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Intelligent Vehicle Alert System for Drowsy Drivers Using Vision Transformers

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ABSTRACT

Road accidents can happen due to various causes but drowsiness, rash driving, drinking, and driving are among the most important factors. Driver drowsiness is a serious threat to road safety. Drowsiness affects the drivers' sensory, cognitive, and psychomotor abilities, which are necessary for safe driving. Most driver monitoring systems already embedded in vehicles to detect drowsiness use vehicle-based features (i.e., measures) computed by outward-facing cameras for lane tracking or steering wheel angle sensors to analyse lane keeping and steering control behaviour. Though various drowsiness detection systems have been developed during last decade based on many factors, still the systems were demanding an improvement in terms of efficiency, accuracy, cost, speed, and availability, etc. Drowsiness is a term in which a driver feels sleepy while driving and this can detect it by blinking of eyes and yawning. In this project, proposed an integrated approach depends on the eye and mouth closure status (PERCLOS)) face features of the driver. The Face Detector is used to locate the face of a driver in an image and returns as a bounding box or rectangle box values. The Facial Landmark Shape Predictors uses two algorithms namely fixed thresholding and dynamic frame thresholding to extract the facial features that help in calculating essential parameters, i.e., Eye Aspect Ratio (EAR) and Mouth Opening Ratio (MOR). The two methods use both MOR and EAR parameters to decide the driver's drowsiness level. Then it Alert or warn the driver by playing sounds or voice message. This helps to find the status of the closed eyes or opened mouth like yawning, and any frame finds that has hand gestures like nodding or covering opened mouth with hand as innate nature of humans when trying to control the sleepiness. This system uses computer vision technology which uses cameras to predict the driver's fatigue and alert the driver to take a rest.

1 Introduction

Drowsy driving is the dangerous combination of driving when sleepy. This usually happens when a driver has not slept enough, but it can also happen because of untreated sleep disorders or shift work. Prescription and over-the counter medications can also cause drowsiness, and alcohol can interact with sleepiness to increase both impairment and drowsiness. No one knows the exact moment when sleep will come over their body. Falling asleep at the wheel is clearly dangerous, but being sleepy also affects your ability to drive safely, even if you don't fall asleep. Drowsiness:



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- a. Makes you less able to pay attention to the road.
- b. Slows your reaction time if you must break or steer suddenly.
- c. Affects your ability to make good decisions.

A survey report and research provided by the National Highway Traffic Safety Association (NHTS) on road accidents, about 795 people die from drowsy driving and 91,000 people die from motor vehicle crashes involving drowsy driving in 2017. So, the drowsy driver is considered as one of the factors for road accidents. Driver monitoring or driver drowsiness detection is becoming increasingly important in the age of fast automobiles and swollen traffic jams and must be included in driving assistance systems. Additionally, after extended durations of driving, driver weariness and attention levels might change. Therefore, it is crucial to have a top-notch system that can automatically monitor every part of a driver monitor function. Objectives of developing a driver drowsiness detection system using CNNs may include:

1. Developing a reliable and accurate deep learning algorithm that can detect drowsiness using a camera feed.
2. Implementing real-time monitoring of the driver's face and eye movements to detect early signs of drowsiness.
3. Providing an intuitive and user-friendly interface that alerts the driver when they are becoming drowsy.
4. Enabling the system to differentiate between normal and abnormal eye and facial movements, such as blinking, yawning, and nodding.
5. Integrating the system with other safety features, such as lane departure warnings or automatic emergency braking, to provide a comprehensive driver safety solution.

2 Recent Works

Muhammad Ramzan, Hikmat Ullah Khan (2019) classify the existing techniques into three categories: behavioral, vehicular, and physiological parameters-based techniques. Second, top supervised learning techniques used for drowsiness detection are reviewed. Third, the pros and cons and comparative study of the diverse method are discussed. Eye-blink detection technique is applied. The method firstly converts the color eye image into grayscale using Luminosity algorithm. Then to detect the two-upper eye corner and one lower eye lid points, Harris corner detector is used. After the points identification, midpoint value between the upper two corner points is calculated CNN uses the layers of the spatial convolution that is considered best for the image, which show the strong correlations.

Joao Ruivo Paulo, Gabriel Pires (2020) explores two methodologies for drowsiness detection using EEG signals in a sustained attention driving task considering pre-event time windows, and focusing on cross subject zero calibration. Driving accidents are a major cause of injuries and deaths on the road. A considerable portion of those are due to fatigue and drowsiness. This article is proposed to tackle this research domain, here, we explore drowsiness detection based on EEG signals' spatiotemporal image encoding representations in the form of either recurrence



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plots for deep convolutional neural network (CNN) classification. Results comparing both techniques using a public dataset of 27 subjects show a superior balanced accuracy of up to 75.87% for leave-one-out cross-validation, using both techniques.

Ramesh Chandra Poonia (2021) proposed Early Identification and Detection of Driver Drowsiness by Hybrid Machine Learning. The proposed system will be integrated with the vehicle's electronics, tracking the vehicle's statistics and providing more accurate result. In this paper, they have implemented real-time image segmentation and drowsiness using machine learning methodologies. In the proposed work, an emotion detection method based on Support Vector Machines (SVM) has been implemented using facial expressions. The algorithm was tested under variable luminance conditions and outperformed current research in terms of accuracy.

Comprehensive Drowsiness Level Detection Model Combining Multimodal Information was proposed by Shin-ichi Shikii, Wataru Nakai(2021) presents a drowsiness detection model that is capable of sensing the entire range of stages of drowsiness, from weak to strong. The key assumption underlying our approach is that the sitting posture-related index can indicate weak drowsiness that drivers themselves do not notice. It first determined the sensitivity of the posture index and conventional indices for the stages of drowsiness.

Mireya Fernández-Chimeno(2022) Driver Drowsiness Detection model Based on Respiratory Signal Analysis where A driving simulator cabin has been used to perform the validation tests and external observers have rated the drivers' state of alertness in order to evaluate the algorithm performance. In this paper, a drowsiness detection method based on changes in the respiratory signal is proposed. The respiratory signal, which has been obtained using an inductive plethysmography belt, has been processed in real time in order to classify the driver's state of alertness as drowsy or awake. The proposed algorithm is based on the analysis of the respiratory rate variability (RRV).

Nutshell of existing system are:

- Physiological measurement method.
- Vehicle based measurement method.
- Geometric extraction method.
- Appearance-based feature extraction.

3 Proposed Work

We propose a deep neural network architecture specifically designed for classifying driver behavior in real-time, which we call Faster Region Convolutional Neural Network (FRCNN). Our solution uses multi-stream inputs (i.e., side video streams, side optical flows, front video streams, and front optical flows) and merges via fusion layers abstract features extracted by different convolutional blocks. Overall this ensemble demonstrably improves model robustness. The proposed model contains two steps. In the first step, we perform pre-processing



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on the data. In the second step, we detect the objects involved in these distracting activities and the ROI of the body parts from the dataset's images.

Deep learning is used to suggest a new frame that classifies the driver's eye condition, i.e. open or closed. Deep learning convolution neural network concept is employed. Fixed thresholding and dynamic thresholding algorithms are used to extract facial features.

Proposed system comprises 5 modules:

- Distracted Driver Dashboard
- DD Classification System
- DD Monitoring System
- Warning System
- Experimental Analysis

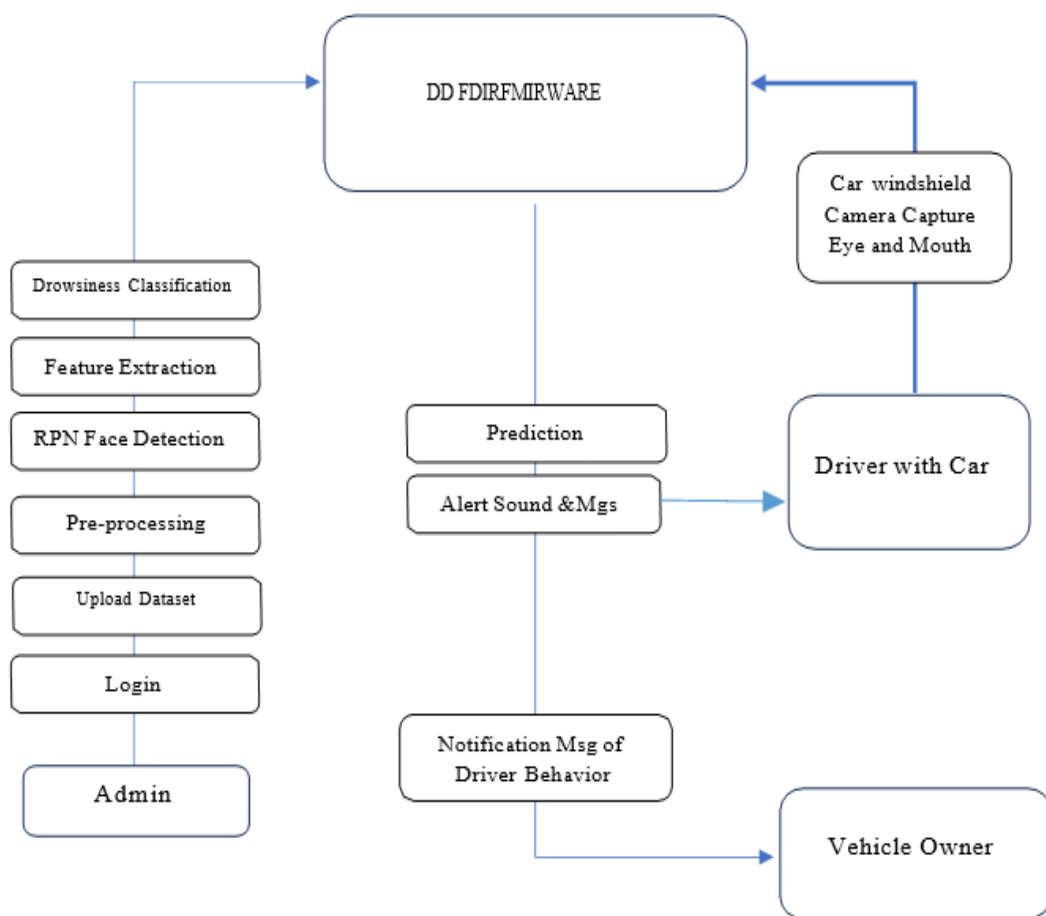


Figure 1: Proposed block diagram



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3.1 Distracted Driver Dashboard

In order to label the collected videos a simple multiplatform action annotation tool using modern web technology.

- a) Vehicle Owner
- b) Admin

3.2 DD Classification System

During this phase, we are taking pictures of people's faces for further processing. We are utilising a webcam or an external web camera for this purpose. There is no way to complete The procedure without first taking the image, and there is no way to identify the emotions without first capturing the image.

Pre-processing Module: Following the capture of photos, we will do image processing on the captured images. The grey scale photos will be created by converting the colour photographs to grey scale.

Training module: This step will involve the preparation of a dataset, which will consist of a binary array of all the photographs that have been taken. The collected photographs will be saved in a .YML file, which will contain all of the face data that was obtained. The .YML file allows us to process the collected photos more quickly because of its compressed nature.

The captured video sequence is sent to the next module for further processing. Frames are extracted and DD image processing will be done. Face detection and segmentation method based on improved RPN. DD image is given as input to the Facial Landmark feature extraction. Extracted features threshold are then classified using CNN.

3.3 DD Monitoring System

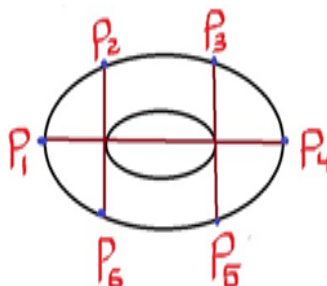
Driver Identification and DD Identification is done in this module. The DD image is then classified as either Drowsiness (fatigue) or Normal by comparing using EAR and MAR.

Eye Aspect Ratio (EAR): Ratio of the length of the eyes to the width of the eyes.

Mouth Aspect Ratio (MAR): Ratio of the length of the mouth to the width of the mouth.

$$EAR = MAR = (|P_2 - P_6| + |P_3 - P_5|) \div 2 \times (|P_1 - P_4|)$$

- Threshold for EAR is set to 0.15 and,
- Threshold for MAR is set to 0.4





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3.4 Warning System

In this module, developed an awareness system by generating alarm for the driver if intentional state is detected. The system also alerts by voice message and steering wheel signals and warn the driver in any of intentional states, eye close and mouth yawn. And also warning e-mail to the authority (owner) for extra supportive alertness to the driver.

3.5 Experimental Analysis

To evaluate the proposed framework, three experiments were carried out. Several measures such as false positive rate (FPR), false negative rate (FNR), accuracy, and processing time have been investigated to assess the performance of the system.

4 Results

System will predict the drowsiness of the driver by analyzing the facial features and proper action will be taken automatically to alert the driver.



Figure 2: *System predicted mouth open*

In the above figure 2. System predicts that the driver's mouth is open, it means that the algorithm or model has determined, based on the input data and its learned patterns that the driver's mouth is likely in an open state. This prediction is then used to assess the driver's level of drowsiness or fatigue and trigger appropriate warnings or alerts to mitigate the risk of accidents caused by driver inattention.



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Figure 3: *System predicted eye closed*

In the above figure 3. System predicts that the driver's eyes are closed, it means that the algorithm or the model determined, based on the input data and its learned patterns that the driver's eyes are likely in a closed state. This prediction is then used to assess the driver's level of drowsiness or fatigue, triggering alert or warning to mitigate the risk of accidents caused by driver intention.

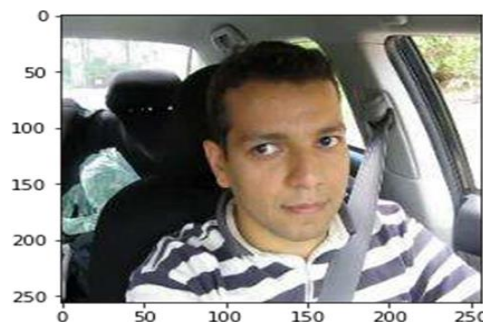


Figure 4: *System predicted normal*

In the above Figure 4. System predicts the driver as "normal," it means that, based on the collected data and learned patterns, the system has determined that the driver is currently awake, attentive, and not displaying signs of drowsiness or fatigue. This prediction suggests that the driver is actively engaged in the driving task and poses a lower risk of potential accidents due to inattention or drowsiness.

5 Conclusion

A more secure method of driving has long been required. To provide a better driving experience given the variety of drivers on the road, it is crucial to have more tailored safety measures. Due to an increase in traffic accidents, top-of-the-line safety features and driver aid systems are now standard equipment for automobile manufacturers. Consumer behaviour has changed, and the majority of customers are searching for cutting-edge driving assistance systems. AI, with its cognitive powers, provides the final solution to tackling the bulk of issues that have led to accidents. In conclusion, designing and developing a driver drowsiness detection system using



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deep learning algorithms, specifically Convolutional Neural Networks (CNNs), has the potential to significantly improve road safety by detecting early signs of drowsiness in drivers. The project would involve data collection and annotation, CNN model development, real time monitoring, integration with existing technology, user interface development, performance evaluation, and deployment and maintenance. By using deep learning algorithms and CNNs, the system can learn from vast amounts of data and become more accurate over time. The ultimate goal of the system is to provide a reliable and accurate solution that can help prevent accidents caused by driver fatigue, improving road safety and saving lives. Overall, the design and development of a driver drowsiness detection system using deep learning algorithms and CNNs is a complex and challenging project, but it has the potential to make a significant impact on improving road safety and reducing the number of accidents caused by driver fatigue. It is an exciting area of research and development with many possibilities for innovation and advancement.

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