https://doi.org/10.46335/IJIES.2024.9.6.20 e-ISSN: 2456-3463
Vol. 9, No. 6, 2024, PP. 90-96

International Journal of Innovations in Engineering and Science, www.ijies.net

Drowsiness Detection System

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***Received on**: 5 May,2024* ***Revised on**: 29 June,2024* ***Published on**: 02 July ,2024*

***Abstract**—The aim of this research is to develop a sleepiness detection system that can identify when an individual has briefly closed their eyes. This system will alert the user when it detects tiredness. An alarm goes off to rouse someone who is about to drift off. The primary objective of this project is to make the model computationally efficient, platform neutral, and cost-effective for the low-end spec platform. Furthermore, a combina-tion of two enhanced algorithms is used to increase the detection's face-sensing accuracy. Sometimes the current approach produces false positive results, leading to incorrect detection of drowsiness. Different lighting conditions or face expressions may cause these systems to malfunction. The goal of the suggested approach is to lower accident and to equip the drivers with this technology to reduce fatalities on roads.*

Keywords—drowsiness, fatigue, haar cascade, convolutional neural network

I. INTRODUCTION

91,000 car accidents involving drowsy drivers occurred in 2017, leading to 50,000 injuries, and 697 fatalities in 2019, according to NHTSA police and hospital reports. According to NHTSA, it is difficult to know exactly how many drowsy drivers are involved in accidents, injuries, and deaths, and the reported numbers are likely to be understated [1]. For example, a study by American Automobile Association's foundation for traffic safety estimated that over 320,00 drowsy driving incidents occur annually, including nearly 64,000 fatal crashes [2]. Given the large number of cases, it is clear that drowsiness is a serious issue and needs to be treated to reduce its effects. Tiredness alludes to fatigue, frequently in unseemly cir-cumstances [3]. In spite of the fact that the state of tiredness may as it were final for a couple of minutes, its results can be deplorable. The reason for entering such a state is as a rule credited to weakness, which reduces consideration and sharpness levels [4]. Tiredness may happen either by driving for long separations without sufficient rest or driving at a time when the driver would typically be sleeping [5]. In such cases, the most issue is the tired driver's need of concentration, coming about in a postponed reaction to any occasion on the street [6].

II. LITERATURE REVIEW

A. Overview of Drowsiness Detection Research

Driver behaviors can be extricated to identify driver drowsi-ness [7]. Deng et al. proposed a strategy for confront location by utilizing point of interest focuses and track the confront to discover weariness drivers. They checked signs such as yawning, eye closure, and squinting. The framework is named DriCare [8]. Zhao et al. utilized both point of interest focuses and surface for confront circumstance classifier. They consid-ered diverse parts of the confront such as nose, mouth, and eyes to assess the part of each single portion of the face for weakness location. Within the conclusion, they consider the eye and mouth as a overwhelming sign of weariness [9]. Verma and colleagues taken after [9] procedure and utilized two VGG16 convolution neural systems parallel for driver feeling discovery. The input of the primary organize is the identified locale of interest (ROI), and

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within the moment VGG16 arrange, utilized facial point of interest focuses as input. They included the comes about of both systems for choosing [10]. Another work concentrate on transport driver weariness and tiredness location. Based on the bus driver position and window, the eye has to be inspected by an diagonal see, so they prepared an diagonal confront locator and an assessed rate of eyelid closure (PERCLOS) [11].In [12], a unused dataset for driver tiredness discovery is presented. They called dataset ULG Multimodality Tiredness Database (DROZY), and [13] utilized this dataset with Computer Vision methods to trim the confront from each outline and classify it (inside a Profound Learning system) in two classes: “rested” or “sleep-deprived”. They executed the framework in a low-cost Android gadget. Another dataset made by Abtahi et al. presents two video datasets of drivers with different facial characteristics, like with and without glass and sunglass or diverse ethnicity for planning calculations for yawning discovery. They moreover report 60% accuracy for yawing discovery when the camera is found on the dashboard [14]. The Kinect camera is another instrument for drivers observing and recognizes driving er-rands in a real vehicle. In [16], creators attempt to distinguish seven everyday tasks performed by drivers, typical driving, cleared out-, right-, and rear-mirror checking, versatile phone replying, texting employing a portable phone with one or both hands, and the setup of in-vehicle video gadgets. The Kinect camera comprises of color and profundity picture data from the driver interior the vehicle. They assessed 42 highlights given by Kinect and anticipated include significance utilizing irregular woodlands and chose a few of them. A feed-forward neural arrange (FFNN) is utilized as a learning organize. They accomplished to 80.7curacy with the FFNN organize for assignment classification.

B. Behavioral Indicators of Drowsiness

Within the writing concerning the plan of tiredness location frameworks, distinctive terms of reference are utilized. In spite of the fact that “drowsiness” is the commonly mentioned term, “fatigue” is additionally utilized. In spite of their contrast, weariness and tiredness are traded utilized [16]. Weariness alludes to “the hesitance to proceed a errand as a result of physical or mental effort or a delayed period of performing the same task” [17]. In any case, languor or laziness is char-acterized as the encourage to drop sleeping. Fundamentally, drowsiness is the result of a captivating organic got to rest [17]. Laziness can happen due to numerous reasons, such as phar-maceutical, working for long hours, rest clutters, poor quality (or not having sufficient) rest, and being alert for long periods [17]. In this way, their relationship is obvious, as weakness straightforwardly contributes to laziness. In spite of the fact that they are distinctive concepts, a few analysts considered laziness and weakness alike, due to their comparative results, such as [16–18]. In our work, we allude to these frameworks as laziness location frameworks. Drowsiness is a gradual process, it is said to occur as a collection of symptoms presented below:

- Difficulty keeping eyes open; • Yawning;
- Frequent blinking;
- Difficulty concentrating;
- Swerving out of the lane and delayed reaction to traffic; • Nodding;
- Unjustifiable variations in speed.

These signs slowly gotten to be more clear as laziness develops and, as such, can serve as pointers for the level of driver laziness.

III. METHODOLOGY

A. Haarcascade Algorithm

For object detection and face recognition, the Haar algo-rithm is a widely used image processing algorithm. Identifying features such as eyes and mouth on a face can be done by using the Haar algorithm in drowsiness detection. This can be utilized to evaluate whether the person is in a state of sleepiness or not. The Haar algorithm utilises contrast analysis to evaluate the contrast between various areas of an image. The image’s patterns are recognized by a set of pre-defined Haar features that are trained. The typical dimensions and orientation of these features are rectangular. Taking a picture of the person’s face with a camera is the first step taken by the algorithm to detect sleepiness. The eyes and mouth in the image would be identified using the Haar algorithm afterwards. To determine whether someone is drowsy, the algorithm would analyze the positions and movements of these features over time. For instance, the algorithm may recognize that a person is drowsy and needs to rest if it notices that their mouth is open for a prolonged amount of time or that their eyelids are closed or drooping. Haar edge and line detectors are capable of detecting different facial features that can indicate drowsiness in the driver. A more accurate drowsiness detection system can be created by

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combining multiple features. Identifying the edges of the driver's eyes can be done using the Haar method. The aspect ratio of the observed eyes, a sign of tiredness, can be used to determine if the driver's eyes are closed or half closed.

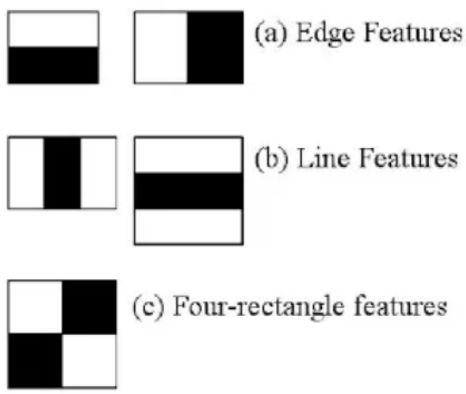

Fig. 1: Classifications of Haar features

B. CNN Algorithm

Convolutional Neural Networks (CNNs) can be used in drowsiness detection systems to automatically extract impor-tant features from images or videos of a person's face or eyes. The CNN model uses a large dataset of annotated images to extract key features that aid in differentiating between these two states. Whether or not an image appears drowsy determines its classification. Among the features that can be seen are drooping eyelids, datasets of drivers with different facial characteristics, like with and without glass and sunglass or diverse ethnicity for planning calculations for yawning discovery. They moreover report 60% accuracy for yawing discovery when the camera is found on the dashboard [14]. The Kinect camera is another instrument for drivers observing and recognizes driving er-rands in a real vehicle. In [16], creators attempt to distinguish seven everyday tasks performed by drivers, typical driving, cleared out-, right-, and rear-mirror checking, versatile phone replying, texting employing a portable phone with one or both hands, and the setup of in-vehicle video gadgets. The Kinect camera comprises of color and profundity picture data from the driver interior the vehicle. They assessed 42 highlights given by Kinect and anticipated include significance utilizing irregular woodlands and chose a few of them. A feed-forward neural arrange (FFNN) is utilized as a learning organize. They accomplished to 80.7curacy with the FFNN organize for assignment classification.

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variations in eye structure, and the degree of ocular closure. After being trained, the CNN model can be used to classify new images or video frames according to whether they are drowsy or not. The CNN model learns to identify patterns and features in the input image by analyzing image or video frames using a convolutional layer system The convolutional layer's output is subsequently passed to fully connected layers, which determine how to translate these characteristics into a final categorization of either awake or sleeping.

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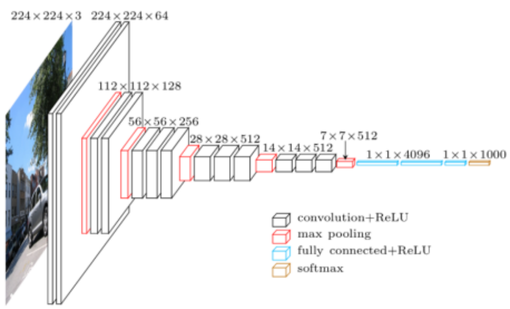
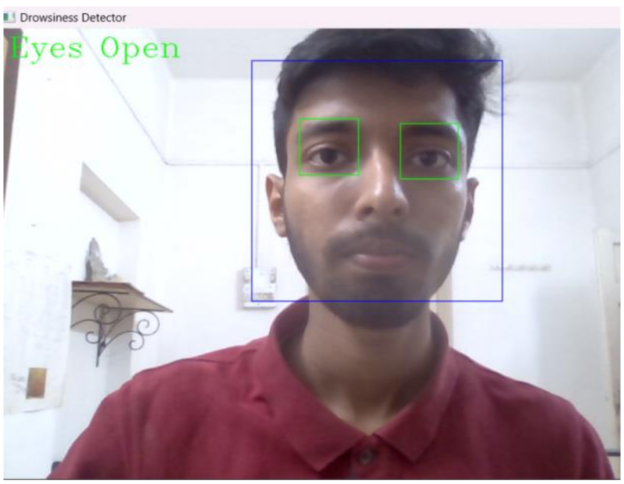


Fig -CNN Architecture



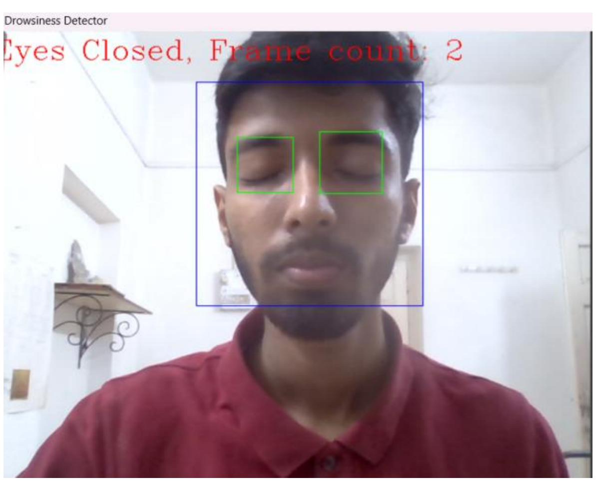


Fig. 3: Real-time implementation of Drowsiness Detection System (open eyes)

C. System Setup

The system implementation of drowsiness detection utiliz-ing the CNN and Haar algorithms involves several typical processes, which are:

- Data Collection: To put a sleepiness detection system into action, the first step involves gathering information. The task involves capturing images or films of individuals in different stages of sleepiness, such as awake, sleepy, and about to go to sleep. Different real-world situations should be depicted through the information and it should be diversified.
- Preprocessing: Preprocessing the data is the next thing to do. To achieve this, it is necessary to convert the images or videos into a format that can be processed by the algorithms. In order to reduce noise and improve accuracy, image normalization, resizing, and cropping may be involved.
- Feature Extraction: The Haar algorithm is used to extract face features like the lips and eyes. Utilizing a series of trained Haar classifiers, distinct patterns in the visual data are recognized.
- Classification: The CNN technique is used for classi-fication, utilizing a deep neural network that has been trained to recognize patterns in image data and classify images as either drowsy or not. Using a tagged dataset of images, the network is trained using preprocessed images with features extracted using the Haar technique. Patterns in picture data are categorized as either drowsy or not, employing the CNN technique for classification.
- Visualization: After receiving training, the system can be utilized to detect drowsiness in real-time situations, like while driving. To alert the driver of drowsiness, the system can generate visual or sound alerts.

D. Necessary preparations

- Classified dataset: The CNN algorithm must be trained using a labeled dataset of images or videos. The dataset needs to have a representative sampling of images or videos of people who are experiencing different levels of drowsiness.
- Haar Cascade Classifiers: To detect specific facial features, such as eyes and mouth, the Haar algorithm necessitates the use of a group of pre-trained classifiers. The OpenCV library usually has these classifiers but they can also be trained from scratch.

- Picture Pre-processing: To improve the accuracy of feature detection and reduce noise, pre-processing of images is required. Image normalization, resizing, and cropping can all be part of the pre-processing steps.
- Machine Learning Framework: The CNN algorithm can only be trained with a machine learning framework like TensorFlow or Keras. Machine learning models can be built, trained, and deployed easily and efficiently with these frameworks.
- Hardware specifications: It takes a lot of computational resources to detect drowsiness with the Haar and CNN al-gorithms. To process and store large datasets, a powerful CPU or GPU is necessary, as well as sufficient memory.
- Real-Time Data Acquisition: Input data from a camera or sensor is necessary for drowsiness detection using Haar algorithm and CNN algorithm. To ensure reliability, a reliable data input system must be established.

All things considered, detecting tiredness through the use of the CNN and Haar algorithms is a difficult procedure requiring a great deal of knowledge in software engineering, machine learning, and computer vision. Developing a drowsiness detec-tion system requires careful consideration of the prerequisites.

E. Implementation Steps

Let's go through how our algorithm works when implement-ing Drowsiness Detection step-by-step.

- Our input will be obtained through the use of a camera. An infinite loop was created to capture each frame in order to access the webcam. The image is saved in a frame variable once each frame is retrieved.
- Create a Region of Interest based on identifying faces in images. Since the object identification method only accepts grayscale images as input, we must first convert the image to grayscale in order to locate the face in it. De-tecting the items doesn't require color information. The Haar cascade classifier will be utilized to detect faces. Then, the detection will take place. The object's border box width, as well as its x, y, and height coordinates, are all used to produce an array of detections. Drawing boundary boxes for each face is now possible as we iterate through them.
- Find the eyeballs using the ROI and feed them to the must be set up for the cascade classifier. Extracting eye data solely from the entire picture is required now. To achieve this, first extract the border box of the eye, and then use this code to extract the picture of the eye from the frame. The left eye merely stores the image data of the eye. Our CNN classifier will receive this data and use it to determine whether the eyes are open or closed. In a similar manner, the right eye will be taken out of the right eye.
- Either open or closed eyes will be identified by the classifier. The eye state prediction involves the use of the CNN classifier. We have to perform a few processes before we can enter our image into the model since the model needs the correct dimensions to start. The process begins by transforming the color image into grayscale and then resizing it. Our data is standardized to enhance convergence. Our model is ready. Our model is currently being employed to predict each eye. Whether the eyes are open or closed is determined by the value of the prediction variable; if it is 1, the eyes are open.
- Determine whether the individual is drowsy by calculat-ing their score. A feature that shows the person's present state in real-time assists in displaying the results on the screen. A score that is higher than a predetermined threshold indicates that the subject has had their eyelids closed for an extended amount of time. This is when the alarm goes off.

In general, the CNN algorithm is used to categorize images, whereas the Haar method is utilized to discover and track features. Through the combination of the advantages of both approaches, drowsiness detection systems are able to recognize signs of sleepiness in real-world situations.

IV. Results

The implementation of our drowsy driver detection system has yielded significant advancements in addressing the critical issue of drowsy driving, with promising results indicating its potential to significantly enhance road safety.

- Enhanced Detection Accuracy: Through the fusion of two improved algorithms, our system has demonstrated marked improvements in face-sensing accuracy. Despite challenges posed by varying lighting conditions and facial expressions, the system exhibited commendable perfor-mance in accurately identifying instances of brief eye closure indicative of fatigue.
- Real-time Alerting Mechanism: Our system's real-time alerting mechanism is highly effective in preventing ac-cidents by promptly detecting signs of driver fatigue and issuing timely alerts. This proactive approach empowers drivers to take necessary corrective actions, such as rest breaks, thereby reducing the risk of fatigue-related accidents on the roads.
- Precision and Reliability: Rigorous testing and

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re-finement have ensured the precision and reliability of proactive intervention when necessary, thereby enhancing overall road safety outcomes.

- User-friendly Interface: The incorporation of a user-friendly interface, including intuitive alerting mechanisms such as audio notifications, prioritizes user experience and improves driver responsiveness to potential hazards on the road.
- Scalability and Cost-effectiveness: Prioritizing scala-bility and cost-effectiveness, our system offers a viable solution for widespread implementation across diverse contexts. By making road safety measures accessible without imposing prohibitive costs, we aim to foster a culture of safety and reduce accidents and fatalities on roads.

In conclusion, the results underscore the efficacy of our drowsy driver detection system in mitigating the risks associated with drowsy driving. Continued refinement and optimization, coupled with ongoing research efforts, are essential to further enhance its effectiveness and ensure its sustained impact on road safety. We believe that our findings can help to advance the field of road safety technology.

V. Application And implications

- Enhanced Road Safety: At the forefront of our project is the unwavering commitment to fostering safer roads for all stakeholders, including drivers, passengers, and pedestrians. By proactively detecting signs of drowsiness and alerting drivers in real-time, our system aims to prevent accidents and minimize the potential for harm on the roads.
- Real-time Detection: Preventing accidents before they happen is greatly aided by our technology's ability to quickly detect driver fatigue and sleepiness in real-time. By keeping an eye on driver behavior and sending out early signals, we enable drivers to correct their condition and take the required breaks, which lowers the risk of fatigue-related accidents.
- Accurate Drowsiness Detection: The efficacy of our technology depends critically on the accuracy of its drowsiness detection. We make sure that our technology provides precise and dependable drowsiness detection, enabling proactive intervention when necessary, by lim-iting false positives and false negatives.
- User-friendly Alerts: We put the user experience first, which is why we designed our system to be simple to use and intuitive. We want to keep drivers attentive and involved by providing them with user-friendly alerts, such as audio notifications, which will improve their reactivity to any hazards on the road.
- Integration with Vehicle Systems: Our system can be easily integrated with a variety of vehicle systems, including those found in older cars without dash cams as well as those installed in more recent models. This Scalability and Cost-effectiveness: We aim to achieve broad implementation of our system in many contexts by making it both economical and scalable. Because of its scalability and affordability, road safety may be prioritized by communities without being prohibitively expensive.

VI. Future Scope

Future objectives of this research include utilizing multiple threads in which the processes are shared and many processes are conducted simultaneously to improve the single-process drowsiness detection approach. Processes that are running or executing simultaneously can perform better since they take less time to finish. This enhances the user interface's responsiveness as well. This gadget can also track the light rays that are reflected from the eye by employing a micro camera; the cessation of reflected light is equivalent to the closing of the eyes. These additions might enhance the method for detecting tiredness. It is also possible to incorporate the head position as a component to increase the robustness of sleepiness detection. For upcoming implementations, the following factors can additionally be taken into account: In order to assess if a patient is fit to drive, there may also be equipment that tracks their heart rate. The driving behavior based metrics utilized in simulations and real driving situations may differ significantly.

VII. Conclusion

There are numerous technologies available to identify driver weariness, as this paper explains. This study attempts to ex-amine developing technologies and identify the most effective methods.

is an effort to stop the leading factor in deadly car crashes. The top-selling device on the market right now is essentially a reed switch that can detect tilt and head angle. This product is not very effective and quite limited. The BMW device that detects driver weariness in their high-end vehicles is marginally more successful in its identification, but it does not provide the appropriate alert to the driver. The market and technologies of today are still in their early stages. New technologies continue to emerge through many means.

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