Enhancing Road Safety: A Deep Learning Approach to Detect Driver Drowsiness

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Abstract— In modern society, significant shifts in time management have disrupted the natural sleep cycles of individuals. This has led to insufficient rest, resulting in pervasive drowsiness at any given time of the day. The repercussions of this altered sleep pattern are particularly evident in activities demanding heightened alertness, such as driving. Drowsiness has emerged as a major contributor to road accidents, with the Central Road Research Institute (CRRI) attributing approximately 40% of such incidents to fatigued drivers. Recognizing the potential dangers, there is a critical need for interventions to mitigate the risks associated with driver drowsiness. This paper outlines the development of a comprehensive drowsiness detection system that analyzes the driver's eye state to deduce their drowsiness level and issues timely alerts, thus averting potential threats to road safety.

Keywords— *Drowsiness Detection, Fatigue Detection, Classification, Driver Monitoring System, Road Safety*

I. INTRODUCTION

Driver fatigue and drowsiness pose significant risks to road safety, contributing to a substantial number of accidents worldwide. Recognizing the critical need to address this issue, the Drowsiness Detection System emerges as a sophisticated solution leveraging cutting-edge technologies. This system combines computer vision and machine learning techniques to monitor drivers in real-time, identifying subtle signs of drowsiness and fatigue. By employing facial recognition and eye-tracking algorithms, the system analyzes key indicators such as eye closure duration and head movements. The objective is to provide an early warning mechanism that prompts drivers to take corrective action, preventing potential accidents caused by impaired alertness. This research contributes to the advancement of intelligent transportation systems, aiming to create a safer driving environment and reduce the incidence of accidents associated with drowsy driving. As the Drowsiness Detection System becomes an integral part of vehicle safety technology, it holds the promise of significantly enhancing road safety and saving lives.

Machine learning focuses on the development of models and programs which when provided with data can make observations and learn for themselves. Nowadays we have cameras that produce high-quality images on which the machine learning algorithms can be applied and also we have computation power at our disposal because of which we can apply it to solve real-world problems. In this paper, we propose a practical implementation of these algorithms to build a technology to provide safety to drivers who drive vehicles at night. According to Vandana Saini et. al., around 20% of all accidents are fatigue-related and around 50% on certain roads[1]. So, driver fatigue contributes a significant proportion to all road accidents.

Drowsiness is a state of reduced wakefulness and alertness that can lead to a strong desire to fall asleep. It is often characterized by a feeling of fatigue, difficulty concentrating, heavy eyelids, and a decreased ability to perform cognitive and physical tasks effectively. Drowsiness is a natural physiological response to various factors, including inadequate sleep, extended periods of wakefulness, certain medications, and underlying medical conditions.

Drowsiness is different from normal tiredness in that it specifically refers to the feeling of being on the verge of falling asleep even when you're trying to stay awake. It can become dangerous if it occurs while performing tasks that require high levels of attention, such as driving or operating heavy machinery, as it can impair reaction times and increase the risk of accidents.

Sleep-deprived drivers responsible for 40% of road accidents, say transport officials . In situations where drowsiness becomes chronic or severely impacts daily functioning, it might be a symptom of a sleep disorder like sleep apnoea, narcolepsy, or insomnia. Addressing the underlying causes of drowsiness is important for maintaining overall well-being and ensuring safety in various activities.

II. LITERATURE SURVEY

Paper Title- Early Identification and Detection of Driver

Drowsiness by Hybrid Machine Learning

Description- The research in this field focuses on four types of fatigue detection. The first is made up of the conductors' physiological signals, such as electroencephalogram (EEG), electrocardiograph

(ECG), and electrocardiogram (EOG). This category gives good results, but getting these signals is usually very complicated and laborious

Paper IoT-Based Smart Alert System for Drowsy Driver Detection

Description-Upon successful integration of the Pi Camera Model V2 with the Raspberry Pi 3, continuous recording of the driver's facial movements is initiated. This research primarily concentrates on assessing driver behavior and measuring collision severity, as detailed in the subsequent sections. The Raspberry Pi 3 Model B and Pi Camera modules play a crucial role in accurately computing the Eye Aspect Ratio (EAR) by consistently capturing facial landmarks through designated facial landmark points.

Paper Title- Driver Drowsiness Detection by Applying Deep Learning

Techniques to Sequences of Images

Description-The drowsiness detection system developed in this study is an integral part of a driver-centric Advanced Driver Assistance System (ADAS) [25,26]. This system operates within specific constraints: early detection and minimizing false positive occurrences. The core concept revolves around alerting the driver exclusively during genuine instances of fatigue to prevent unnecessary alerts that might lead to driver disengagement due to frustration.

Paper Title- A Deep Learning Approach To Detect Driver Drowsiness

Description- Besides the reported accuracy, some issues were identified during testing of the alternative approach that combines deep learning and fuzzy logic. These problems were particularly noticeable in tests involving videos of a young Asian man wearing glasses, specifically subject.

Paper Title: "Driver Drowsiness Detection by Applying Deep Learning Techniques to Sequences of Images"

Description: Focused on a driver-centric Advanced Driver Assistance System (ADAS), this study aims for early detection and minimizing false positives. The research applies deep learning techniques to sequences of images to develop a drowsiness detection system as a part of ADAS.

Paper Title: "A Deep Learning Approach To Detect Driver Drowsiness"

Description: This paper discusses a drowsiness detection system's development, focusing on its integration into an Advanced Driver Assistance System (ADAS). The study revolves around alerting the driver exclusively during genuine instances of fatigue, minimizing false positives to prevent driver disengagement.

Paper Title: "Machine learning-based Drowsiness Detection System Using Facial Features"

Description: This research introduces a machine learning-based drowsiness detection system that utilizes facial features. By employing Open CV for facial landmark detection and gaze estimation, the system extracts key features such as eye aspect ratio (EAR) and mouth aspect ratio (MAR) for input to the machine learning model.

III. PROPOSED METHODOLOGY

The proposed drowsiness detection system consists of three main stages: data collection, feature extraction, and machine learning model development.

Data Collection : A diverse dataset of facial images is collected, featuring drivers in various drowsiness states, lighting conditions, and driving scenarios. The dataset is labeled with drowsiness levels ranging from fully awake to highly drowsy, enabling the model to learn the complex patterns associated with drowsiness onset.

Feature Extraction : Open CV is employed for facial landmark detection, gaze estimation, and eye closure detection. Key facial features, such as eye aspect ratio (EAR) and mouth aspect ratio (MAR), are calculated based on the detected landmarks. These features serve as inputs to the machine learning model.

Machine Learning Model: – A machine learning algorithm, such as Support Vector Machines (SVM) or Convolutional Neural Networks (CNN), is trained on the extracted features. The model learns to differentiate between awake and drowsy states based on the patterns in the feature space. After training the machine learning model, it is tested on both synthetic and real-world datasets that simulate various driving conditions.

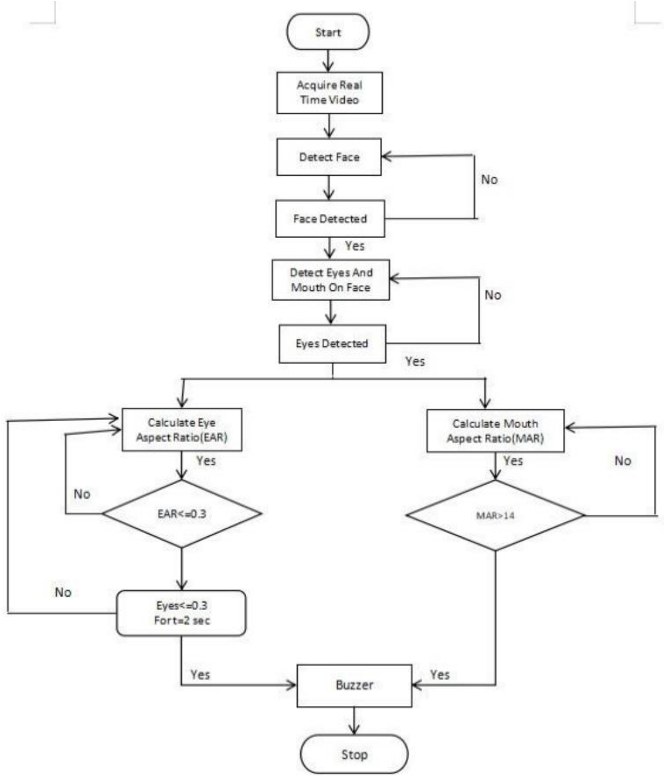
Output – After all steps, driver detection system becomes ready to use.

A. APPLICATION

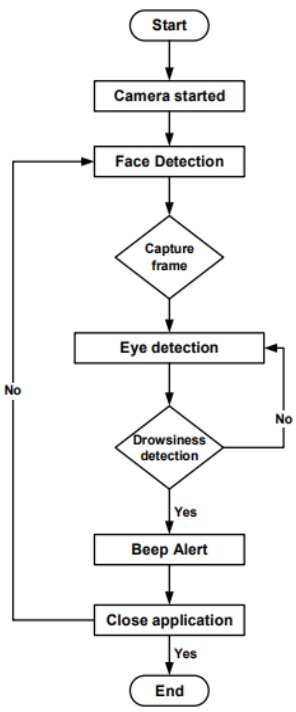
The application of the Drowsiness Detection System is paramount in addressing the pervasive issue of driver fatigue across diverse transportation domains. Embedded within automotive safety systems, this technology serves as a vigilant guardian, continuously monitoring the driver's level of alertness during travel. Its seamless integration into vehicles, whether personal or commercial, enhances road safety by providing real-time alerts when signs of drowsiness are detected. Beyond private transportation, the system extends its reach to public transportation networks, where professional drivers operating buses and trains can benefit from an additional layer of safety assurance. In the aviation sector, the Drowsiness Detection System finds application in mitigating the risks associated with fatigue among pilots during long flights or critical flight phases. Furthermore, its deployment in security and surveillance settings ensures the attentiveness of operators, contributing to overall situational awareness. As a proactive measure, the system is instrumental in long-distance travel scenarios, helping reduce the likelihood of accidents attributed to driver fatigue. The versatility of this technology encompasses its incorporation into Intelligent Transportation Systems (ITS) and collaboration with existing driver assistance systems, positioning the

Drowsiness Detection System as a cornerstone in the multifaceted effort to enhance road safety across various modes of transportation.

B. SYSTEM ARCHITECTURE



C. FLOW DIAGRAM



D. IMPLENTATION AND RESULTS

I)IMPLEMENTATION

The Drowsiness and Yawn Detection system using facial landmarks, leveraging the dlib library for face detection and landmark prediction. The code utilizes various libraries, including OpenCV for computer vision tasks, dlib for facial analysis, and imutils for handling video streams. The playsound library is employed for playing alert sounds, and the time module is used for time-related operations.

Two essential functions are defined within the code: eye_aspect_ratio and mouth_aspect_ratio. These functions compute the eye and mouth aspect ratios based on the distances between specific facial landmarks.

The implementation sets threshold values such as eye_ar_thresh and mouth_ar_thresh to determine conditions for triggering drowsiness and yawn alerts. Additionally, parameters like look_forward_duration, control the duration for "look forward" alerts and the eye_ar_consec_frames. mouth_ar_consec_frames of consecutive frames required to trigger drowsiness and yawn alerts.

The face detection process involves initializing a face detector and loading a pre-trained facial landmarks predictor using dlib. The code then sets up a video stream using OpenCV's VideoStream module.

Counters (COUNTER_EYE and COUNTER_MOUTH) keep track of consecutive frames that meet the conditions for drowsiness and yawn alerts. A timer (time_face_not_detected) is used to measure the duration without face detection, triggering a "look forward" alert if this duration exceeds the specified threshold.

Fig1.1(Prediction of given datasets)

The main loop reads frames from the video stream, processes each frame for face detection and facial landmarks, and checks for drowsiness, yawns, and extended periods without face detection. The visual feedback includes rectangles around detected faces and circles around facial landmarks. The system displays relevant alerts on the frame.

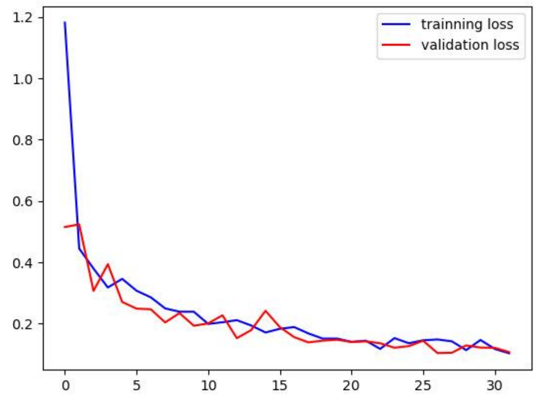


Fig1.2(Training vs.Validation loss graph)

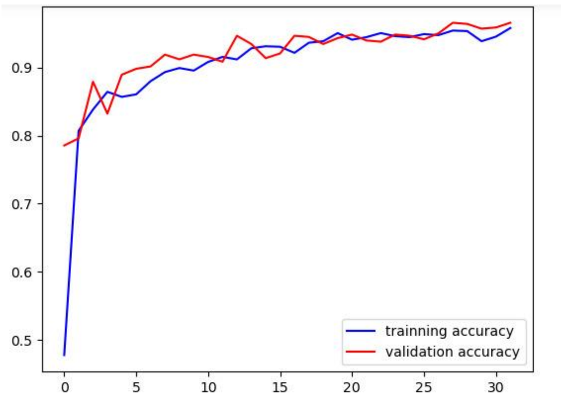


Fig1.3(Training vs.Validation accuracy graph)

The code includes clean-up procedures to close OpenCV windows and stop the video stream when the program is terminated. In summary, the implementation combines facial landmarks and alert mechanisms to identify drowsiness, yawns, and instances where the user needs to look forward based on real-time video analysis.

II)RESULTS

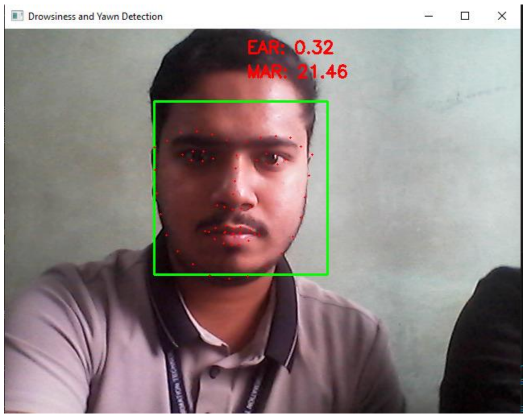


Fig2.1(Normal state)

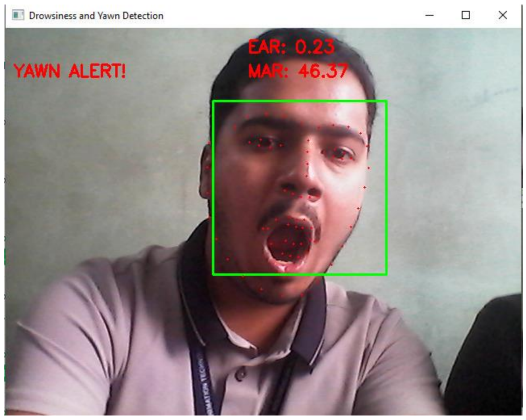


Fig2.2(State under yawning)

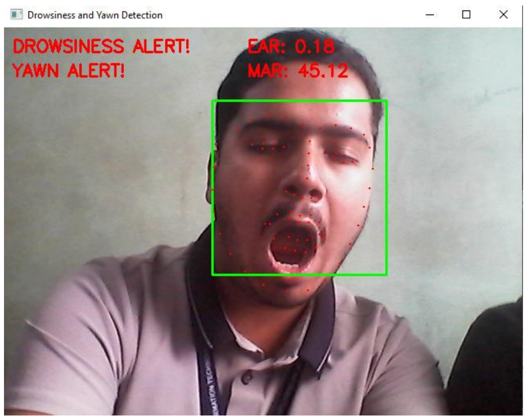


Fig2.3(State under yawning and drowsiness)

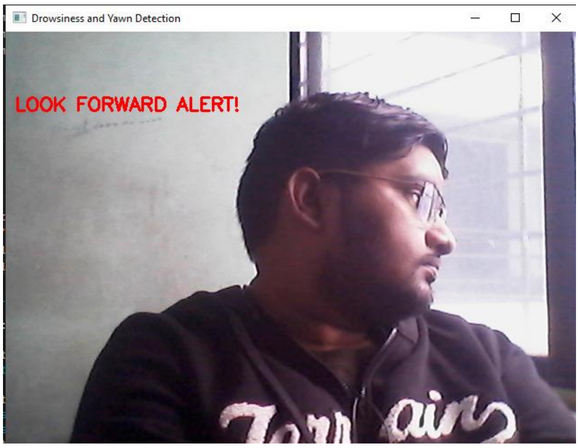


Fig2.4(State under misdirection)

IV. CONCLUSION AND FEATURE SCOPE

The developed drowsiness detection system, employing machine learning and OpenCV, offers a tangible solution to a pressing road safety issue. By accurately identifying drowsy drivers and alerting them in real-time, the system contributes to reducing accidents, saving lives, and advancing the field of driver safety technology. The successful implementation of this system holds the potential to transform the way we approach drowsy driving, paving the way for safer roads in the future.

This technology is a big step towards solving the problem of drowsy driving and could save many lives on the road. In the future, we could make it even better by adding more ways to detect sleepiness or by putting it in cars to warn drivers when they need to be more alert.

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