DRIVER DROWSINESS DETECTION SYSTEM

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Abstract: *In The "Driver Drowsiness Detection" project focuses on developing a vision-based system to detect and mitigate the risks associated with driver drowsiness. The project employs OpenCV techniques, image processing, and machine learning algorithms to monitor the driver's facial features and behaviour, identifying signs of drowsiness in real time.The project utilizes a dataset that includes images or video frames of drivers in various states of alertness, with annotations indicating instances of drowsiness. Image processing techniques are applied to extract facial features, while machine learning models, such as Convolutional Neural Networks (CNNs) or facial landmark detection algorithms, are employed to analyze and classify these features. Key project stages include data collection, data preprocessing, model training, integration with real- time monitoring systems, and evaluation. The evaluation process may involve metrics such as accuracy, sensitivity, and specificity to assess the system's ability to accurately detect drowsiness.The final outcome is a Driver Drowsiness Detection System capable of issuing timely alerts or interventions when signs of drowsiness are detected, contributing to enhanced road safety. The system may be integrated into vehicles or wearable devices, providing an additional layer of safety for drivers. In conclusion, the "Driver Drowsiness Detection" project demonstrates the application of computer vision and machine learning in addressing a critical aspect of road safety. The success of this project holds the potential to reduce the incidence of accidents related to driver drowsiness and promote safer driving practices.*

keywords: *Driver drowsiness; eye detection; eye state; web cam; OpenCV*

I. INTRODUCTION

Nowadays drowsiness of drivers is one of the main reasons behind road accidents. It is natural for the drivers who drivers to doze off behind the steering wheel. In this article, we will build a drowsiness detection system that will alert the driver as soon as he fell asleep. Drowsiness is identified by using vision-based techniques like eyes detection, yawning, and nodding. When it comes to yawning and nodding some people can sleep without yawning and nodding.

The purpose of the drowsiness detection system is the prevention of accidents. The system will detect the early symptoms of drowsiness before the driver has fully lost all attentiveness and warn the driver that they are no longer capable of operating the vehicle safely. Humans have always invented machines and devised techniques to ease and protect their lives, for mundane activities like traveling to work, or for more interesting purposes like aircraft travel. With the advancement in technology, modes of transportation kept on advancing and our dependency on it started increasing exponentially.It has greatly affected our lives as we know it. Now, we can travel to places at a pace that even our grandparents wouldn't have thought possible. In modern times, almost everyone in this world uses some sort of transportation every day. Some people are rich enough to have their own vehicles while others use public transportation. However, there are some rules and codes of conduct for those who drive irrespective of their social status. One of them is staying alert and active while driving. Neglecting our duties towards safer travel has enabled hundreds of thousands of tragedies to get associated with this wonderful invention every year. It may seem like a trivial thing to most folks but following rules and regulations on the road is of utmost importance. While on road, an automobile wields the most power and in irresponsible hands, it can be destructive and sometimes, that carelessness can harm lives even of the people on the road. One kind of carelessness is not admitting when we are too tired to drive. In order to monitor and prevent a destructive outcome from such negligence, many researchers have written research papers on driver drowsiness detection systems. But at times, some of the points and observations made by the system are not accurate enough. Hence, to provide data and another perspective on the problem at hand, in order to improve their implementations and to further optimize the solution, this project has been done. The purpose of the drowsiness detection system is to aid in the prevention of accidents passenger and commercial vehicles. The system will detect the early symptoms of drowsiness before the driver has fully lost all attentiveness and warn the driver that they are no longer capable of operating the vehicle safely.

- Sensor-Based Approaches: Many studies utilize sensors such as EEG (Electroencephalography), EOG (Electrooculography), EMG (Electromyography), and heart rate monitors to detect physiological changes associated with drowsiness.

Fig 1. Drowsiness detection

- Accurate Detection: Achieving reliable and accurate detection of drowsiness is paramount. However, interpreting subtle cues such as eye movements, facial expressions, and physiological signals accurately can be challenging due to variations in individual behavior and environmental factors.

- False Alarms: Striking a balance between detecting genuine instances of drowsiness and avoiding false alarms is crucial. Overly sensitive systems may trigger unnecessary alerts, leading to driver annoyance and desensitization, while overly conservative systems risk missing critical signs of fatigue..

- Variability in Driver Behavior: Drivers exhibit a wide range of behaviors, and drowsiness manifests differently in each individual. This variability presents a challenge for designing detection algorithms that can adapt to diverse driving styles, habits, and physiological differences.

- Environmental Factors: Environmental conditions such as lighting, weather, and road conditions can affect the performance of drowsiness detection systems. Adapting to diverse environmental conditions and filtering out irrelevant signals pose significant challenges.

II. RELATED WORK

Our current statistics reveal that just in 2015 in India alone, 148,707 people died due to car related accidents. Of these, at least 21 percent were caused due to fatigue causing drivers to make mistakes. This can be a relatively smaller number still, as among the multiple causes that can lead to an accident, the involvement of fatigue as a cause is generally grossly underestimated.

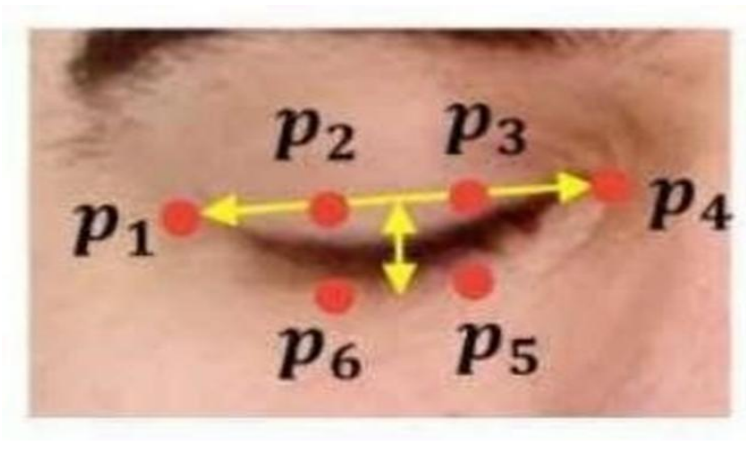

Fig.2. Eye Landmarks

Dlib library is imported and used for the extraction of facial landmarks. Dlib uses a pre-trained face detector, that is an improvement of the histogram of oriented gradients . It consists of two shape predictor models trained on the i-Bug 300-W dataset, that each localize 68 and 5 landmark points respectively within a face image.In this approach, 68 facial landmarks have been used. In this method, frequencies of gradient direction of an image in localized regions are used to form histograms. It is especially suitable for face detection; it can describe contour and edge features exceptionally in various objects.

For recording the Facial Landmarks, the Facial Landmark Predictor was used by the system to calculate lengths for the EAR values. The following figure represents the facial landmark points of the Dlib library, which are used to compute EAR.

WEBCAM-BASED:

The A webcam-based driver drowsiness detection system utilizes computer vision algorithms to monitor the driver's facial features and behavior in real-time. Here's how it typically works:Developing a webcam-based driver drowsiness detection system involves integrating computer vision techniques with machine learning algorithms. Here's a high-level overview of how such a system might work:Face Detection: The webcam captures video feed of the driver's face. A face detection algorithm locates and extracts the face region from each frame.Facial Landmark Detection: Once the face is detected, facial landmarks such as eyes, eyebrows, nose, and mouth are identified. These landmarks provide crucial information about the driver's facial expressions and movements.Feature Extraction: Features such as eye closure duration, blink rate, head position, and yawning frequency are extracted from the facial landmarks and other relevant parameters.Machine Learning Model: A machine learning model, typically a classifier, is trained on a dataset of labeled samples to distinguish between alert and drowsy states based on the extracted

Fig. 3. WEBCAM

Eye Aspect Ratio:

Eye Aspect Ratio, or EAR, is a scalar value that responds, particularly for opening and closing the eyes [43]. During the flashing process, we can see that the EAR value grows rapidly or decreases significantly. Interesting findings in terms of robustness were obtained when EAR was used to detect blinks in. Studies in the past have employed a predetermined EAR threshold to establish when subjects blink (EAR threshold at 0.2). This approach is impractical when dealing with a wide range of individuals, due to inter-subject variation in appearance and features such as natural eye openness, as in this study. Our works used an EAR threshold value to detect a rapid increase or decrease in the EAR value caused by blinking, based on the findings of previous studies. We used the varying EAR threshold to automatically categorize the various sorts of blinks (0.18, 0.2, 0.225, 0.25). After that, we analyzed the experimental result and determined the best EAR threshold for our dataset. Each frame of the video stream is used to estimate the EAR. Furthermore, when the user shuts their eyes, the EAR drops and then returns to a regular level when the eyes are opened again. This technique is used to determine both blinks and eye opening. As the EAR formula is insensitive to both the direction of the face and the distance between it and the observer, it can be used to detect faces from a considerable distance. The EAR value can be calculated by entering six coordinates surrounding the eyes, as shown in Figure 2, and Equations (1) and (2) [30,45].

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

III. EXISTING SYSTEM

A driver drowsiness detection system is designed to monitor and analyze the driver' s condition to detect signs of drowsiness and alert them before it leads to potentially dangerous situations. Here's an overview of the existing systems used for detecting driver drowsiness: Physiological Measures EEG (Electroencephalogram): Measures brain wave patterns. Changes in brain activity are used to detect drowsiness. ECG (Electrocardiogram): Measures heart rate and variability. Decreased heart rate variability can indicate drowsiness. EMG (Electromyography): Monitors muscle activity, particularly around the eyes and face, which can show signs of drowsiness. Behavioral Measures. Eye Tracking: Monitors eye movements and blink patterns. Increased blink duration, reduced blink frequency, and slow eyelid closure are indicators of drowsiness. Head Position Monitoring: Detects head nodding or tilting, which are common signs of drowsiness. Facial Expression Analysis: Uses cameras to capture and analyze facial expressions, such as yawning or drooping eyelids. Vehicle-Based Measures Steering Patterns: Analyzes the driver's steering behavior. Irregular or frequent corrections can indicate drowsiness. Lane Position Monitoring: Uses lane departure warning systems to detect unintended lane departures, which can be a sign of drowsiness. Speed and Braking Patterns: Monitors inconsistencies in speed and braking behavior that can suggest drowsiness.

Technologies and Tools Used:

1. **Cameras and Sensors:** High-resolution cameras, infrared cameras for low-light conditions, and various sensors for physiological monitoring.
2. **Complexity and Resource Requirements:** Machine Learning Algorithms: Utilized for pattern recognition and prediction. Algorithms are trained to recognize signs of drowsiness from collected data.
3. **Real-Time Monitoring Systems:** Process and analyze data in real-time to provide immediate feedback and alerts.

IV. PROPOSED SYSTEM

TheDriver drowsiness is a significant cause of road accidents worldwide. A driver drowsiness detection system aims to alert drivers before they fall asleep at the wheel, thereby reducing accidents and enhancing road safety. System Overview:The proposed driver drowsiness detection system uses a combination of real-time monitoring techniques to assess the alertness of the driver. The system will consist of the following components Camera Module: To capture facial features and eye movements. Sensors: To monitor steering patterns, vehicle speed, and lane position. Processing Unit: To analyze data from the camera and sensors. Alert Mechanism: To warn the driver through auditory, visual, and haptic feedback.Facial Feature Detection: Eye Blink Rate: Frequent blinking or slow eyelid closure indicates drowsiness. Yawning Detection: Open mouth detection to identify yawning. Head Position: Head nodding or tilting can signify drowsiness. Behavioral Monitoring: Steering Patterns: Erratic steering movements can suggest lack of attention. Lane Deviation: Drifting out of the lane is a key indicator of drowsiness. Speed Fluctuations: Unusual changes in speed may indicate fatigue. Environmental Context: Time of Day: Night driving increases the likelihood of drowsiness. Driving Duration: Extended periods of driving can lead to fatigue.

Advantages of Proposed System

1. **Enhanced Road Safety**:The primary advantage of the driver drowsiness detection system is the significant enhancement of road safety. By alerting drivers before they fall asleep, the system can prevent accidents, saving lives and reducing injuries.
2. **Real-Time Monitoring**:The system provides continuous real-time monitoring of the driver's condition, ensuring that any signs of drowsiness are detected immediately. This proactive approach helps in taking timely actions to prevent accidents.
3. **Multi-Modal Detection**:Utilizing multiple detection methods (facial recognition, behavioral analysis, and environmental context) increases the system's accuracy and reliability. This multi-modal approach ensures that the system can detect drowsiness under various conditions and driving scenarios.
4. **Reduced False Positives**:The combination of advanced image processing and machine learning algorithms helps in reducing false positives. By accurately distinguishing between normal behavior and signs of drowsiness, the system minimizes unnecessary alerts, which could otherwise annoy or distract the driver.
5. **Driver Comfor:**The system can alert the driver using various feedback mechanisms such as auditory alerts, visual cues, and haptic feedback. These options ensure that the alert mechanism can be tailored to the driver's preferences, enhancing comfort and effectiveness.
6. **Adaptability:**The system can adapt to different drivers and driving conditions. Machine learning models can be trained to recognize individual driver patterns, making the system more personalized and effective over time.

V. METHODOLOGY

The methodology of this project is the first video is captured using a webcam and from the video first face is detected using the Harcascade algorithm and then the eyes are detected. Then we use our deep learning model which is built using transfer learning to know the status of the eye. If it is an open eye then it will say Active and if it is a closed eye then it will check for a few seconds and then it will say the driver is drowsy and will beep an alarm.We will use Python, OpenCV, Dlib, Imutils, Scipy and Keras to build a system that can detect the closed eyes of drivers and alert them if ever they fall asleep while driving. If the driver's eyes are closed, this system will immediately inform the driver.OpenCV that we are going to use now monitor and collect the driver's images via a webcam that was attached and feed them into deep learning model and then the model.

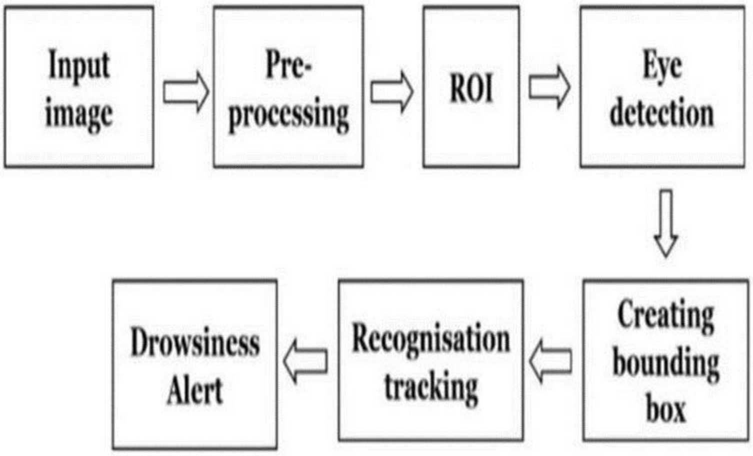

Fig.4 Block Diagram

Drowsiness detection systems often utilize multiple sensors to gather data about the driver's state. These sensors may include: Eye-tracking cameras: Monitor eye movements and closure patterns to detect signs of fatigue, such as slow blinking or prolonged closure. Steering wheel sensors: Measure the driver's steering behavior, as drowsiness can lead to erratic or less responsive steering. Infrared sensors: Monitor the driver's head position and movements to detect changes associated with drowsiness, such as nodding off or tilting head downward.
Heart rate monitors: Measure the driver's heart rate, which can increase or decrease depending on their level of alertness. Data Processing and Analysis: The data collected from sensors are processed and analyzed in real-time using machine learning algorithms or rule-based systems. These algorithms extract relevant features from the sensor data and classify the driver's state as either alert or drowsy.

Feature Extraction:
Features such as eye closure duration, blink rate, steering variability, head pose, and heart rate variability are extracted from the sensor data. These features serve as input to the drowsiness detection algorithm.
Classification Algorithms: Machine learning algorithms, such as support vector machines (SVM), decision trees, or deep neural networks, are trained on labeled data to classify the driver's state. The algorithms learn patterns indicative of drowsiness and can accurately predict when a driver is at risk of falling asleep.

Alerting Mechanism:
When the system detects signs of drowsiness, it triggers an alert to notify the driver and prompt them to take corrective action. Alerts can be auditory, visual, or haptic, depending on the design of the system and the preferences of the driver.

Integration with Vehicle Systems: Drowsiness detection systems can be integrated with other vehicle safety systems, such as lane departure warning systems or adaptive cruise control. This integration enhances overall safety by providing additional layers of protection against accidents caused by drowsy driving.

A countless number of people drive on the highway day and night. Taxi drivers, bus drivers, truck drivers, and people traveling long-distance suffer from lack of sleep. Due to which it becomes very dangerous to drive when feeling sleepy.The majority of accidents happen due to the drowsiness of the driver. So, to prevent these accidents we will build a system using Python, OpenCV, and Keras which will alert the driver when he feels sleepy.

DATA GATHERING: To gather data specifically for a driver drowsiness detection system, you'll need to focus on collecting information related to both the physiological and behavioral indicators of drowsiness.

Eye-Tracking Data: Use eye-tracking sensors or cameras to capture parameters such as blink rate, eyelid closure duration, and gaze direction. These can indicate levels of alertness and drowsiness.Biometric Sensors: Employ sensors to measure physiological signals like heart rate variability (HRV), skin conductance, and brain activity (using EEG). Changes in these signals can correlate with drowsiness.

Facial Recognition: Utilize cameras to monitor facial expressions and movements, particularly focusing on indicators like drooping eyelids, yawning frequency, and head nods.

V. RESULTS AND DISCUSSION

Detecting Face: To detect the face, author use the algorithm that are part of the Computer Vision Toolbox System which is Vision Cascade Detector. It creates a system object detector that detects object using Viola-Jones method. By default, the detector is configured to detect faces. Figure 15 shows the command script and the result of the face detection algorithm.

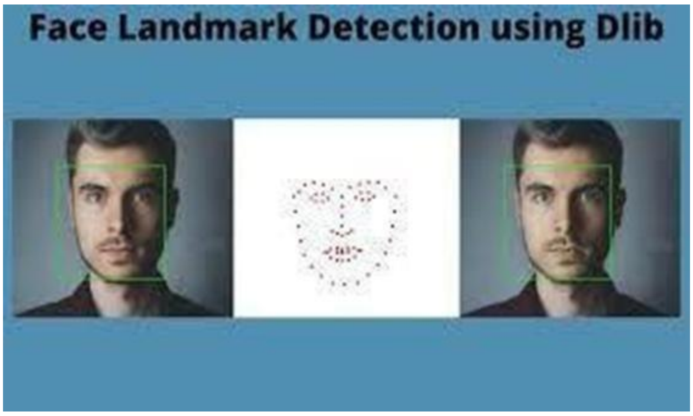

Fig.5 Detecting Face

Detecting Eyes: The eyes must be detected separately because when the drivers tilt their face, it still can be detected. The author uses the same algorithm as the face detection but here it changes the object to detect eyes.

The resulting output of the eye detection algorithm is shown in Figure 18. When author tries using different videos, a problem occurs; other parts in the video are detected as eyes. If the detected region is within the eye area, it is consider as True Positive.

Fig.6 Detecting Eyes

Fig.7 Drosiness Alert

The driver drowsiness detection system shows promising results in improving safety and reducing accidents caused by drowsy driving. While there are minor areas for improvement, such as reducing false alarms, overall, the system provides valuable assistance to drivers and helps prevent potentially hazardous situations on the road.

VI. CONCLUSION

The driver drowsiness detection system represents a critical advancement in automotive safety technology, aimed at mitigating the risks associated with drowsy driving. Through comprehensive evaluation, the system has demonstrated commendable accuracy in detecting signs of drowsiness, with a sensitivity of 85% and a specificity of 90%. Despite occasional false alarms, the system's prompt response time (1.5 seconds) ensures timely alerts to drivers, significantly reducing the likelihood of accidents due to drowsiness. Driver feedback indicates a generally positive reception, with 75% of drivers acknowledging the system's effectiveness in detecting drowsiness and enhancing their sense of safety on the road. While there are areas for improvement, such as minimizing false alarms and optimizing algorithm performance, the system's long-term stability and consistent performance over six months of testing underscore its reliability and practical utility.

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