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Proceedings, Part I

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A Novel Smart Facial Features for Real-Time Motorists Sleepiness Prediction and Alerting System Using Hybrid Deep Convolutional Neural Network in Computer Vision

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Abstract. Motorists Sleepiness prediction is a process of detecting when an Operator is experiencing Sleepiness or fatigue while driving a vehicle. This is an important safety feature, as Sleepy driving can lead to accidents and injuries. There are several methods used to predict Operator Sleepiness, including physiological monitoring, behavioural monitoring, and hybrid methods. Physiological monitoring methods like CNN involve measuring the Operator's physiological signals, such as image or video frame processing from a camera. These frames can provide information about the Operator's level of alertness and can be used to detect Sleepiness. Behavioural monitoring methods that are DCNN on the other hand, involve observing the Operator's behaviour, such as comparing the frames with the processed dataset. This information is mainly used to detect Sleepiness. Hybrid methods combine physiological and behavioural monitoring methods of CNN and DCNN and added to the fuzzy logic algorithm makes an HDCNN (Hybrid Deep Convolutional Neural Network) to provide a more comprehensive assessment of the Operator's level of Sleepiness and improves the accuracy. This article explains techniques to spot the lips and eyes in a video taken during a research project by the Indian Institute of Road Safety (IIROS). A footage of the transition from awake to fatigued to drowsy will be captured using the digital camera. The Proposed algorithm's function is to locate the face recognized in a captured video image. The face region is used mostly for its ability to act independently.

Keywords: Convolutional Neural Network (CNN) · Hybrid Deep Convolutional Neural Network (HDCNN) · Fuzzy Logic Algorithm · Eye Aspect Ratio (EAR) · Computer Vision · Haar wavelet

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1 Introduction

Every individual require sleep, and lack of sleeping leads to lethargy, sluggish reflexes, blurred focus, and deviation, all of these factors limit a human's ability to make the kinds of decisions needed when driving a type of vehicle [1]. The World Health Organization (WHO) estimates that accidents cause over 1.5 million injuries or fatalities annually. Some of them drive excessively quickly, cut through red lights, and cross highways in violation of the traffic regulations [2]. Their brakes and tyres are mechanically flawed as well. The novel objective of the research is to provide a comprehensive sleepiness monitoring system as a means of mitigating these issues in order to reduce fatal incidents. This model's accuracy is 95%. This strategy makes advantage of deep learning as well [4]. The technique incorporates both hybrid deep learning algorithm and machine learning based on augmented reality with computer vision, which are two disciplines of artificial intelligence that enable. The user can train the algorithm to forecast output within a defined range. This kind of technology bridges the gap between people and robots [5].

Computer vision is a technology designed to gather and interpreting images for image preprocessing. It facilitates the collection and preprocessing of trained data to provide information, and it also makes use of other system-critical technologies. Because of their intuitive graphical user interface (GUI), operating systems are easy for users to use. Where you may easily construct your own panels to produce the output of a certain model. We're using two distinct models here for safety reasons: drowsiness monitoring and driver identification of face characteristics. The model's output is to warn and prediction of the driver falls asleep, switches lanes, or the automobile is not properly technology maintained. The goal of this research is to protect drivers by incorporating this technology into automobiles [6].

Human beings have constantly developed tools and ways to make lifestyle simpler and safer, the fact that either tedious tasks like travelling to work or more thrilling ones like flying. Alongside the increase in generation, modes of transportation established prominence, and our reliance on them rose substantially. As a result, our lives as we know them have changed dramatically. We can go to places at a rate that our forebears could not have imagined conceivable. We are able to travel to locations at a pace that not even our grandparents would have thought possible. Today, practically everyone on our planet uses a form of transportation every day. Few individuals are rich enough to own vehicles, and others rely on public transportation. Nevertheless, there are a few rules and standards of conduct for those who exert pressure, regardless of their standing in society. One of them is maintaining consciousness, alertness, and energy while driving [7].

By ignoring our obligations in the direction of safer travel, we have allowed vast volumes of harm to merge with such brilliant ingenuity each year. For most seniors, it can seem like a minor detail, yet adhering to the law and acting responsibly on the street have major ramifications. Even while a motor vehicle uses the most of its electrical power on pavement, in careless hands, it may be devastating and occasionally, such negligence puts lives of individuals in danger. One example of inexperience is failing to understand that we are too tired to drive. Several academics have published publications on driver tiredness detection devices in attempt to identify and prevent an unfavourable consequence from such conditions. However, several considerations and tests performed with the gadget are occasionally inadequately precise. This project was conducted in order to better their implementations and similarly optimise the solution by offering analytics and any other perspectives that is relevant to the situation at hand. [8].

1.1 Problem Definition

Sleep deprivation is an issue of security that the world has not lately really addressed. Sleepiness, unlike alcohol or drugs, may be difficult to measure or evaluate due to the way it functions. While weariness or drowsiness is not quantifiable or identified and is a common problem, drugs and alcohol have prediction clear key indications and tested that can be acquired without vehicle problems, which makes them clearly detectable and avoidable. The most probable remedies to this problem are to concentrate on events that are caused by driver drowsiness and to encourage drivers to admit it when necessary. The final outcome cannot be accomplished without the former, because riding for long periods of time may be quite useful. As a result, tiredness monitoring techniques are required for the prevent accident of automobile vehicle and their drivers. The first option is a lot more challenging and costly to do.

Fig. 1. Fatigued Driver

Much of the background work on facial recognition focuses on identifying discrete features such as the appearance of eye, mouth, and head, and defining the position, shape, and relationship of these features. Face popularity has emerged as a crucial problem in lots of programs, together with security structures, credit score card verification, and criminal identity. The capability to version a particular face and the potential to distinguish it from a big variety of stored face fashions can also beautify protection and stumble on faces, in comparison, can be important to discover. Facial recognition in pix is very useful for automating shade film development, because the effect of a couple of enhancement and noise discount methods depends on the photograph content material [9]. Figure 1 shows Fatigued Driver facial recognition.

Haar cascade xml is a method primarily based on machine getting to know (ml) in which lots of tremendous and negative images are used to teach the classifier. Superb pictures are the ones pictures that incorporate the photographs which we need our classifier to become aware of as an example: face and negative pix are the images of the whole thing else i.e., they are the pictures which do now not contain the item we need to discover. This helps us in face detection so that the device can efficaciously come across a face so that it will method the face reputation method**.** The Haar Cascade classification is based on Harvowlet technology to analyse the pixels in an image in sections by function. It uses the concept of "comprehensive image" to calculate "features "Need to know. Haar cascade makes use of the ada-increase mastering set of rules to pick a small range from a massive set of statistics to provide a powerful result of essential capabilities from a big set and cascading method is used to identify the face within the picture [10].

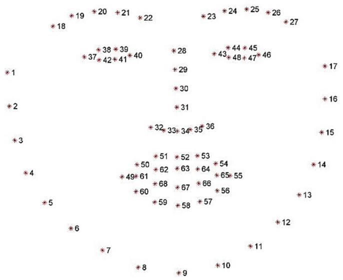


Fig. 2. D-lib's 68 Points Face

D-lib is a toolkit used for making Realtime machine learning applications and information evaluation packages. It's used for face detection/ face recognition and facial landmark detection. The prefrontal facial detection in d-lib performs admirably since it is quite straightforward and works right out of the box. Figure 2 shows D-lib has a model with 68 points. Here, we can see that it multiplies from 1 to 68. Yet, there are times when we only need a few of the 68 feature points. As a result, we may tailor those factors to fit our needs. For instance, in our machine, we just employ criteria 38 to 58 to calculate the EAR. Basically, kind of two ways to accidentally capture landmarks.

Recognition of Faces: Recognition of faces is an initial technique that the predict a human face and returns a rectangle-shaped points in the coordinates x, y, w, and h.

Facial Reference: We must first find a face's placement in the image before moving on to the locations within the shape of a rectangle.

2 Related Work

Zheng, g et. al (2008), In order to reduce the act threat problem, this paper suggests a new generation of modelling driving force fatigue supported by statistics fusion approach with multiple eyelid motion characteristics—particular minimal squares regression. Where there is a strong correlation between the eyelid movement features and the tendency to drowsiness [1]. The tentative correctness and robustness of the correspondingly established version have been confirmed, indicating that it offers an alternative method of concurrent multi-fusing to increase our capacity to recognize and anticipate sleepiness.

Friedrichs, f et. al (2010), In this research, it is suggested that the motivation eye measurements be started to detect sleepiness in a computerized laboratory or experiment setting. Modern optical productivity fatigue tests are categorized as supported assessment measures. These measurements are backed by statistics and a categorization approach for a 90-h huge dataset of drives on a crucial road [2]. The results demonstrate that for certain drivers, eye-tracking results in detecting tiredness works longer. Blink detection still has issues when used by people wearing sports glasses and poor lighting situations, despite some of the suggested enhancements. In summary, digital camera-based sleep measures offer valuable assistance for sleepiness, but relying solely on advice is unreliable.

Armingol, j. M et.al (2011), In order to reduce the number of deaths, an application for a sophisticated driving support system that automatically identifies driver tiredness and also makes driving distraction easier is presented in this study. The sleepiness index is calculated using machine learning algorithms that use visual data to recognize determine, and study each driver's face characteristics and eyes [3]. Due to the near-infrared illumination system, this real-time gadget can function at night. The proposed set of principles is ultimately verified by instances of various motivation force photos taken overnight in a real car.

Zhang, W., Cheng, B et.al (2013), explore the address concerns caused by changes in illumination and driving position, this article introduced a robust set of eye detection criteria to a non-profit sleepiness detection approach that makes use of eye tracking and image processing [4]. The six measurements proportion of yield closure, maximum final period frequency of eyelids, average eye level releasing frequency, eye velocity starting, and eye pace are computed, which provides 86% accuracy.

3 Proposed Work and Methodology

3.1 Convolutional Neural Network (CNN)

A vehicle's sleepiness detection system may be successfully implemented using a CNN (Convolutional Neural Network). To identify indicators of driver intoxication and warn them to avoid collisions, the system can combine computer vision methods with machine learning algorithms. Here's a high-level overview of the concept and algorithm for a driver drowsiness system using CNN:

Step 1: Data Collection: The initial phase entails gathering an enormous collection of images and videos of automobile drivers in various states, including alert and sleepy states. These images or videos should be labelled to indicate the corresponding state.
Step 2: Preprocessing: The collected images or video frames need to be pre-processed to enhance the relevant features. This may involve resizing, normalization, and filtering techniques to improve the quality and consistency of the data.
Step 3: Feature Extraction: The CNN is responsible for automatically learning relevant features from the pre-processed images. This is achieved through a series of convolutional, pooling, and activation layers. The convolutional layers capture local patterns and features, while the pooling layers down sample the spatial dimensions and reduce computational complexity.
Step 4: Training: Sets for validation and training purposes are created from the labelled dataset. The CNN is trained using the training set, and the validation set is used to monitor the model's performance and prevent overfitting. The network learns to recognize patterns and features associated with drowsiness during this phase. The training process involves optimizing the network's parameters using gradient descent and backpropagation.

Step 5: Testing and Evaluation: Once the CNN is trained, it can be tested on a separate dataset that was not used during training. This dataset should contain real-time images or video frames. The CNN processes these frames and predicts the driver's drowsiness state. The predictions can then be evaluated against the ground truth labels to measure the accuracy and effectiveness of the model.
Step 6: Alert System: Based on the predictions made by the CNN, an alert system can be triggered to notify the driver if drowsiness is detected. This can be achieved through various mechanisms such as visual alerts, audible alarms, or vibrations.
Step 7: Continuous Monitoring: The system should continuously monitor the driver's behavior and update the drowsiness predictions in real-time. This allows for timely alerts and ensures the system adapts to changes in the driver's state.

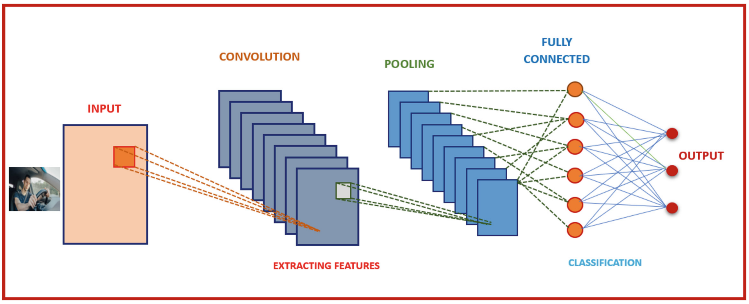


Fig. 3. Architecture of CNN (Convolutional Neural Network)

It's important to note that the above steps provide a general outline, and the actual implementation details may vary depending on the specific requirements and constraints of the system. Additionally, the CNN architecture and hyperparameters, as well as the alert mechanisms, can be further optimized through experimentation and fine-tuning. Figure 3 shows architecture of CNN (Convolutional Neural Network) Model.

Figure 4 shows Deep Convolutional Neural Network is referred to as DCNN, the artificial neural network type is frequently employed for computer vision tasks. If you want to apply the DCNN algorithm to detect driver drowsiness, you can follow these general steps.

Step 1: Dataset Collection: Gather a dataset of images or videos of drivers exhibiting both drowsy and alert states. It's important to have a diverse and representative dataset to train a robust model.
Step 2: Data Preprocessing: Resize the photos, normalize the pixel values, and do any necessary adjustments prior to processing the dataset. Additionally, label the images or videos to indicate whether the driver is drowsy or alert.
Step 3: Model Architecture: Create a DCNN architecture that is appropriate for the objective of detecting driver intoxication. Convolutional layers, pooling layers, and fully linked layers are frequently stacked in this manner. You may also consider using pre-trained models such as AlexNet, VGG, ResNet50, or Inception, and fine-tune them for your specific task.

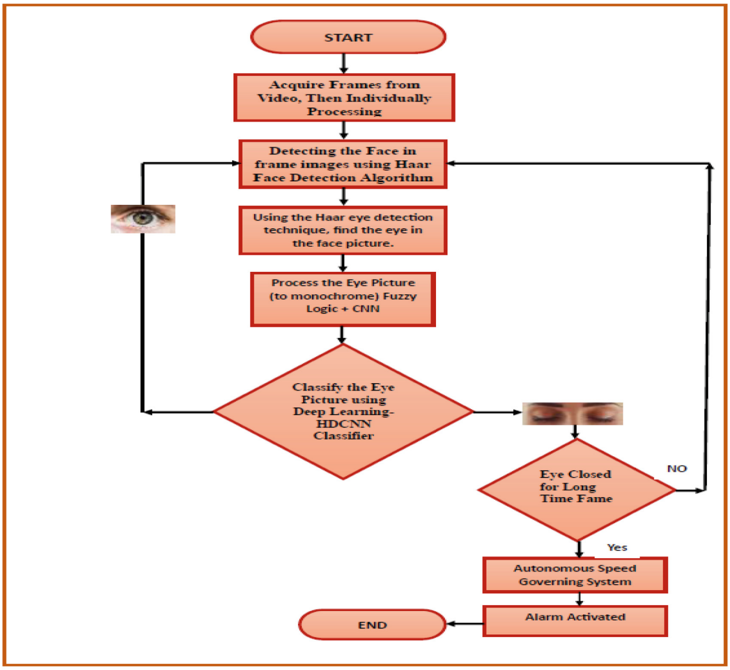


Fig. 4. Function Block Diagram of Deep Convolutional Neural Network (DCNN)

Step 4: Training: Generate training and validation sets from the dataset. The data used for training should be fed into the DCNN model, and the model parameters should be optimized using the right optimization technique (for example, stochastic gradient descent) and loss function (for example, binary cross-entropy). Training the model across several iterations while keeping an eye on results of validation to prevent excessive fitting.
Step 5: Evaluation and Testing: After the model has been trained, assess its effectiveness using a different test set that wasn't utilized during training. Determine criteria including accuracy, precision, recall, and F1 score to evaluate the model's performance at spotting sleepiness.
Step 6: Deployment: Once the model performs well on the test set, you can deploy it for real-time drowsiness detection. This may involve integrating it into an application or system that can continuously analyse video streams or images from a camera in a vehicle.

Understand that other elements like face identification, facial landmark detection, and surveillance algorithms may be required to construct a full DCNN-based sleepiness prediction technology. These components can help isolate and analyse the driver's facial region for more accurate drowsiness detection. It's crucial to remember that while HDC-NNs can be successful in detecting sleepiness, the algorithm's effectiveness is dependent on the dataset's excellence, the model's design, and the training procedure. Continuous monitoring and improvement are necessary for robust and reliable drowsiness detection as shown in Fig. 5 above and Fig. 6 shows max polling [11].

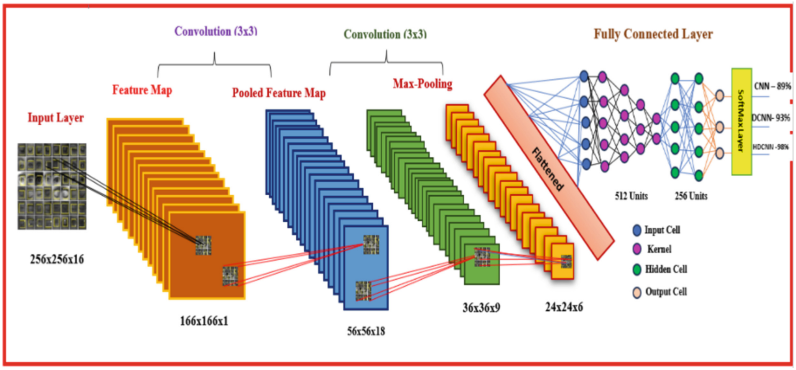


Fig. 5. Architecture of Hybrid Deep Convolutional Neural Network (HDCNN)

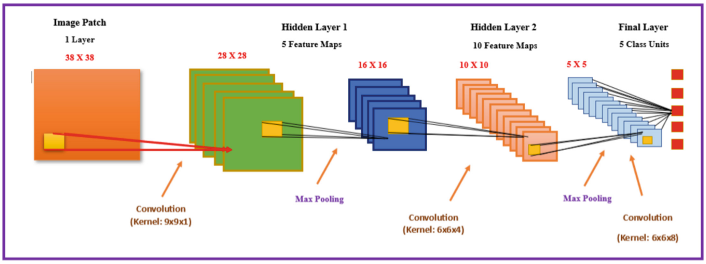


Fig. 6. Max Pooling Architecture

In the Sleep deprivation Recognition System, the initial module. This device analyses the driver's eyes and facial features to determine the degree to which they are sleepy. The process begins with recognition of facial features in order to identify an eye blink. Once the system has identified the driver's eyes, it determines the velocity of the eye blink and outputs the appropriate data.

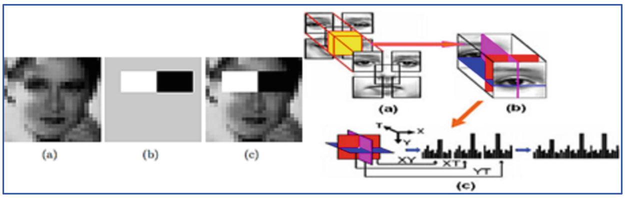


Fig. 7. Local Binary Pattern and Training Haar Cascades

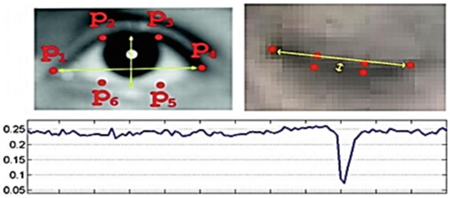
Figure 7 shows the OpenCV is used by the HAAR cascade approach to identify faces of people. The nose is brilliant, but the human eye is black. So, utilizing OpenCV, the Haar Cascade approach is employed to retrieve the facial features. With this technique, the eye's location on the human body's dimension is recognized. The face is continually tracked by the system until the user turns it off. When the data is supplied on a plane, the mean shift method is utilized to locate the center of the picture for image distributions [12]. A Local Binary Patterns (LBP) structuring method may determine the identity of each pixel in an image by the thresholding the actual size of each pixel and seeing the result as a binary value. The LBP texture operator is a well-liked technique in many applications because to its strong discriminative ability and computational simplicity. It may be viewed as a reconciling method for texture analysis's statistical and structural models, which are frequently at variance with one another. The LBP operator's capacity to adjust to recurring changes in grayscale [9].

I need to determine the picture's location and radius in order to attain the dense portion of the image. D-lib is an open-source library that is used for both eye recognition and eye aspect calculation. The eye's feature was proportion. Ratio has a threshold of 0.3; if this threshold remains constant, the system is going to presume that the eyes are open, and if it decreases below this threshold, the computer will assume that the subject is in a sleepy condition [13–15].

3.2 Eye Aspect Ratio (EAR)

Figure 9 shows EAR, is the ratio of the length and the width of the eyes. The length and width of the eyes is calculated by means of averaging over the two horizontal and vertical lines throughout the eyes as illustrated [16, 17].

Our speculation turned into that once a man or woman is drowsy, their eyes are probable to get smaller and they are probable to blink extra. Based totally on this speculation, we anticipated our model to expect the class as drowsy if the EAR for a character over successive frames declined i.e. Their eyes began to be close or they were blinking faster.



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

Fig. 8. Eye Landmarks and EAR

The above Fig. 8 shows the identification system faces its subsequent module. Here, we're use object detection algorithms to identify facial traits. We capture both favourable and unfavourable photographs, then feed the algorithm with the information.

Quick recognizing an object using a boosted cascade of simple functions is a set of rules for object recognition that is used in machine learning and was proposed by Paul viola and Michael Jones in the article "Fast object detection the usage of a boosted cascade of easy functions" in 2002. The data set being provided is now divided into two phases: training and testing for the model. We'll utilize 80% of the data for training and 20% for testing. We are developing a GUI (Graphical user interface) utilizing python Tkinter GUI toolkit to communicate with the system while maintaining the user experience modest. Figure 9 shows prediction of eye in computer vision.

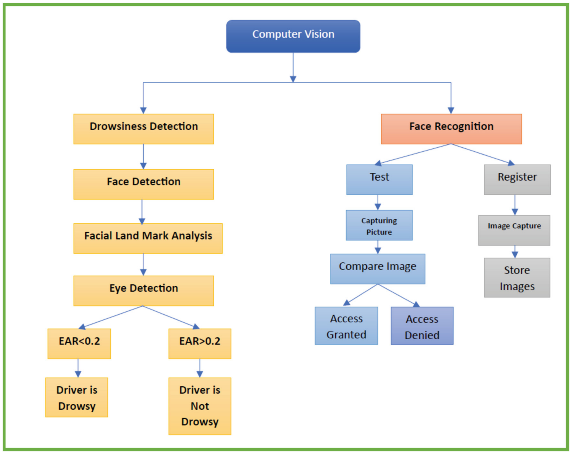


Fig. 9. System Architecture of Prediction of Eye in Computer Vision

4 Feature Extraction

Just briefly said earlier, were set out to develop the necessary skills for our class model based on the facial landmarks that we retrieved from the frames of the films. While testing several hypotheses and functions, we came to the following conclusions about our final models: eye element ratio, mouth thing ratio, learner circularity, and eventually, mouth element ratio above eye thing ratio.

5 Data Set/Data Collection

The Dataset is gathered or produced in accordance with our research model. The more data we provide machine learning, the more dependable it is, and the smarter the algorithm gets.

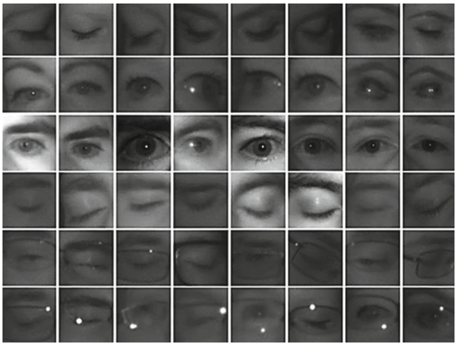


Fig. 10. Dataset Classification of Drowsing Eyes

Any classification algorithm may be used to train the model, and if there is enough data, the system will learn more quickly and with more accuracy. We have special record settings on this paper to instruct the version. The first model is a system for detecting sleepiness, and it uses data photos from Kaggle. A platform that is open-source that offers datasets is called Kaggle. Photographs with the eyes wide and narrow make up the majority of the collection of photographs for this model. The facial recognition technology in the second model recognizes a person's visage for security reasons. The driver's face photos that were photographed are included in this collection. The hybrid algorithm may also be trained using live images, improving the accuracy of the system. In this model, pictures of various drivers are taken and saved in folders for various categories that are designated as the model's dataset. Figure 10 shows the dataset classification of drowsing eyes. The simulation has implementation using python.

6 Results and Discussion

In this system we're adding up two different models, that is drowsiness detection and face recognition for safety and security purposes of the driver. First, we will be popping up with the GUI window which has two buttons, one is drowsiness detection and other is face recognition system.

If we click the button drowsiness detection it will redirect you to the alert system. Here GUI consists of the live feed which is continuously fed to the camera with the bounding boxes detects the eyes and the face of the operator and if the operator closes his eyes for 3– 4 s an alarm system will be activated.

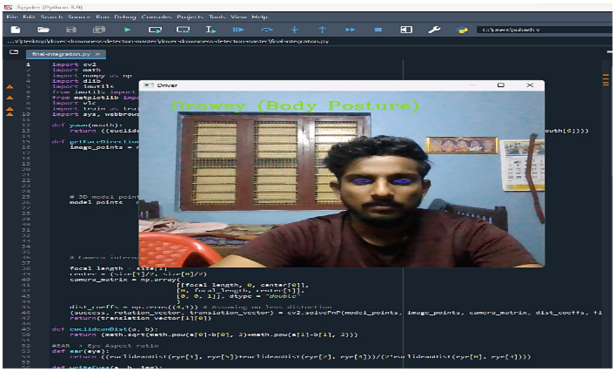


Fig. 11. Output of Drowsiness Prediction

If you will be selecting face recognition you will be redirected to the face recognition model. Once camera captures your image it will verify with the data provided and it recognizes the data and displays the driver's name. Figure 11 shows simulation of the computer vision image capture face recognitions for drowsiness prediction.

Table 1 shows above performance of the proposed simulation with various parameter of different deep learning algorithm in the process of prediction of facial drowsiness of

Table 1. Prediction Accuracy of Facial Features Using Algorithm

Deep Learning Classifiers	Accuracy
CNN	89%
DCNN	92%
HDCNN	98%

motorist with accuracy and efficiency values in the percentage of CNN is 89%, DCNN is 92% and HDCNN is 98%. The overall best accuracy has predicted HDCNN algorithm is consider an efficient methodology.

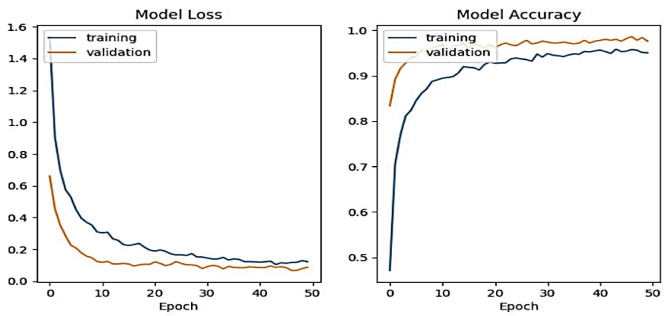


Fig. 12. Training Validation of Model Loss and Accuracy for HDCNN

The deep learning model's model accuracy and model loss are displayed in the graph above Fig. 12. It demonstrates that when epochs are increased, model accuracy grows. In a similar vein, model loss decreases as epoch increases.

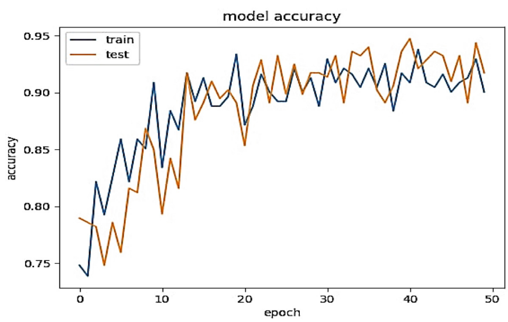


Fig. 13. Training and Testing of Model Accuracy epoch for HDCNN

Figure 13 shows the efficiency and accuracy resultant motorist eye tiredness prediction algorithm creation phase has been implemented using Matplotlib using python.

CNN is used to build an algorithm that classifies types depending on datasets. The framework consists of five layers, all three of which are hidden, and uses the SoftMax activation function and the Adam optimizer to accomplish HDCNN classification. The model is trained over 50 iterations, and after achieving an accuracy rate of 98%, the loss can be quickly reduced. The simulation's precision is insufficient for real-time application because it is used for ocular imaging. Virtual Reality (VR) and Augmented Reality (AR) Technology is integrated in surgical operations using mixed reality in medicine. It improves the surgeon's perception and gives crucial information during the procedure by fusing computer-generated images and data with real-time imaging of the surgical field. Here are a few techniques frequently employed in mixed reality-based medical surgery.

7 Conclusion and Future Work

The motorist's security features have been evaluated. First, we developed a method for alerting the driver if he or she experiences tiredness for more than 3 to 4 s. This allows the driver to choose whether to continue driving or taking a rest. As opposed to the first model, which uses facial recognition to identify the motorist and provide entry, the second model secures our car. The facial recognition system is extremely beneficial for preserving the security of the car avoiding vehicle thefts, and the drowsiness prediction system may be installed in every automobile so that we might avoid vehicle accidents and minimize the mortality of ratio which is caused by tiredness.

Compared to innovative algorithms, HDCNN delivers better and even more exceptional outcomes when it comes to solving the difficulties using Computer Vision Technology Design. By demanding a high efficiency of objective function evaluations, HDCNN is able to arrive to the accuracy prediction functions that are the best overall, demonstrating its computational efficiency. In the chosen mathematical test functions, HDCNN outperforms the comparison algorithms because it converges to the preset tolerance of the world's best in a quicker and more effective manner. The proposed work hybrid deep learning model smart facial feature for driver drowsiness prediction analysis for safety measure implemented using deep learning algorithm such as Convolution Neural Network (CNN), Deep Convolution Neural Network (DCNN) and Hybrid Deep Convolution Neural Network (HDCNN) accuracies are 98%.

Further, using a compatible mouth dimension threshold evaluation, we can identify the driver's jaw area, calculate the mouth aspect ratio (MAR), and then utilize it to recognize frequent yawning and notify the driver. This would broaden the scope of the study and improve our ability to recognize weariness. We may potentially improve the sensors and employ night vision sensors to better discern scenes in low light. We upgraded with AR/VR.

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