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Machine Learning and Deep Learning for the Detection of Eye Fatigue

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Abstract: *Eye fatigue is becoming increasingly common worldwide. Currently, the only effective method for detecting eye fatigue is through sample survey questionnaires. This study proposes a machine learning-based method for detecting eye fatigue using a Single-Channel Electrooculography System. Participants complete industry-standard eye fatigue questionnaires, and their responses are used as data labels. We then collect their electrooculography signals using a single- channel device. From these signals, we extract the five most relevant features related to eye fatigue. A machine learning model is then developed, utilizing these five features for detection purposes. Experimental results indicate a clear objective correlation between electrooculography signals and eye fatigue. This method shows promise for practical daily use in detecting eye fatigue. An eye fatigue detection method by machine learning based on the Single-Channel Electrooculography-based System is proposed. Subjects are required to finish the industry-standard questionnaires of eye fatigue; the results are used as data labels. Then, we collect their electrooculography signals through a single-channel device.*

Keywords: feature extraction**;** eye fatigue**;** machine learning

I. INTRODUCTION

In today's digital era, the pervasive use of electronic devices such as smartphones, computers, and tablets has led to an increase in eye strain and fatigue, affecting a large portion of the global population. Eye fatigue, also known as Computer Vision Syndrome (CVS), is characterized by symptoms such as eye discomfort, headaches, blurred vision, and dry eyes. Prolonged exposure to screens and continuous focusing on close objects can lead to adverse effects on productivity and health, making it essential to monitor and mitigate eye fatigue in real-time.

Recent advancements in artificial intelligence, particularly in the fields of machine learning and deep learning, have provided innovative solutions to detect and prevent eye fatigue. Machine learning and deep learning models have the capability to analyze subtle variations in eye behavior, such as blinking rate, gaze direction, pupil dilation, and other ocular parameters. These models can detect early signs of fatigue by identifying patterns and anomalies that are often imperceptible to the human eye.

Face Recognition: Face detection is a process that aims to locate a human face in an image. Face recognition is a necessary step in all face processing system, and its overall performance of drowsiness detection systems. To begin tracking a face, we have to first detect it. We use vision.CascadeObjectDetector to detect the face in video frame. By this command only the face is detected from video frame. The best Face detection is done by Viola-Jones method developed by Paul Viola and Michael Jones.

Haar-Like Features: This feature considers rectangular regions at a location in detection window. The advantage of haar-like features is its calculation speed. Due to haar-like feature any size can be calculated at constant time. Haar-like features can be expressed by two or three joins-black and white. Rectangle feature can indicate whether the border lies between dark region and light region

Eye Tracking : The experimental results on eye detection are based on the assumption that eye regions eye regions from video frame are corrected located. PERCLOS Percentage of Eye Closure over time) is most useful method for measuring eye blinking. We can determine that if eyes is open, then the condition is normal and if the eyes are closed then a alarm signal is generated to alert the driver. We need to detect the eye region because we have to examine eye to know whether the person feels sleepy or not.

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II. LITERATURE SURVEY

A Real-Time Wireless Brainˆa Computer Interface System for Drowsiness Detection A real-time wireless electroencephalogram (EEG)- based brainˆacomputer interface (BCI) system for drowsiness detection has been proposed. Drowsy driving has been implicated as a causal factor in many accidents. Therefore, real-time drowsiness monitoring can prevent traffic accidents effectively. However, current BCI systems are usually large and have to transmit an EEG signal to a back-end personal computer to process the EEG signal. In this study, a novel BCI system was developed to monitor the human cognitive state and provide biofeedback to the driver when drowsy state occurs. The proposed system consists of a wireless physiological signal-acquisition module and an embedded signal-processing module. Here, the physiological signal-acquisition module and embedded signal-processing module were designed for long-term EEG monitoring and real-time drowsiness detection, respectively. The advantages of low ower consumption and small volume of the proposed system are suitable for car applications. Moreover, a real-time drowsiness detection algorithm was also developed and implemented in this system. The experiment results demonstrated the feasibility of our proposed BCI system in a practical driving application.The wireless physiological signal-acquisition module mainly consists of the EEG amplifier and acquisition unit, microprocessor unit, and wireless transmission unit. Here, the EEG amplifier and acquisition unit, which includes a preamplifier.

Fatigue Detection System for Extracting Driver's Eye Features Traffic safety remains one of the most concerning issues for humans, with people dying in traffic accidents every moment, and nearly half of them being related to fatigue driving. When drivers feel fatigued, the eyes undergo significant changes. In this study, eye movement characteristics were utilized to detect the fatigue state of drivers, and a fatigue detection system was developed, combining the PERCLOS algorithm and the EAR algorithm, which were validated through experiments to assess system usability. The system was developed and designed based on traditional image processing algorithms in OpenCV and the facial feature recognition capabilities of the Dlib library. By using the 68-dimensional facial landmark detection model in the Dlib library, facial feature points were extracted, and eye tracking functionality was achieved through the feature points of the eyes

A Multimodal Fusion Fatigue Driving Detection Method Based on Heart Rate and PERCLOS Existing visual-based fatigue detection methods usually monitor driversˆa fatigue by capturing their facial features, including eyelid movements, yawn frequency and head pose. However, these approaches typically do not take driversˆa biological signals into consideration. An accurate model for fatigue detection requires combining both facial behavior and biological data. This paper proposes a novel non-intrusive method for driver multimodal fusion fatigue detection by extracting eyelid features and heart rate signals from the RGB video. The multimodal feature fusion method could significantly increase the accuracy of fatigue detection. Specifically, we established two fatigue detection models based on heart rate and the PERCLOS value respectively with one-dimensional Convolutional Neural Network (1D CNN), where the PERCLOS refers to the percentage of eyelid closure over the pupil.

III. PURPOSE

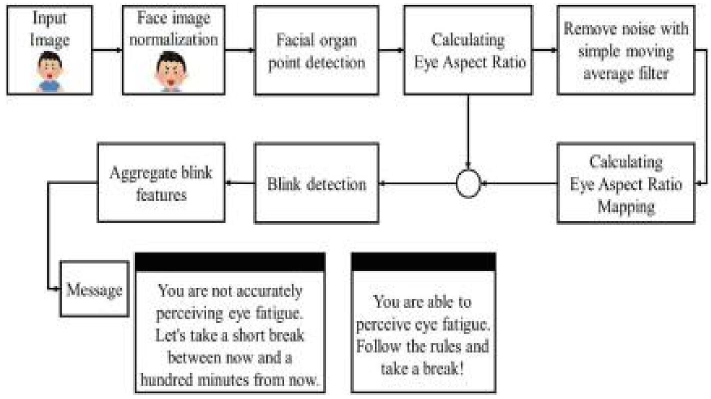
The aim of the Eye fatigue is becoming increasingly common worldwide. Currently, the only effective method for detecting eye fatigue is through sample survey questionnaires. This study proposes a machine learning-based method for detecting eye fatigue using a Single-Channel Electrooculography System. Participants complete industry-standard eye fatigue questionnaires, and their responses are used as data labels.

IV. OBJECTIVE OF SYSTEM

- Collect and analyze eye movement data.
- Implement machine learning and deep learning models for detection.
- Provide real-time feedback to users.

V. PROPOSED SYSTEM

A machine learning-based application that detects and notifies users about eye fatigue levels through a user-friendly interface. Enhanced awareness and management of eye health, leading to reduced fatigue and improved productivity



VI. SYSTEM ARCHITECTURE

1. Input Image: The system takes an input image of the driverˆas face. This image could be captured using an in- car camera.
2. Face Image Normalization: Face image normalization involves pre-processing the input image to standardize it. This ensures that variations such as lighting conditions, angles, and distance do not affect the accuracy of the system. Normalization might include resizing the image or adjusting brightness/contrast to prepare it for further processing.
3. Facial Organ Point Detection: This step detects key facial landmarks, such as the eyes, nose, mouth, and other important points on the face. Specifically, it focuses on detecting the eyes, as this system is centered around the driver's eye behavior.
4. Calculating Eye Aspect Ratio (EAR): Eye Aspect Ratio (EAR) is calculated based on the distance between certain key points around the eyes. EAR is an important indicator of drowsiness or fatigue. When the eyes begin to close (due to tiredness), the EAR value decreases significantly. If the EAR value remains low for a certain period, it can indicate that the driver is falling asleep or fatigued.
5. Noise Removal with Simple Moving Average Filter: To avoid false alarms or errors caused by random noise (like brief eye movements), a simple moving average filter is applied to smooth the data. This step helps in filtering out noise by averaging the EAR values over time to ensure only consistent changes in eye closure are detected.
6. Blink Detection: Blinking patterns are a crucial indicator of drowsiness. Frequent or slow blinks, or eyes that remain closed longer than normal, are typical signs of fatigue

VII. CONCLUSION

It completely meets the objectives and requirements of the system. The framework has achieved an unfaltering state where all the bugs have been disposed of. It is a four-step method that first detects the face of the driver in the image from among several detected faces. Finally, the eyes are classified as closed or open based on the curvature of the eyelids. The proposed method achieved an average classification accuracy of 95image dataset with homogeneous backgrounds, an average classification accuracy of 70complex benchmark image dataset, and greater than

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