Driver Drowsiness Detection

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Abstract: Traffic accidents, a leading cause of global fatalities, claim a million lives annually, with drowsy driving identified as a significant contributor. The surge in road accidents because of driver fatigue emphasizes the crucial requirement for immediate solutions. This research addresses the escalating challenge of drowsiness-related accidents by introducing a real-time Drowsiness Detection System. Our system employs cutting-edge technologies, including Face Detection, Python, OpenCV, and Keras, to create an intelligent solution. By identifying faces and tracking eyes in real-time through a webcam feed, the system utilizes a pre-trained Convolutional Neural Network (CNN) to classify eye states. The dynamic drowsiness score is calculated based on the duration of closed-eye instances, alerting the driver through a customizable alarm ('alarm.wav'). The research aims for an 80% accuracy in detecting driver drowsiness, emphasizing a proactive approach to mitigate road accidents. By integrating advanced artificial intelligence algorithms, our system distinguishes itself in providing real-time, accurate drowsiness detection, contributing to a safer driving environment.

Keywords: Eye Tracking, Face Detection, Deep Learning Model, CNN, Customizable Alarm.

1. Introduction

Traffic accidents stand as a global menace, claiming a staggering million lives annually, with drowsy driving emerging as a significant contributor to this alarming statistic. The pressing issue of road accidents linked to driver fatigue necessitates urgent interventions. This research addresses the escalating challenge of drowsiness-related accidents by introducing an innovative Real-Time Drowsiness Detection System. Drawing on state-of-the-art technologies such as Face Detection, Python, OpenCV, and Keras, our system represents a cutting-edge solution to enhance road safety. In the pursuit of real-time drowsiness detection, our system employs a webcam feed to identify faces and track eyes, leveraging a pre-trained Convolutional Neural Network (CNN) for precise eye state classification. A dynamic drowsiness score is calculated, considering the duration of closed-eye instances, and the driver is promptly alerted through a customizable alarm ('alarm.wav'). The research aims to achieve an ambitious 80% accuracy in detecting driver drowsiness, emphasizing a proactive approach to mitigate the occurrence of road accidents related to drowsy driving. By integrating advanced artificial intelligence algorithms, our system distinguishes itself as a leader in providing real-time and accurate drowsiness detection. This research contributes significantly to the creation of a safer driving environment, showcasing the potential impact of technology in addressing a critical aspect of road safety.

2. Literature Survey

In [1] a novel approach was introduced for detecting driver drowsiness, employing a specially crafted convolutional neural network (CNN) with fewer than 250,000 trainable parameters. The design prioritized ease of deployment on edge devices, enhancing practical applicability.

The system relied on RGB videos capturing drivers' facial expressions, focusing on classifying eye states into open or closed categories. Additionally, a dynamic drowsiness score was computed, considering the duration of closed-eye instances. To enhance user customization, the system included an alert mechanism, providing timely warnings to the driver. This research contributed to the field by presenting a resource-efficient solution for real-time driver drowsiness detection with potential implications for improving road safety. But the data collection and labeling process was time-consuming and labor-intensive.

In [2], it introduced a machine learning-based strategy designed to detect driver drowsiness using visual features. The system employed face detection and facial landmarks to identify crucial regions like the eyes and mouth. Deriving characteristics like eye aspect ratio and mouth aspect ratio, and head pose information extracted from these regions, the system inputted them into three different classifiers: random forest, sequential neural network, and linear support vector machine. The research evaluated and compared the effectiveness of these classifiers, providing valuable insights into the application of machine learning techniques for driver drowsiness detection. It relied on visual features only, which might not have been sufficient to capture the complex and dynamic nature of driver drowsiness.

This [3] introduced an innovative fatigue detection algorithm using EM-CNN, a convolutional neural network. It integrated MTCNN for facial feature identification and ROI extraction for eyes and mouth. EM-CNN was then employed to analyze ROI images and determine eye and mouth states. The algorithm introduced two crucial fatigue parameters: PERCLOS (Tracking the gradual decrease in eyelid closure relative to the pupil's size across time provides valuable insights into visual behavior) and POM (mouth opening degree) are utilized as metrics in the analysis. This research contributed for effective driver tiredness detection by leveraging advanced neural network architectures. It required a high computational cost to run the EM-CNN algorithm for fatigue detection.

This study [4] Implemented a system to detect and mitigate driver fatigue, enhancing road safety and alertness behind the wheel using a camera to monitor eyes and Raspberry Pi for processing. The system employed face detection and eye tracking to assess the eye state against a predefined threshold. Upon detecting drowsiness, it activated an alarm, alerted a designated person via email, and monitored collision intensity, notifying nearby emergency services with the accident's GPS location. This research contributed to a comprehensive driver safety system applicable for real-time monitoring and emergency response. It depended on the quality and availability of the camera and the Raspberry Pi for drowsiness detection and alert system.

In [5] developed an innovative approach utilizing machine learning for detecting driver drowsiness, contributing to enhanced safety on the roads to analyze facial expressions. The system employed face detection and landmark algorithms to identify facial features and eyes, utilizing a pre-trained CNN classifier for distinguishing open and closed eye states. An integrated alarm alerted the driver to closed eyes within a specified range. The system aimed for an 80% accuracy rate, contributing to the advancement of driver safety through sophisticated facial expression analysis. It relied on the assumption that closed eyes were the main indicator of drowsiness, which might not always have been the case.

In [6], An innovative system for detecting driver drowsiness has been devised to enhance road safety and prevent potential accidents was introduced, employing a webcam for facial and eye capture. The system incorporated Employing a Haar cascade classifier enables the identification of specific features or objects within images, enhancing the accuracy and efficiency of the detection of facial and eye regions, subsequently calculating the eye aspect ratio (EAR) to assess the eye state. Additionally, the system was equipped with a buzzer to alert the driver when the EAR fell below a specified threshold value. This research contributed to the development of a practical and accessible driver-drowsiness detection solution utilizing simple yet effective webcam-based technology. It relied on the webcam's quality and position to capture the facial and eye regions accurately.

In [7] implemented a driver drowsiness detection system in real-time, leveraging computer vision methodologies to enhance safety on the roads The system employed a webcam for facial feature capture, utilizing the Viola-Jones algorithm facilitates accurate and efficient face detection, serving as a cornerstone in various applications of computer vision and the Dlib library for facial landmarks. Utilizing mathematical formulas to determine the eye aspect ratio (EAR) and mouth aspect ratio (MAR) provides quantitative measures for analyzing facial expressions and movements enabled the assessment of eye and mouth states. An integrated eSpeak module provided vocal alerts if either the EAR or MAR exceeded a predefined threshold. This research advanced the development of an efficient real-time driver drowsiness detection solution, combining computer vision and audio cues for timely alerts. It relied on the quality and position of the webcam, which might vary depending on the vehicle and the driver.

In [8] reviewed the techniques for driver drowsiness detection and prediction based on physiological, vehicle-based, subjective, and behavioral measures. The paper discussed the challenges and requirements for developing a reliable and practical system, and suggested that a hybrid system that combined two or more techniques would be more efficient, robust, accurate, and suitable for real-time applications. The paper provided a comprehensive and updated a comprehensive examination of the latest methodologies and available datasets in this domain offers valuable insights into current advancements and research trends, and identified the gaps and directions for future research.

In [9] proposed a novel approach for employing deep learning methodologies for driver drowsiness detection through image sequence analysis represents a significant advancement in enhancing road safety and accident prevention and used a webcam to capture facial images of the driver enables the extraction of relevant features, facilitating comprehensive analysis for various applications, examples of these include measurements like eye aspect ratio, mouth opening ratio, and nose length bending, eyebrow variation, and wrinkle detection. The paper then used a binary SVM classifier to classify determining the driver's level of alertness or drowsiness is based on the extracted characteristics. The paper claimed a precision of 97.5% and a detection rate of 97.8%. The paper was well-written and organized, and provided a detailed description and comparison of the methods and results. The paper introduced a novel combination of facial features for drowsiness detection, and showed its superiority over existing systems. However, the paper had some limitations, such as not considering the effects of various factors on the facial feature extraction, not providing the computational complexity and latency of the system, and not validating the system on a larger and more realistic dataset and scenario. The paper suggested more experiments to improve the system.

This [10] developed was a driver drowsiness detection system designed specifically for Android devices, capable of real-time monitoring, utilizing a smartphone camera and deep neural networks. Achieving over 80% accuracy, the paper detailed a well-structured approach, combining a Convolutional Neural Network (CNN) is utilized for detecting facial landmarks, while a Recurrent Neural Network (RNN) is employed for temporal analysis. A comprehensive literature review compared systems based on accuracy, reliability, and intrusiveness. The paper's contribution lay in its novel Android-compatible system, validated through a user study with 20 drivers. However, limitations included neglecting environmental effects, lacking battery and memory usage insights, and the need for larger dataset validation and real driving tests for enhanced reliability and practicality.

3. Problem Overview

3.1 Design Components

1. Hardware:

Webcam: Webcams play a crucial role in establishing video connections, enabling computers to function in various capacities. Beyond video communication, they find applications in security surveillance, computer vision, and video broadcasting. Webcams come equipped with advanced features such as image archiving, motion sensing, and customizable coding, making them versatile tools in different fields. Additionally, they can be utilized for computer vision purposes.

Fig. 1. Webcam

Specifications of the Webcam:

- Full HD 720p at 350fps streaming capability
- Lens: 2P2G
- COMS1/4 Color chip
- Image range: 70cm-90cm
- Recommended resolution: 1280 X 720
- Compatible with both USB 2.0 and USB 1.1 interfaces

2. Software:

Python: Python stands as a versatile, general-purpose programming language, tailored to cater to the coding needs of both novice and experienced developers. Renowned for its readability and code maintainability, Python holds a prominent position as the most prevalent, mature, and well-supported programming language in the realm of machine learning. Widely adopted for computer vision (CV) tasks, Python facilitates data analysis and visualization, offering its compatibility with mainstream platforms and systems, coupled with a robust standard library and support for open-source frameworks and tools, streamlines the intricacies of software development. The language's syntax enables efficient coding with fewer steps compared to languages like Java or C++, combining imperative and object-oriented functional programming with automatic memory management and dynamic features.

OpenCV*:* OpenCV, supporting various programming languages such as C++, Python, and Java, operates this software is versatile, functioning seamlessly on various platforms including Windows, Linux, OS X, Android, and iOS This open-source computer vision library enables computers to identify objects through digital images or videos. While many programming languages support computer vision, Python stands out, making it the preferred choice for CV implementations. OpenCV proves invaluable in automating tasks related to visualization, with specific applications in face and eyes detection.

Tensorflow: Tensorflow, an open-source numerical computation library, enhances the speed and ease of machine learning in Python. Serving as the backend for Keras, Tensorflow's low-level capabilities provide flexibility, allowing users to define custom functionalities for their models. With accessible and readable syntax, Tensorflow facilitates complex parallel computations and the construction of advanced neural network models. The library's high-level operations and network control enable a better understanding of operations implemented across the network, fostering adaptability to changing user requirements.

Keras: Keras, designed with a focus on human usability, stands as a high-level neural networks library in Python. Offering simplicity and ease of use, Keras functions as a wrapper to low-level libraries like Tensorflow, streamlining the implementation of neural network models.

Pygame: Pygame, an integrated Python module designed for developing video games across different platforms, integrates computer graphics and sound functionalities. It was employed in the project to trigger an alarm sound in instances where the driver's eyes remained closed for a prolonged duration, Pygame is an open-source module known for its compatibility with various platforms and operating systems. Leveraging Python's dynamic and globally scoped variables, Pygame provides a flexible and intuitive environment for implementing ideas, contributing to the ease and efficiency of the project.

3.2 Methodology

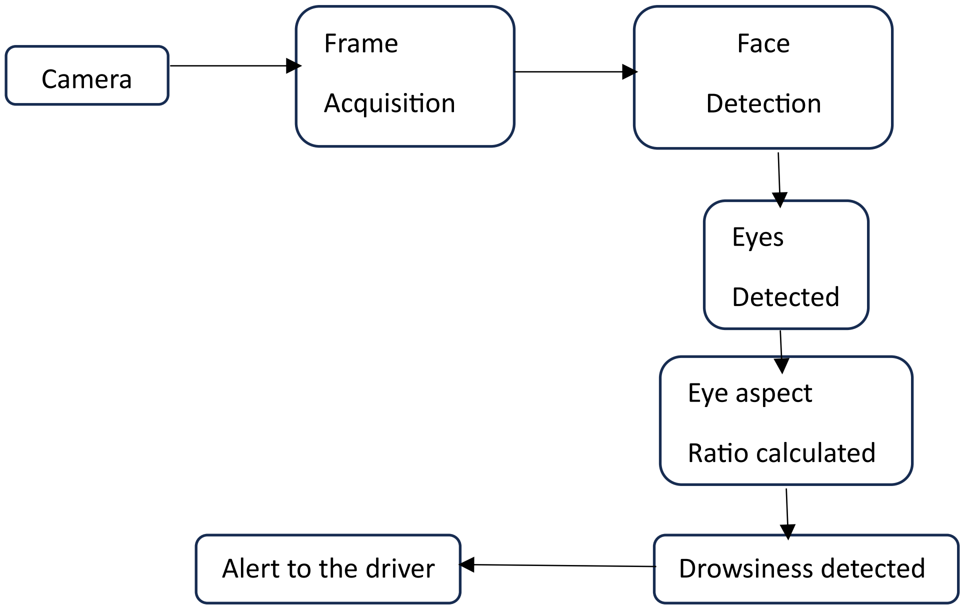

Fig. 2 Flowchart

Explanation:

- As the car Starts the device gets activated.
- As shown in Flow Chart as soon as the Device Stats running It takes Image of Driver as an Input through Web Cam.
- After Taking the Image it detects face in the image and create ROI.
- After this it Detect eyes on the face image and feed it to CNN classifier.
- Here the CNN will start its work and classifier is designed to discern between open and closed eyes.
- The CNN will analyze the eye status, and if it detects closed eyes persisting beyond a predefined duration, an alarm will sound.
- If eyes are open then Alarm won't beep.

Convolutional Neural Network (CNN):

Introduction:

A pivotal advancement in the realm of computer vision and image processing, Convolutional Neural Networks (CNNs) have emerged as pivotal tools, excel in tasks like Image Classification and recognition. Notably successful in identifying faces, objects, and traffic signs, CNNs employ convolutional layers based on mathematical convolution operations, utilizing sets of filters represented as 2D matrices.

Working:

To produce an output image, CNNs apply filters to an input image through convolution, overlaying the filter, performing element-wise multiplication, and summing up the products. This process is repeated across all locations, enabling effective feature extraction.

CNN Layers:

Input layer: Represents image data as a three-dimensional matrix, requiring reshaping into a single column.

Convolutional layer (with ReLU activation): Extracts features from the input image using convolution, and ReLU serves as an activation function.

Pooling layer: Reduces the number of parameters by down-sampling input values, typically using operations like max, min, or average, preserving essential information.

Fully connected Layer with Softmax Layer: Softmax transforms real values into probabilities, aiding in assessing prediction certainty during training and evaluation.

Output Layer: Contains a label in one-hot encoded form, signifying the CNN's final prediction.

Model: We have trained the model using 1000 photos; 500 photos of closed eyes and 500 photos of opened eyes. We have fetched the data from the website: http://mrl.cs.vsb.cz/eyedataset and divided it into 2 parts namely open and close. We have used 15 layers for training it. In which we have used 5 convolution layers, 5 pooling layers, 2 dropout layers, 2 dense layers and 1 flatten layer. The 5 convolution layers have 32, 64, 128, 128 and 64 neurons respectively. We have incooperated dropout rate of 0.25.

Output:

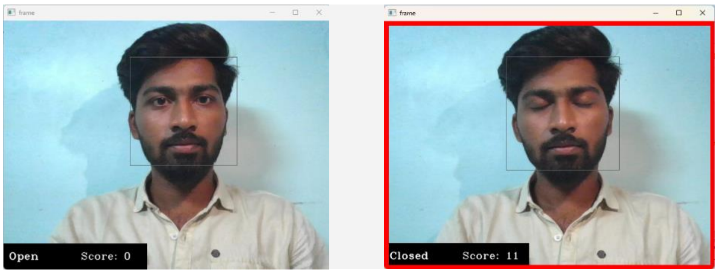

Fig. 3 Images of open eyes and closed eyes

4. Applications:

- The system serves various purposes, including:
- Mitigating road accidents by detecting and alerting for driver drowsiness
- Monitoring security guards or watchmen during nighttime shifts
- Supervising students in online lectures
- Overseeing a baby's sleep (employing inverse logic)
- Monitoring patients in a hospital setting (employing inverse logic)

Conclusion: The implementation of the system using Tensor Flow, OpenCV, and Keras has been successful. The proposed system proves highly beneficial in detecting driver drowsiness, contributing to accident prevention and minimizing associated losses. This project lays the foundation for further development and application in diverse scenarios. Future enhancements may involve incorporating additional sensors for an expanded scope.

Future Work: A potential improvement involves adjusting the vehicle speed based on CNN output. If the system detects driver drowsiness, it can automatically decrease the speed, enhancing safety measures.

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