Drowsiness Detection and Alert Android App Using OpenCV

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Abstract

Drowsiness while driving is a significant cause of road accidents worldwide, with many such accidents resulting in fatalities or severe injuries. In recent years, researchers have been investigating the use of computer vision techniques to detect drowsiness in drivers and alert them to take appropriate action.

The proposed app uses OpenCV, a popular computer vision library, to perform facial landmark detection and eye tracking to monitor the user's level of drowsiness. The app employs a machine learning algorithm trained on a data-set of labeled images to recognize patterns that indicate drowsiness. The facial landmark detection process is carried out by identifying specific points on the users face, like the corners of the eyes, the nose, and the mouth. These points are then used to compute the eye aspect ratio (EAR), which is a way of measuring how open the user's eyes are. When the eyes are closed, the EAR value decreases, indicating drowsiness. The app uses this to detect drowsiness and alert the user using an alarm. The proposed drowsiness detection and alert app using OpenCV is an effective and potentially life-saving tool for drivers. It combines computer vision techniques, machine learning algorithms, and user-friendly interfaces to detect drowsiness accurately and alert drivers to take appropriate action. The app can help reduce the incidence of vehicular collisions resulting from operator fatigue, making the roads safer for everyone.

Keywords: *Driver Drowsiness Detection, OpenCV, Machine Learning, Haar Cascade Classifier, Android App, Face Detection, Eye Detection, Eye Monitoring, Accident Prevention.*

1. INTRODUCTION

The phenomenon of operator exhaustion represents a notable determinant in road accidents, and detecting drowsiness early can help prevent accidents. With the advancements in computer vision and machine learning, it has become possible to develop systems that can detect drowsiness using cameras. The OpenCV framework is a software library for computer vision applications that is freely accessible to the public as open-source code. It provides a range of tools and algorithms that can be used to develop such a system. In this Android app, we leverage the power of OpenCV to detect drowsiness in real-time using the camera on an Android device.

The system proposed makes use of a camera mounted on the dashboard of the vehicle to capture the driver's face and analyze it for signs of drowsiness. The system first detects the face in the video stream using OpenCV's Haar Cascade Classifier. Once the face is detected, the system uses facial landmarks to track the movement of the eyes and mouth. The system then analyzes the eye movements, such as the amount of eye closure to detect drowsiness.

These facial features are essential indicators of drowsiness since droopy eyelids or a slack jaw are signs of fatigue. The process of detecting facial landmarks involves the identification of specific points on the face, such as the corners of the eyes, the nose, and the mouth. These points are utilized to compute the eye aspect ratio (EAR), which serves as an indicator of extent to which the user's ocular aperture is expanded. As the user's eyes become increasingly closed, the EAR value diminishes, indicating an increasing level of drowsiness.

The application continuously monitors the EAR values to detect changes that may signify the onset of drowsiness. When the EAR values remain below a predetermined threshold for an extended period, the app generates an alert to caution the driver. Once the app has detected the eyes and mouth, it checks whether the eyes are closed beyond a percentage or if the head is drooping. The app uses a threshold to determine whether the eyes have been closed beyond the threshold or if the head has drooped too far. If the threshold is exceeded, the app triggers an alert to the user, prompting them to take a break or to stop driving. The app can be customized to suit different needs, and its effectiveness can be enhanced by integrating machine learning algorithms to improve its accuracy over time.In conclusion, this Android app using OpenCV provides a powerful tool for detecting drowsiness and promoting road safety. Its implementation has the potential to save lives and prevent accidents caused by driver fatigue. The app's accuracy can be improved over time by incorporating machine learning algorithms, making it an even more effective tool for detecting drowsiness.

2. LITERATURE REVIEW

The survey conducted encompasses the latest technologies and research pertaining to our project topic. Its objective is to gain a deeper comprehension of the advancements made in this field of study and to ascertain where our project efforts should be directed. Specifically, this literature review delves into the subject of current drowsiness detection technologies, including those for facial landmark detection, blink detection, and yawn detection. Numerous techniques have been examined, such as deep CNN, computer vision, behavioral measures, and machine learning techniques, each with their own distinct advantages, challenges, and levels of accuracy. Furthermore, scholarly inquiry has been conducted into the employment of EAR and MAR-based methodologies to detect instances of blinking and yawning, respectively.

Paper [1] describes a facial recognition system that uses facial landmark detection and shape prediction to identify facial features. It employs the EAR to detect drowsiness and calculates the YAWN value to detect yawning. The system uses eSpeak to give voice alerts. But if there are obstructions like goggles or spectacles that reflect light, capturing clear eye frames is crucial for maintaining model accuracy.The face also needs to be aligned properly for the system to work effectively. If the driver's face if tilted to the sides, the system might not work at all

In [2] This system employs both computer vision technology and an alcohol gas sensor to identify instances of drowsiness and alcohol intoxication. It incorporates the use of Raspberry-pi and Arduino UNO with I2C protocol, and is founded on the principles of computer vision and embedded systems development. Eye closure is detected with a HAAR-based cascade classifier, and the alcohol gas sensor acts like a Breathalyzer. The system may require calibration to establish a baseline for detecting changes in the driver's condition and also depends heavily on the external sensors like the alcohol gas sensor.

In [3] the paper discusses different methodologies for detecting drowsiness. The main three ones discussed are PERCLOS, CAMSHIFT, HAAR TRAINING. The paper only takes about various algorithms for drowsiness detection but does not provide a system for its detection and prevention of accidents caused due to it.

Paper [4] discusses two solutions. The solution proposed solution first uses a combination of a CNN and an RNN to recognize patterns in images and sequences of images, respectively, to accurately determine whether a driver is drowsy or alert. The second option uses AI techniques and deep learning to process driver images. A linear SVM with HOG detects the face, while regression trees detect facial landmarks. YOLO-v4 is another technique that could be used.Both systems achieve a similar accuracy of approximately 65% on training data and 60% on test data. However, the fuzzy logic-based system has an advantage over the other system since it avoids false alarms and reaches a high specificity rate of 93% (proportion of videos where the driver is not drowsy that are correctly classified). Although the results are not highly satisfactory, the ideas advanced in this study show potential and can establish a sound basis for subsequent research endeavors. The paper also talks about integrating the system with the vehicle which might be costlier compared to a simple android app proposed in this paper.

In [5] to detect drowsiness levels through eye signals, a MLP neural network with three intermediate layers (using tansig function) and two inputs (average of upper pixels and average of lower pixels) and one output (drowsiness level) was employed. The neural network utilized full propagation and decreasing gradient methods, with 9964 frames of training data collected from five drivers' sleepiness. The network was trained for 1000 epochs, with 70% of the data being used for training, and the remaining 30% for testing. The mean square errors for the trained and tested data by the network were 0.0623 and 0.0700, respectively, yielding an estimated accuracy level of 93%. But the possibility of the driver wearing glasses is ruled out in this system.

In [6] the aim was to create a driver monitoring and drowsiness detection app using Android Studio. The app analyzed the driver's physiological and facial data, and incorporated speed monitoring and an emergency call button. Prior to operating a vehicle, the smartphone application enables the user to conduct a physiological assessment that involves measuring their heart rate. Unlike previous projects, data was stored on the user's phone for privacy and ease of use. The app achieved an accuracy of approximately 88.5% for drowsiness detection and 93.3% while driving by combining speeding data with facial analysis.

In [7] the paper proposes a drowsiness detection system for Android mobile devices using multilayer perceptron classifiers. It detects facial landmarks and identifies the driver's level of alertness with high accuracy (81%) while maintaining a small model size to accommodate limited storage and calculation capacity. The training data-set includes various subjects of different ethnicities in diverse simulated driving scenarios, these subjects were recorded under both daytime and nighttime illumination conditions. This system can be integrated into driver-assistance and drowsiness detection systems, with further work planned to improve performance in detecting driver distraction and yawning. Nevertheless, the Dlib Framework lacks the capability to detect distinct orientations of the driver's countenance, such as tilting the head entirely to the right or left. Consequently, these particular images are excluded from the dataset employed for analysis.

[8] proposes an android app that detects drowsiness using Google vision API classes. The proposed system does not require any external or embedded hardware. And the proper functioning of the app does not depend on the orientation of the driver's face, as long as both eyes are detected by the camera.

In [9] the article details an enhanced drowsiness detection system that relies on machine learning based on convolutional neural networks (CNNs). The principal objective is to design a system that is sufficiently lightweight to be employed in embedded systems, all the while attaining exceptional performance. The system can detect facial landmarks from images taken by a mobile device and employ a deep learning model based on a convolutional neural network (CNN) to recognize indications of drowsy driving behavior. The key accomplishment is the development of a deep learning model that is both compact and accurate, with an average accuracy rate of 83.33% across all categories, and a maximum model size of no more than 75KB. The integration of this system into the dashboards of future automobiles can readily bolster advanced driver-assistance programs, or alternatively, the system can be implemented into mobile devices to intervene when drivers exhibit symptoms of drowsiness.

3. OBJECTIVES

The main goal of the application is to detect when the user is feeling drowsy. To do this, the application uses a library called OpenCV to watch the user's facial expressions, such as their eyes, and analyze how they move to see if the user is showing signs of drowsiness, like if the eyes are closed beyond a particular percentage. If the application detects that the user is getting drowsy, it will notify them in order to avoid any potential accidents. The application can use different methods to alert the user, such as sounds, vibrations, or visual cues, but in this system, a sound alert is being used.

4. METHODOLOGY

Firstly the facial landmark detection is done. Facial landmark detection is a computer vision technique that involves identifying and locating the key points on a person's face, such as the corners of the eyes and mouth, the nose tip, and the eyebrows. This technique is used in the first step of the process described to localize the face in the image. Once the face has been localized, shape prediction techniques are employed to identify significant facial attributes., such as the position and shape of the eyes and mouth. This information is then used to calculate the Eye Aspect Ratio (EAR) for drowsiness detection.

The EAR, which stands for Eye Aspect Ratio, quantifies the degree of openness or closedness of the eyes by analyzing the proportional distances between the horizontal and vertical landmarks of the eye.

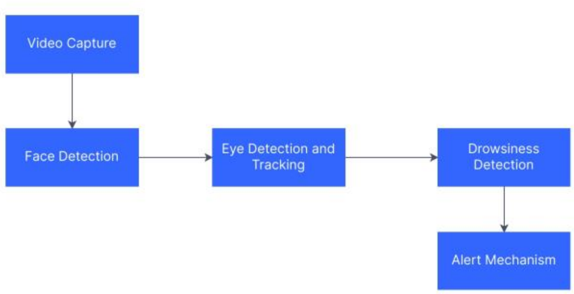
In the next step, OpenCV's built-in HAAR cascades are used for facial detection. These cascades are essentially a set of classifiers that can distinguish between objects in an image, and are pre-trained on thousands of positive and negative images. By using these cascades, the program can accurately detect faces in the image. Finally, an alert module is employed to produce an alarm at appropriate times. This module is designed to detect when the driver is becoming drowsy, based on the calculated EAR, and produce an alarm to alert the driver to stay awake and attentive while driving. The alarm can be in the form of a sound, vibration, or other sensory stimuli, and is intended to prevent accidents caused by driver drowsiness.

5. PROPOSED SOLUTION

A. Modules

The proposed system can be divided into the following modules:

Fig 1. Modules in the proposed model



Video capture: The system captures video feed from a camera mounted on the vehicle's dashboard or rear view mirror. This video feed will be processed in real-time by OpenCV.

Face detection: OpenCV is used to detect faces in the video frames. This module identifies the driver's face and tracks its position and orientation. Face detection is done by using Haar cascades or deep learning-based face detection models.

Eye detection and tracking: Once the face is detected, the system uses OpenCV to detect eyes in the face region. Eye tracking is used to determine if the eyes are closed or if the driver is looking away from the road. This is done by first detecting the eyes using Haar cascades eye detection model and then tracking the eyes in subsequent frames.

Drowsiness detection: The system analyzes the eye and head movements to detect signs of drowsiness, drooping eyelids, and nodding. This is done by calculating various parameters such as the aspect ratio of the eyes, the frequency and duration of blinks, and the angle of the head. If the system detects that the driver is becoming drowsy, it triggers an alert to warn the driver.

Alert mechanism: The system provides an audio or visual alert when drowsiness is detected. The alert can be a beep, a voice message, or a flashing light, depending on the driver's preference. The alert is triggered when the system detects certain parameters that indicate the driver is becoming drowsy.

B. Architecture

Fig 2. Block Diagram of the proposed architecture

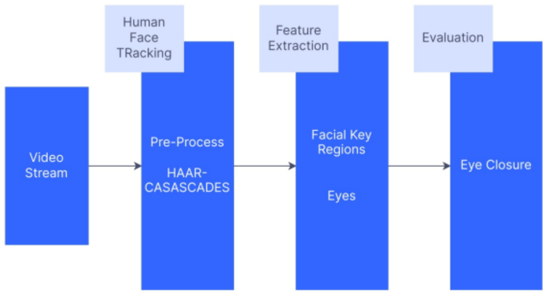
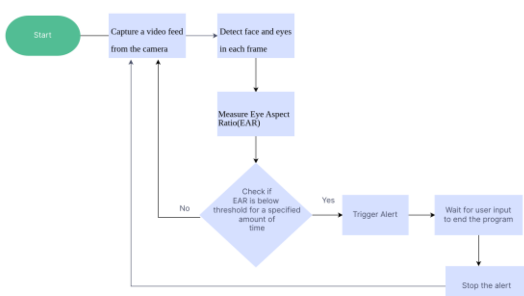


Fig 2 illustrates the high-level architecture of the system, which comprises of input to the model, as well as pre-processing and evaluation stages. The first stage, Stage 1, is responsible for pre-processing the video stream for human face tracking. The second stage, Stage 2, involves extracting the key facial regions such as the eyes. Lastly, the third stage, Stage 3, involves detecting drowsiness symptoms, particularly eye closure. A flowchart representing the work flow of the system is given below as Fig 3.

Fig 3. System work flow diagram



C. Dataset and Preprocessing

The EyeBlink dataset is used to train the Haar cascades model. The EyeBlink dataset is a publicly available dataset that contains video data of drivers in various driving conditions, including day and night driving. The videos were captured using a camera mounted on the vehicle dashboard and are labeled as either drowsy or alert based on the presence or absence of eye blinks. The dataset was developed by a research team from the University of Nebraska-Lincoln and is available for academic and research purposes. The dataset contains video data from 40 drivers, including 20 male and 20 female drivers. The videos were captured using a camera mounted on the vehicle dashboard. The videos were preprocessed to extract frames and crop the region of interest (ROI) containing the driver's face and eyes. The ROI was then resized to 24 x 24 pixels and converted to grayscale for further analysis.

6. RESULTS

The culmination of this project is a software application that can detect drowsiness in users and generate alerts to mitigate the risk of accidents. The developed Android app successfully detected drowsiness using OpenCV's eye aspect ratio (EAR) algorithm. The app was tested on the EyeBlink dataset. The EAR threshold was set at 0.25, below which the app deemed the eyes to be closed and triggered a warning alarm. The developed application is given the name iDriveSafe.

Fig 4. Login Page of the application

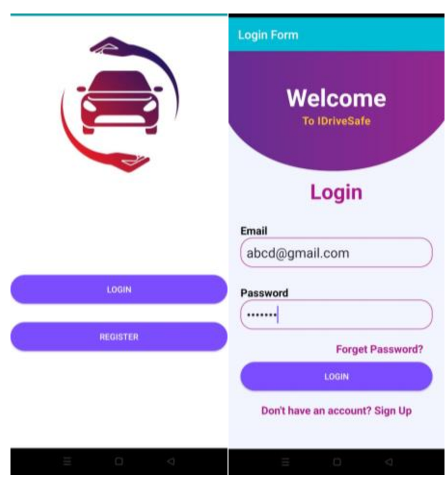


Fig 5. Successfully Logged in

On launching the app a login page is shown to the user where a new user can register using his mail id and a password of his/her own choice like shown in Fig 4. Already registered users can login and start the detection system. Fig 5 shows the page after the user has logged in and the options available.

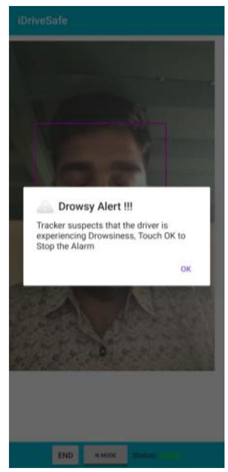
Fig 6. Detecting face using mobile front camera

After the user had logged in and selected the monitoring option. The app starts detecting and monitoring the face through the front camera. Fig 6 shows that.

Fig 7. Detecting driver drowsiness

The app monitors the eyes and the head position to detect if the driver is getting drowsy as shown in Fig 7.

Fig 8. Alerting the user using an alarm



On detecting the drowsiness the app sounds an alert alarm to alert the driver and wake them up. The alert keeps on going till the driver click OK and cancels it. After being canceled the app goes back to monitoring the drivers face for further drowsiness detection.

Fig 9. Detecting face using mobile front camera with a subject using glasses

Fig 10. Detecting driver drowsiness with a subject using glasses

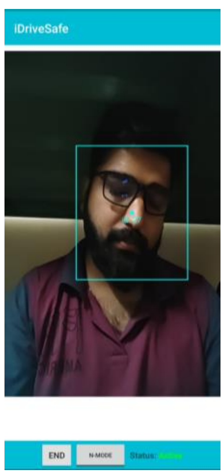
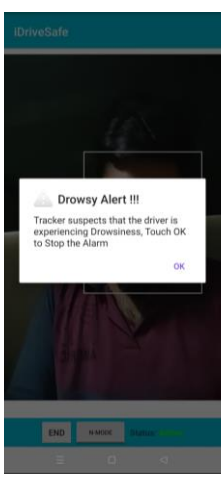


Fig 11. Alerting the user using an alarm



Furthermore the app can perform the same operations with subjects wearing glasses and even work if their face is tilted a bit as shown in Fig 9,10,11.

7. CONCLUSION

To summarize, we have created an Android application that utilizes OpenCV to detect and monitor a driver's level of drowsiness during long-distance travel. Our algorithm incorporates facial landmark detection, eye aspect ratio calculation, and machine learning classification to accurately detect drowsiness. We have also implemented a reliable alert system that produces audio signals when drowsiness surpasses a certain threshold. The application's user interface is user-friendly, and it allows drivers to adjust the alert system's sensitivity to match their individual preferences. Our objective is to reduce the number of accidents caused by drowsy driving and make roads safer. However, we understand that further testing and improvements are necessary to validate the accuracy and dependability of our algorithm in various driving situations.

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