Detecting the Driver's Closed Eyes Using Support Vector Machine

SANTOSH SINGH[1], SHERILYN KEVIN[2], OMKAR SAWANT[3], PRAVIN CHOUDHARY[4]

[1] Head of Department, Department of IT, Thakur College of Science and Commerce, Thakur Village, Kandivali (East), Mumbai, Maharashtra, India

[2] Assistant Professor, Department of IT, Thakur College of Science and Commerce, Thakur Village, Kandivali (East), Mumbai, Maharashtra, India

[3, 4] PG Students, Department of IT, Thakur College of Science and Commerce, Thakur Village, Kandivali (East), Mumbai, Maharashtra, India

Abstract—In today's fast-paced world, road safety remains a critical concern as millions of lives are at stake every day due to vehicular accidents. Driver tiredness is one of the primary causes of these issues. Therefore, the detection of closed and open eyes in drivers holds immense significance in enhancing road safety and preventing potential accidents resulting from driver fatigue or distraction. Driver's eyes closed or open detection using deep learning algorithm is a promising approach to prevent accidents caused by driver drowsiness. Deep learning algorithms have shown superior performance in image classification tasks, and they can be used to extract features from eye images that are indicative of whether the eyes are open or closed. This study gives detailed deep learning approaches of different strategies and methodologies used in driver closed and open eye recognition systems. The accurate identification of the driver's eye state is a crucial component of modern driver monitoring systems. Support Vector Machine (SVM) is used for the detection of a car driver's close or open eye. The models are trained on a dataset of closed and open eyes which is taken from the Kaggle. The model achieves a 98.82% accuracy rate for detecting whether the driver's eyes are open or closed.

Indexed Terms— Classification, Closed Eyes, Deep Learning, Open Eyes, Support Vector Machine.

I. INTRODUCTION

Road safety continues to be a top priority in a world that is becoming faster and faster. Every day, millions of vehicles use our roads, increasing the likelihood of accidents. While there are many variables that might lead to a traffic collision, one important one is the driver's condition. Drivers who are inattentive or sleepy in particular put themselves and other road users at serious risk. Closing one's eyes, even for a split second, is one of these drivers' most worrisome habits since it can have disastrous results. In the future, all automobiles should be equipped with an eye blink sensor to avoid these types of accidents. Vehicle accidents are most prevalent when driving is poor. Most of them occur when the driver is drowsy [7]. In the realm of road safety, the capacity to identify drivers who are closing their eyes or showing signs of fatigue has the potential to be revolutionary. With the correct protocols and technology in place, accidents brought on by closed eyes or sleepiness are completely avoidable. The basic drowsiness detection system has three blocks/modules: acquisition system, processing system and warning system [2]. The restrictions of image-based systems are closely tied to the quality of the camera employed and its adaptability to diverse lighting situations. However, Image-based metrics are commonly used to construct versatile, low-cost, real-time systems [11].

The signs and symptoms of feeling the eyes as closed are frequent yawning, daydreaming, difficult in keeping eyes open, Slower reaction times, impaired judgement, etc. This research has broad implications. It may reduce property damage, save lives, reduce injuries, and reduce the load on emergency services and hospital systems. In addition, it has the potential to optimize transportation infrastructure, reduce insurance costs, and improve the general effectiveness and safety of our roads. The proposed solution aims to accurately recognizing and responding to closed eyes of drivers in real-time to prevent potential accidents.

II. LITERATURE REVIEW

In their study, Ghulam Masudh Mohamed et. al utilized a combination of CNN Transfer learning to determine the state of a car driver's eyes (whether they are closed or open). Their findings revealed a detection precision rate of 87.4%, in identifying instances where car drivers had their eyes closed [1]. Kanamarlapudi leelalikhitha et. al employed a combination of Bayesian classifier, FLDA and SVM in their study. Interestingly the combined use of FLDA and SVM yielded results compared to the Bayesian classifier. The researchers achieved a sensitivity of 0.896, for FLDA and 0.956 for SVM with both algorithms demonstrating a specificity score of 1[2]. Anand Singh Rajawat et al. used a fusion deep learning algorithm (FDLA) to assess a driver's level of fatigue in real time. Based on how frequently and how long a motorist's eyes are closed, its system analyses video data to assess how fatigued the driver is [3]. Based on a real-time video stream of the driver, Srikanth Kilaru et al. use a Convolutional Neural Network and Mobile Net CNN Architecture with Single Shot Multi box Detector to determine if the driver's eyes are open or closed. The haar cascade technique is used to determine whether the driver is sleepy. The blink frequency is detected by the algorithm. If the value stays at 0, it identifies that an individual is drowsy and sounds an alarm to wake them up [4]. As an input to the technique known as the Deep Cascaded Convolutional Neural Network, Mustafa Kamel Gatea et al. retrieved the features of the eye.On a practical level, they made the Raspberry Pi microcontroller (model B3) a part of the Driver Drowsiness Detection System (DDDS).They adopted a 60 frames per second (f/s) image with a resolution of 450 x 320 pixels. Their detection system gives an accuracy of 99% [5]. For detecting driver tiredness in low lighting circumstances, Ahmed Ibnouf et al. uses CNN with a haar cascade. On the test dataset, their method had a 97.92% accuracy rating. Even in tough and extremely poor lighting conditions, the system was able to detect the driver's condition [6]. Dr. S. R. Ikhar et. al use an IR sensor to track an eye's blinking, and the sensor's output is made available for comparison with an Arduino. When the value hits the predetermined level, the buzzer will automatically vibrate and the LED will glow, which will cause the automobile to stop [7]. Manoj Rode et. al developed a system that uses the Eye Aspect Ratio (EAR) technique in addition to OpenCV, keras, NumPy, and Pygame to identify sleepy drivers. The model has great accuracy in determining whether or not the driver is sleepy. The model was able to achieve performance accuracy of between 90 and 95 percent. Other sleepy detecting applications, such as those in the military, factories, offices, railroads, etc., found their model to be useful as well [9]. To detect driver fatigue, Kiran Bhagwat et al. observe the eye and mouth state. The driver will be alerted if signs of weariness start to show. If the system notices that the mouth is closed and the eye is open, it won't be able to identify any signs of sleepiness. Hence No alarm is raised [10]. Yaman Albadawi et al. used svm classifiers, Random Forest, and sequential neural networks to identify driver drowsiness in real-time. The outcomes of every algorithm tested were compared. The best accuracy, sensitivity, specificity, macro precision, and macro F1-score, which is 99%, were found to be provided by random forest. Sequential neural network algorithm, which provided 96% accuracy, 97% sensitivity, and 96% specificity, macro precision and macro F1-score, was the second-best algorithm. The SVM model provided 80% accuracy, 70% sensitivity, and 88% specificity [11]. To identify the driver's tiredness, N Raghu et al. used the CNN algorithm. Based on the individual's eye movement, their model has an accuracy rate of 83.2% and can alert the individual to his drowsiness [12].

III. ALGORITHM

Support Vector Machines (SVM) are applied to a variety of applications, such as regression and classification. This study is done using SVM algorithm to accurately classify the images as open or closed of the drivers to prevent accidents. An overview of the SVM methodology that use in research article is provided in Fig.1

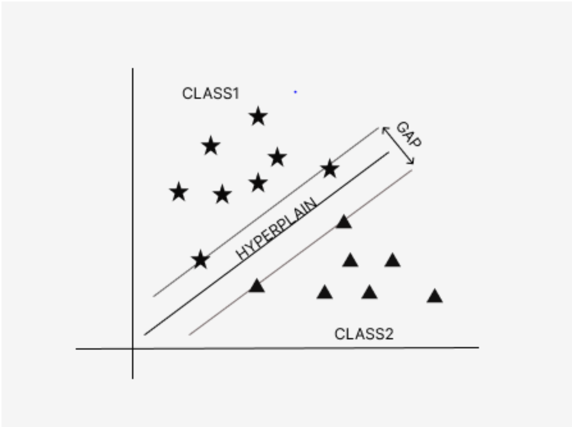

Figure 1: Support Vector Machine

A comprehensive methodology is employed for the development of a driver alertness detection system using Support Vector Machines (SVM). The initial phase involves data collection, where a substantial dataset of driving scenarios, comprising images or videos of drivers, is amassed. Labels are added to the dataset, indicating the driver's level of tiredness and whether their eyes are open. The subsequent data preprocessing phase involves transforming the raw data into a format suitable for SVM input and extracting pertinent features from the data, including head posture, eye-related features, and facial landmarks. To assess the model's effectiveness, the dataset is divided into training, validation, and test sets. The SVM model is chosen based on the specific problem, with considerations for multi-class classification to detect varying degrees of drowsiness or binary classification to identify open or closed eyes. Various kernel functions, such as radial basis function (RBF), polynomial, and linear, are tested to determine the best fit for the data. Subsequently, the SVM model is trained on the training dataset, with hyper parameters fine-tuned for optimal performance. Model evaluation is conducted on the validation set using metrics like accuracy, precision, recall, and F1-score, with robustness ensured through cross-validation. Finally, the model's performance is assessed on the test dataset to verify its ability to generalize to new data, marking a critical step in the development of a reliable driver alertness detection system. The working of the SVM model is shown in figure 2.

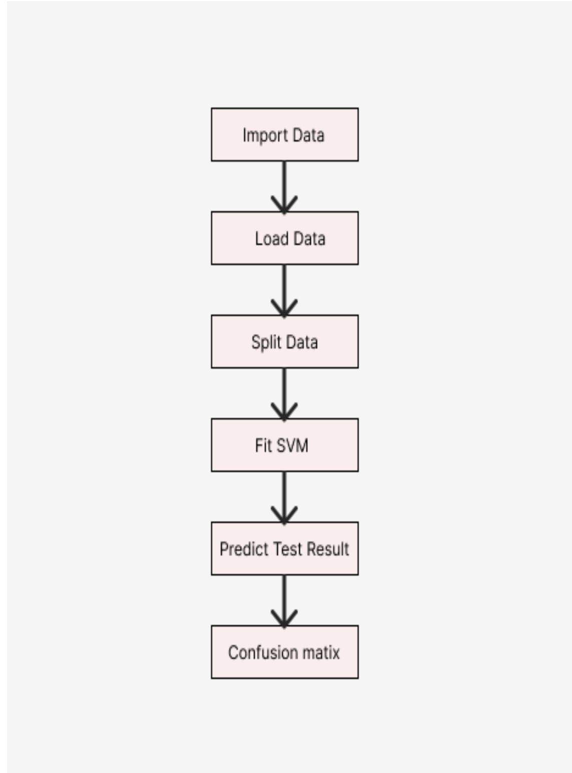

Figure 2: Working of the model

IV. DATASET

The dataset for the study contains images of human eye in open and closed states collected from Kaggle. It includes 3400 images, each 200*200 pixels, comprising 1760 images of closed eyes and 1640 images of open eyes. The dataset consists of RGB images of both open and closed eyes which are further converted into gray images for training the model. The images were randomly split for training and testing the model. 80% of the images from the dataset are used for training the model and the rest 20% images are used for testing the accuracy of the model.2710 images are used for training and 680 images are used for testing the model. The dataset used is shown in figure 3.

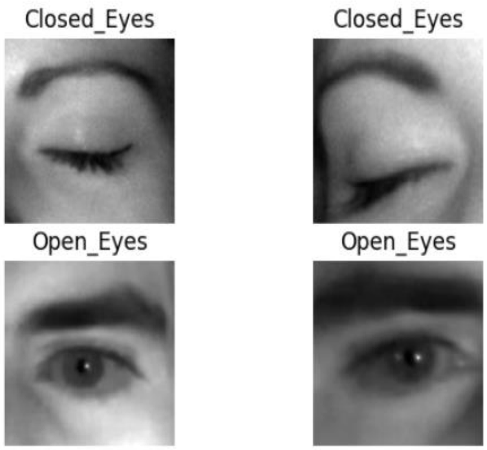

Figure 3: Open and Closed Eye dataset

V. RESULT

The Support Vector Machine algorithm used in this paper helps to detect the state of the eyes of the drivers by taking its image in real time. A total of 3400 images of both open and closed eyes are taken to train the model, out of which 80% images are used for training the model and the rest 20% images are used for testing the model accuracy. The training dataset includes 2720 images of eyes whereas the testing dataset has 680 images. The RGB images of both open and closed eyes are converted into gray images. All the images are reshaped into two dimensions so that the Support Vector Machine model can be used to classify the images as open or closed eyes. The size of the image dataset taken to build the model is 200*200.After that, Feature Scaling of all images is done to standardize the range of features of the datasets. The linear Support Vector Classifier (SVC) is applied on the dataset which will classify the images into open eyes and closed eyes of the drivers. The model easily classify state of eyes of drivers which will prevent road accidents that happen due to drivers closeness of the eyes and also save the life of the individual that are seated on the vehicle. The model gives an accuracy of 98.82% for detecting the driver's eyes whether they are open or closed. The model's precision, recall and f1-score for classifying the open or closed eye of drivers is 99%, 98.09%and 98.19% respectively as shown in Fig.4. The Confusion matrix shown in Fig.5 helps in understanding the classification of open or closed eyes dataset.

	precision	recall	f1-score	support
Closed_Eyes	0.98	1.00	0.99	361
Open_Eyes	1.00	0.98	0.99	319
accuracy			0.99	680
macro avg	0.99	0.99	0.99	680
weighted avg	0.99	0.99	0.99	680

Figure 4: Precision, Recall and F1-Score

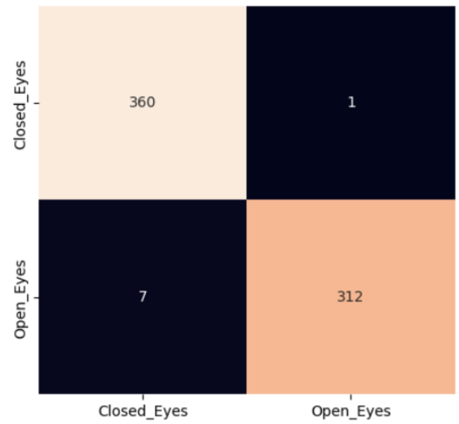

Figure 5: Confusion Matrix

CONCLUSION

The study helps in classifying the open or closed eyes of a driver while driving the car. This will help in preventing car accidents due to drowsiness of drivers by detecting it at early stages of eyes closing and thus alarming the driver. The images are taken with the standard size of 200*200.After applying the feature scaling on the images the RGB images are converted into gray images for training the model. The Support Vector Classifier gives the accuracy of 98.82% for classifying the state of the eyes as whether open or closed. The model achieves the precision, recall and F1-Score of 99%, 98.09%and 98.19% respectively as shown in Fig 4. The model looks promising for classifying the state of eyes which can help to prevent car accidents and thus saving the life of the drivers and the individual that are seated on the vehicle.

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