of an eye tracking system.

3.2. Imutils

Imutils is a set of useful functions that facilitate basic image processing tasks using OpenCV. It simplifies various image processing operations such as resizing, rotating, and displaying images. Use the pip install imutils command to install Imutils.

In this project, we use Imutils to obtain the necessary eye cues to calculate the distance between the eyes.

3.3. Scipy

Scipy is an open-source Python library used for scientific computing. It provides many easy-to-use and efficient numerical routines, including optimization, integration, interpolation, and linear algebra. To install Scipy, use the pip install scipy command. This work uses Scipy to calculate the distance between eye marks. This distance is important to determine whether the eyes are closed or open.

3.4. Pygame

Pygame is a set of Python modules designed for creating video games. Includes computer graphics and sound library. To install Pygame, use the pip install pygame command. This work uses Pygame to play an alarm sound when you close your eyes for a long time.

3.5. Dlib

Dlib is a modern C++ tool that includes machine learning algorithms and tools for writing complex software in C++. It is widely used in face recognition such as prediction and facial feature point detection. Install Dlib using the pip install dlib command. In this project, Dlib is used to detect the landmark of the face, which is important for determining the location of the eyes.

4. Outcome Screen Shot

Once the copying is finished, the document is ready to be used in the model. Use the "Save As" command to copy the tem-plate file and use the suggested name specified by the directory as the file name. Highlight everything in this newly cre-ated file and import your prepared text. You are now ready to style your paper.

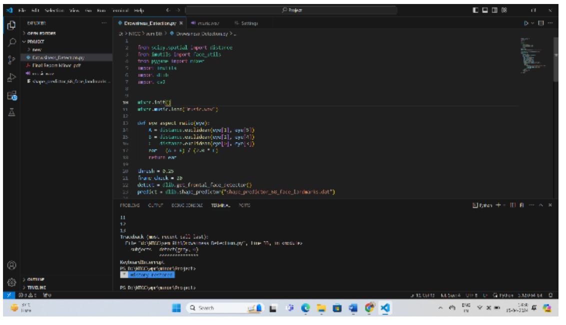

Figure 4. On running the program this first screen is shown

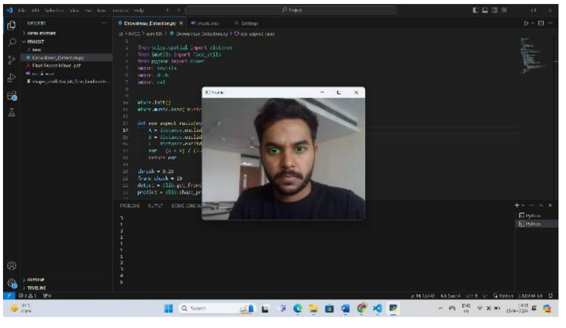

Figure 5. Case:1 Showing that the camera is open and detecting that the eyes are open

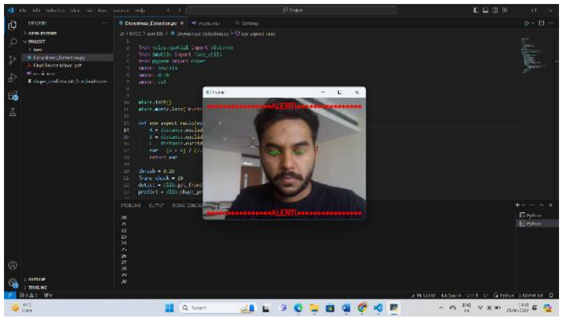

Figure 6. Case:1 Indicating that the camera is active and detecting closed eyes, triggering an alarm

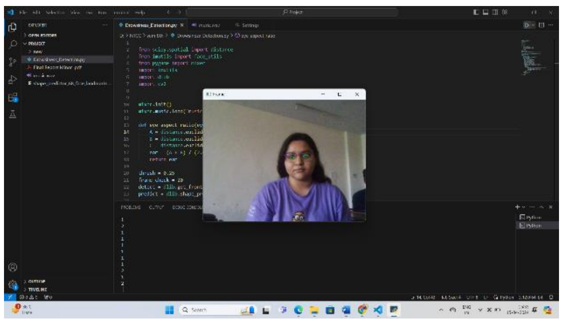

Figure 7. Case:2 Showing that the camera is open and detecting that the eyes are open

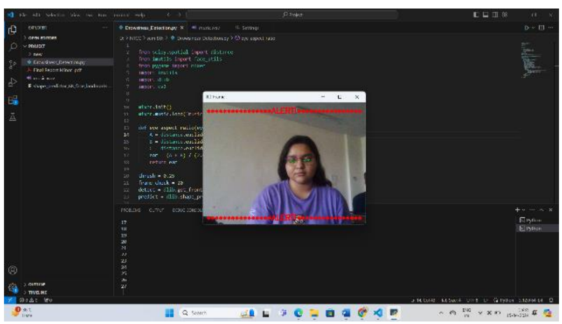

Figure 8. Case:2 Indicating that the camera is active and detecting closed eyes, triggering an alarm

5. Result and Discussion

The integration of facial recognition technology in driver drowsiness detection systems brings promising results. These systems effectively detect signs of driver drowsiness by analyzing facial features such as eye closure, head position, and facial expressions. This integration enhances the real-time monitoring capabilities of drowsiness detection systems and enables timely warnings and interventions to prevent potential accidents caused by driver fatigue. In addition, the use of facial recognition technology enables non-intrusive monitoring and ensures user comfort and acceptance of these systems in various driving environments. Overall, the inclusion of facial recognition in driver drowsiness detection systems is a significant improvement in increasing road safety and reducing the risks associated with driver fatigue.

The main method of determining image features in diagnosing driver fatigue is face extraction. Facial recognition is one of the prediction problems that not only finds the specific region of interest (such as eyes, nose, mouth) but also captures the image of the entire face. The face landmark detector in the Dlib library is used to detect 68 coordinates specified as (a, b).

Open Eye Coordinates

Figure 9. In this figure, the study of eyes P1, P2, P3, P4, P5, and P6 used to measure the eye-to-eye ratio (EAR) with eyes open is approximately 0.24.

Close Eye Coordinates

Figure 10. Eye-to-eye ratio (EAR) for a close eye is approx. 0.15.

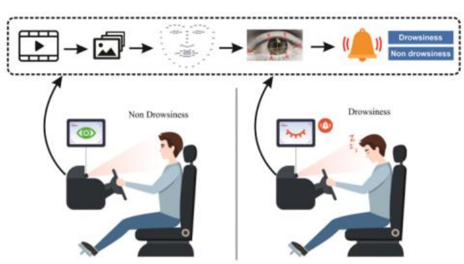

Figure 11. Shows real-time functioning.

Table 1. Showcasing Important Parameters

INDIVIDUAL	EAR RATIO	LIGHT	REMARK	DROWSINESS DETECTION
Case:1	>0.15	BRIGHT	Eye open	Not Drowsy
Case:1	<0.15	BRIGHT	Eye closed	Drowsy
Case:2	>0.15	BRIGHT	Eye open Wear glasses	Not Drowsy
Case:2	<0.15	BRIGHT	Eye closed Wear glasses	Drowsy

6. Conclusion

In conclusion, the integration of facial detection technology into driver drowsiness detection systems presents a promising approach for enhancing road safety. Through the analysis of facial expressions and physiological cues, these systems can accurately identify signs of drowsiness in drivers, allowing for timely intervention to prevent potential accidents. The effec-tive-ness of such systems has been demonstrated through numerous studies, highlighting their potential to mitigate the risks associated with driver fatigue. However, further research is warranted to refine the accuracy and reliability of these systems, particularly in real-world driving scenarios and diverse environmental conditions. With continued advancements in technology and collaboration between researchers, engineers, and policymakers, facial detection-based driver drowsiness detection systems hold significant promise in reducing road accidents and saving lives.

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