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Driver Activity Detection and Alert System Using Machine Learning

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Abstract*:* *The Driver Activity Detection and Alert System is a crucial solution for promoting road safety by monitoring the behavior of drivers and alerting them in case of drowsiness or distraction while driving. With the rising number of road accidents globally, especially in urban areas, the need for an Intelligent Transportation System (ITS) has become more critical than ever. In India, the National Crime Records Bureau (NCRB) reports over 135,000 traffic-related deaths annually, highlighting the urgent need for such innovative systems to be implemented. The proposed method for driver activity detection and alert system involves advanced techniques such as Haar Cascade Classifiers, and Eye Aspect Ratio (EAR). These techniques enable the system to accurately detect any signs of distraction or drowsiness in the driver, and generate an audio alert to remind them to drive safely*

Keywords: Haar Cascade Classifiers, and Eye Aspect Ratio (EAR).

I. INTRODUCTION

The Driver Activity Detection and Alert System is a computer vision-based system designed to monitor and analyze the behavior of drivers while they are driving. In the past few years, driving has become an integral part of our daily lives, especially in urban areas. Unfortunately, sleepiness-related road accidents are becoming increasingly frequent and are posing a major global hazard. When it comes to detecting drowsiness in drivers there are two main methods which can be used; intrusive and nonintrusive. Intrusive techniques involve collecting data relating to one's mind state such as brain wave monitoring or heart rate measurements while nonintrusive methods focus more on behavioral cues such as yawning or eye blinking patterns as indicators of fatigue. Despite the differences between these two methods, both seek to achieve the same goal - intervening before an incident occurs due to driver fatigued has taken place.

II. LITERATURE REVIEW

A literature review is an insightful article that presents the existing information including considerable discoveries just as theoretical and methodological commitments to a specific topic.

M. Ngxande, J. -R. Tapamo and M. Burke [1]. which discussed the use of machine learning techniques to detect a slight change in a driver's facial expression that contains drowsiness information. The paper presented a survey of various approaches to driver drowsiness detection, such as Supervised Learning (SVM), Unsupervised Learning (Hidden Markov Model) and Deep Learning (Convolutional Neural Network). To achieve accurate results, they used a range of features and measures such as eye region detection, eye blinking rate analysis, gaze estimation, head pose tracking, facial landmark detection and much more.

G. Sikander and S. Anwar [2]. This paper is a review and comparison of state of the art and recent advancement in the field of driver fatigue detection. In this paper the features for fatigue detection are categorized into subjective reporting, driver biological features, driver physical features, vehicular features and hybrid features. Mathematical Models Based Implementation, Rule Based Implementation and Machine Learning Based Implementation models are reviewed in this paper. It is suggested that physical features fused with driver characteristics, time of day, duration of drive and rPPG could provide better accuracy and could be incorporated to manufacture reliable systems.

In 2012, Mandeep and Gagandeep [3] devised a technique that employs the mean sift algorithm to identify tiredness. Using a 640x480 resolution webcam, it detects eye blinks in real time. Each eye blink is assessed in comparison to a

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mean value once eyes are identified from each frame. An alert is sent off if the eye opening surpasses a certain threshold for a predetermined number of consecutive frames. The system compares the eye opening at each blink with a standard mean value. A 99% accuracy rate has been reported by the authors. Additionally, it operates at a real-time-appropriate resolution of 640 x 480. The eye blinking readings from a cumulative number of frames are employed in this technique to detect drowsiness, hence the system needs to keep track of previous frames.

M. Ramzan, H. U. Khan, S. M. Awan, A. Ismail, M. Ilyas and A. Mahmood [4]. This paper reviews hybrid techniques, such as physiological measurements combined with driving or behavioral measurements, which aid in resolving issues with individual techniques and produce better drowsiness detection outcomes. For example, the combination of ECG and EEG features produces high-performance outcomes, highlighting the fact that using physiological signals in combination improves performance rather than using them separately.

Chin-Teng Lin, Ruei-Cheng Wu, Sheng-Fu Liang, Wen-Hung Chao, Yu-Jie Chen and Tzyy-Ping Jung [5]. In this paper, a power spectrum analysis, correlation analysis, and linear regression model-based EEG-based drowsiness estimate technology is suggested and tested in a virtual reality driving environment. It showed a strong correlation between driving performance variations and the log sub band power ICA/EEG spectrum.

R. N. Khushaba, S. Kodagoda, S. Lal and G. Dissanayake [6]. In this paper, a new feature-extraction algorithm was developed to extract the most relevant features required to identify the driver drowsiness/fatigue states. This was achieved by analysing the corresponding physiological signals from the brain, eye, and heart.

B. Alshaqaqi, A. S. Baquhaizel, M. E. Amine Ouis, M. Boumehed, A. Ouamri and M. Keche [7]. This study presents a module for the Advanced Driver Assistance System (ADAS), which aims to decrease crashes caused by tired drivers and so improve road safety. They presented a method to find, track, and analyse the driver's face and eyes in order to evaluate PERCLOS, a sleepiness indicator linked to sluggish eye closure that has scientific validity.

Fouzia, R. Roopalakshmi, J. A. Rathod, A. S. Shetty and K. Supriya [8]. This research presents a framework for real-time sleepiness detection based on a shape predictor algorithm that first detects the eyes and then counts the rate of eye blinking. Through image processing methods, which provide a non- invasive method to detect sleepiness without any nuisance and disturbance, the suggested system gathers information about the eye status.

C. -Y. Lin, P. Chang, A. Wang and C. -P. Fan [9]. In this paper, the proposed system includes four parts, which are the face detection, the eye-glasses bridge detection, the eye detection, and the eye closure detection. These proposed design uses gray-scale images without any colour information, and it works effectively in daytime and nighttime.

K. S. Sankaran, N. Vasudevan and V. Nagarajan [10]. The Viola-Jones approach was used as the foundation for the classification of eyes and ocular closure levels given in this research. The person's face is detected using this method, and if the face is found, the PERCLOS is utilised to determine eye closure. The comparison between the HMM and SVM models is described in the computed results that are provided.

A. Awasthi, P. Nand, M. Verma and R. Astya [11]. In this paper, they did the survey on drowsiness detection using machine learning techniques. Different people use different features, such as yawning, head movement, eye closure, and steering angle. To determine whether drowsy driving is a factor in auto accidents, a comparative investigation was conducted.

N. Radha, E. M. Malathy, R. Swathika, R. B. Jananie and A. A. Silviya [12]. The suggested approach employs visual lip movement and eye movement to construct a meaningful DDS. Low and high levels of glare yield the best recognition accuracy, at 98.5% and 78%, respectively. Therefore, this research suggests the DDS system to reduce accidents caused by drowsy and distracted driving.

M. Kahlon and S. Ganesan [13]. In this study, the image from a camera was processed using a driver sleepiness detection method based on the condition of the driver's eyes as determined by Matlab using image processing tools. In order to identify objects like the nose, mouth, or upper body, Matlab produces a System Object using the Viola Jones technique. Because of the influence of light and the position of the driver, the system may occasionally produce erroneous findings.

C. Yashwanth and J. S. Kirar [14]. In this paper, the authors developed advanced algorithms based on artificial intelligence to identify driver exhaustion and the rate of drowsiness. They employed contemporary classifiers to categories the person as drowsy or not drowsy, taking into account both the eyes and the mouth as features. They employed algorithms based on computer vision, pattern recognition, and machine learning.

A. Sinha, R. P. Aneesh and S. K. Gopal [15]. This article examined the performance of face and sleepiness detection using various designs. The face detection algorithms used include Viola Jones, DLib, and Yolo V3. The CNN (Convolutional Neural Network) architecture used in the sleepiness detection is converted to LeNet for classification.

I. Girish, A. Kumar, A. Kumar and A. M [16]. The real-time drowsiness detection device in use here can quickly identify tiredness by finding the driver's eyes and lips and checking them for signs of fatigue. The eye blink is determined by the eye aspect ratio, and the yawn is determinedby the lip distance. The system is able to distinguish between a regular blink and tiredness. Additionally, the yawn is picked up, which can aid in keeping the driver from being sleepy while driving.

A. Ghourabi, H. Ghazouani and W. Barhoumi [17]. In this paper, they jointly monitor the three facial traits of blinking, yawning, and nodding to identify drowsiness (EAR, MAR and optical flow). The Multilayer Perceptron (MLP) and K-Nearest Neighbors (K-NN) approaches were employed in this study.

A. Biju and A. Edison [18]. This study used the Inception-v3 pre-trained model to determine if the driver was drowsy or not, together with the cutting-edge YOLOv3 model for face detection.

III. PROBLEM STATEMENT

To design and implement driver activity detection and alert system using machine learning.

IV. EXISTING SYSTEM

Fatigue is a critical factor that contributes to traffic accidents, and many countries are actively researching how to effectively monitor and prevent driver fatigue. The ability to reduce traffic accidents and fatalities is of utmost importance.

Research has shown that when drivers are fatigued, their heads tend to slope downwards. The correlation coefficient between head position and fatigue degree is about 0.8. However, some drivers' head postures may not change, resulting in a negative correlation coefficient and a failure of the system's judgment and early warning capabilities.

One method of detecting a driver's mental state involves monitoring the steering wheel's movements and patterns. As the driver becomes more fatigued, the number of rotations greatly increases, and their handgrip strength becomes stronger.

Another approach involves installing a camera in the same perspective as the driver in the vehicle and monitoring the time and degree of deviation of the vehicle from the white lines on the road. However, this method requires clear and visible white lines on the road, making it susceptible to outside interference.

Overall, effectively monitoring and preventing driver fatigue is crucial to reducing traffic accidents and saving lives on the road.

V. PROPOSED SYSTEM

The proposed system locates the eyes using image denoising and enhancement, followed by rough location and sifting of similar eye points. A synthetic eye template is used for increased robustness. The system selects a similar eye point collection and obtains the real eye points through prior knowledge calibration.

The eye tracking system uses a target tracking algorithm, which is divided into two parts: the primary algorithm and the modified algorithm. The primary algorithm is based on template matching technology, while the modified algorithm reduces the computation complexity of the system by selecting candidate image regions. With target tracking, the system repositions the eye point only when it loses the tracking object, improving operating efficiency and meeting real-time requirements.

(a) Left Template (b) Right Template (c) Center Template

Fig. 1: The schematic of the eye template

5.1 Objectives

- To detect driver drowsiness and distraction in real-time

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- To alert the driver in a timely and effective manner to prevent accidents
- To improve driver safety and reduce the risk of accidents caused by fatigue or distraction
- To generate reports on driver behavior to help identify areas of improvement for the driver and the organization they work for

VI. METHODOLOGY

Haar Cascade Classifier Algorithm:

Haar Cascade Classifiers are a type of object detection algorithm used for detecting objects in images or videos. Haar Cascade Classifiers are used to detect driver fatigue by training on numerous similar and dissimilar images. OpenCV provides a learning-based method with a detector and trainer. To train the system, separate databases for faces and eyes are used, containing positive and negative images with open and closed eyes as well as different facial expressions.

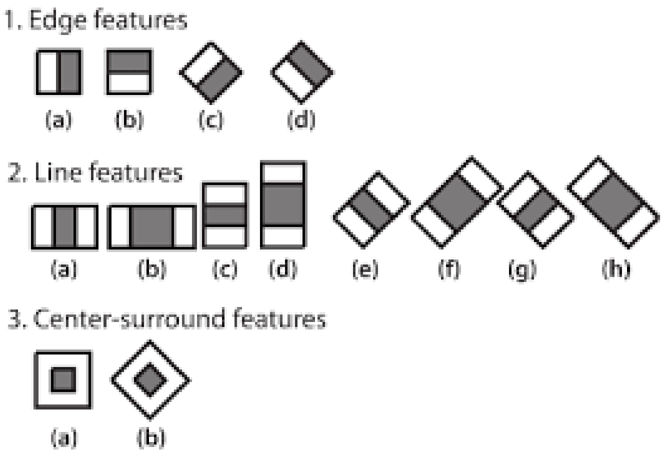
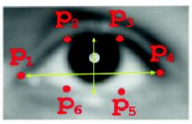


Fig. 2: Haar Cascade Classifiers Working

Eye Aspect Ratio (Ear) Algorithm:

The driver activity detection and alert system uses Haar Cascade Classifiers to predict the face and eye region in a live video stream. The eye aspect ratio (EAR) is calculated using the Euclidean distance between the eyes and the predefined dataset. If the EAR reaches a low value, drowsiness is detected. The system uses Ubidots and Twilio for cloud-based alerting when drowsiness is detected. The programming algorithm involves using Python and OpenCV with Raspberry Pi 3, and imports several libraries for execution



$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

Fig. 3: Eye Aspect Ratio (EAR)

VII. EXPERIMENTAL RESULTS

The expected output for the Driver Activity Detection and Alert System is an automated system that continuously monitors the driver's level of drowsiness while driving. The system uses a camera to capture the driver's face and eye movements in real-time and calculates the Eye Aspect Ratio (EAR) to determine the level of drowsiness. If the EAR reaches a low value, indicating that the driver is becoming drowsy, the system will trigger an alert to the driver through an alarm signal and update it in web page. The system is designed to improve driving safety by preventing accidents caused by driver fatigue.

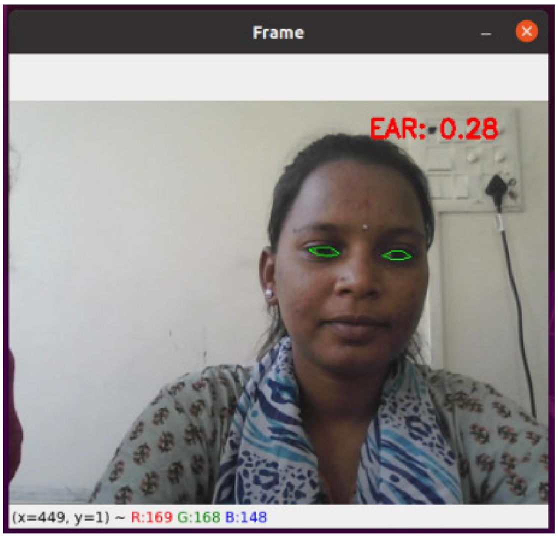


Fig. 4: Face before alert generation

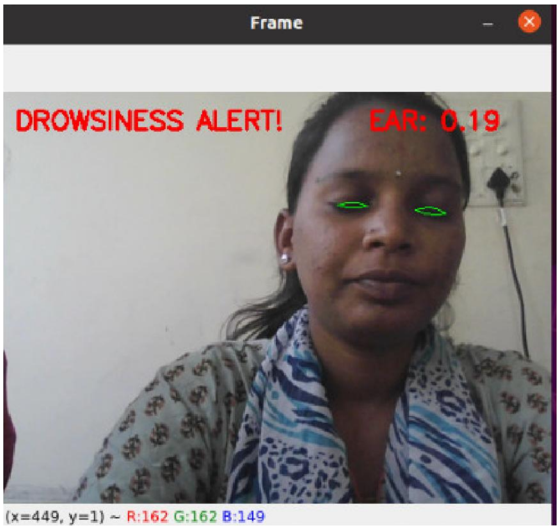


Fig. 5: Drowsiness detected and alert message generated

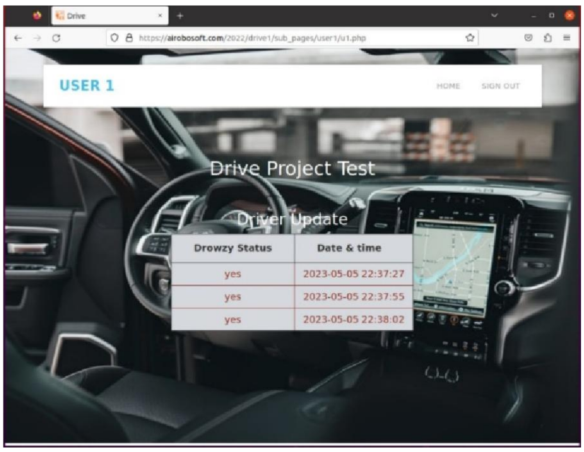


Fig. 6: Updated in web page

VIII. CONCLUSION

This paper presented various algorithms and approaches to driver activity detection and alert system by Machine Learning. However, to further improve the system's accuracy, other methods such as road tracking, head position, and the rotation rate and grip force of the steering wheel should be used as supplementary means. Overall, the system provides an effective and non-intrusive approach to detect drowsiness without causing annoyance or interference to the driver.

IX. FUTURE SCOPE

There are several potential future enhancements for the driver activity detection and alert system. One possibility is to use a modified ECG method to calculate the driver's heart rate without physical disturbance, allowing for an even less intrusive way to detect drowsiness. Additionally, the system could be extended to monitor the reflection ray from the driver's eye using a nano camera, which could provide a better opportunity to detect drowsiness.

Finally, the system could be further improved by incorporating other classifiers such as Bayesian network classifiers and neural networks, and by expanding the system to detect other types of distractions such as mobile phone use or eating while driving.

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