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Driver's Drowsiness Detection at Night Based on Computer Vision

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ABSTRACT: Drivers drowsiness and fatigue decreases the vehicle management skills of a driver. The operator driving vehicle in night has become a significant downside today. Driver in a drowsiness state is the one among the important reason of increasing amount of road accidents and death. Hence the drowsiness detection of driver is considering as most active research field. Many ways are created recently to detect the drowsiness of driver. Existing methods can be classified in three categories based on physiological measures, performance measures of vehicles and ocular measures. Few ways are intrusive and distract the driver from comfortable driving. Some of the methods need expensive sensors for information handling. Therefore, a low cost, real time system to detect the driver's drowsiness developed in this paper. In this proposed system, real time video of driver records using a digital camera. Using some image processing techniques, face of the driver detected in each frame of video. Facial landmarks points on the driver's face is localized using one shape predictor .And calculating eye aspect ratio, mouth opening ratio, yawning frequency subsequently. Drowsiness is detected based on the values of these parameters. . Adaptive thresholding method is used to set the thresholds. Machine learning algorithms were also implemented in an offline manner. Proposed system tested on the Face Dataset and also tested during real-time .The experimental result shows that the system is accurate and robust.

KEYWORDS: Drowsiness detection, Machine learning, Adaptive thresholding, Eye aspect ratio.

I. INTRODUCTION

Driving in a fatigue state is one of the main reason for the increasing amount of accidents.Recent studies about drowsiness indicates that four out of ten accidents are caused by fatigue state of driver which is nearly 25% of accidents, and this percent is growing each 12 months as per report ofroad saftety 2018. This highlights the fact that total accident rate are increasing nowadays due to the driver's drowsiness. Primary reasons for this accidents are driver fatigue state, drink-and-drive and carelessness. This affected many lives and families very badly.

The strategies of fatigue using detection grouped into 3 categories: (1) Physiological measures (2) vehicle performance measures(3) Ocular measures; Among these measures, detection using drivers' physiological measures areless expensive, intrusive, and real-time. Physiological measures are primarily based on physiological signals along with brain waves, coronary rate, pulse charge, and respiratory. Those measures are believed to be the most correct for determining drowsiness. But, this method is intrusive since it require electrodes be connected to the driver's head and body. Numerous studies have also shown the possibility of drowsiness detection by way of ocular measures. These methods generally monitoring drivers eye state using computer vision techniques. The percentage of eyelid closure (PERCLOS) is used by many researchers to indicate drowsiness. Different measures encompass the length of eye closure and blink rate. Drowsiness also can be calculated by means of car behavior consisting of the lateral function, steering movements. Despite the fact that these strategies aren't intrusive, they are subject to numerous barriers associated with the type of vehicles, driving experience, and situation of the road.

Among those numerous opportunities, most promising and non-intrusive method is monitoring the eye state of the driver. And this gives most accurate and robust results to prevent accident rate. Many image based drowsiness detection systems have developed by researchers. But many issues still remain due the inaccurate eye area detection and constantly changing lights situations. The overall performance of contemporary algorithms decreases significantly when tested throughout different situations which are documented in some of reviews.

II. RELATED WORK

Fatigue-driving state detection is a tremendous research area. Existing fatigue-driving state detection methods can be classified based on physiological measures, performance of vehicle, ocular measures. S. Funck, N. Mohler and W. Oertel[1] proposed a method to discover the EEG (Electroencephalogram) features and using that monitoring drowsiness. Drowsiness detection using EEG feartures has simple calculation process..And also give most accurate results. But it is difficult to measure EEG data without the driver feeling uncomfortable is not possible here. V.W.S.

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Tang, Y. Zheng, and J. Cao,[2] described a method to monitor driver fatigue state using bio signals which is measured using bio sensors. It is non-intrusive but Signals changes for person in different illness and unhealthy conditions. Ocular measure based drowsiness detection is most promising and non-intrusive method. In this method, monitoring the eye state of the driver and using computer vision algorithms detecting level of drowsiness.

As considered one of important problems, face recognition algorithm is taken into consideration as a key point and main focus area by researcher. Jatuporn Chinrungrueng, Udomporn Sunantachaikul, and Satien Triamlumlerd,[3]designed a framework for narcolepsy and microsleep detection. Face and eye detection, eye feature extraction,extract single eye and perform drowsiness detection are the main three components of this method.It is implemented on Raspberry Pi. It uses a webcam to monitor driver's eye state and calculating blink duration rate to detect drowsiness. Provide comfortable feeling for driver since it is more portable. Viola-Jones method which is used here for the face detection also may detect other objects .So it may affect accuracy of system. Wei-chen Chiu[4] and Kao-Chin Fan,[5] presents a non intrusive drowsiness recognition method using eye-tracking and image processing. Percentage of eyelid closure, most closure period, blink frequency, average opening stage of the eyes, opening speed of the eyes, and closing velocity of the eyes are the six measures of drowsiness detection . Many methods uses computer vision techniques for drowsiness level detection. It mainly uses viola johnes algorithm[6],[7],[8] and Haar cascade classifier algorithm[11],[12,[13] for face detection.

Research gaps identified is that most of the previous works uses limited parameters to estimate drowsiness. Some of these methods are intrusive which distract the driver badly. Some require very expensive sensors for data handling purposes. Most of the methods focuses only on drowsiness detection during the day time. It do not even consider about the drowsiness detection during low lightening condition or night time.The systems which uses Haar-like features and cascade classifier is computationally more expensive .That means it takes large amount of resources like time ,processing power and memory to run the program. Moreover high false-positive detection take places due to the use this Haar-cascade Adaboost classifier.Existing works do not detect the faces even when they are not perfectly frontal to good extent.

III. PROPOSED METHOD

Proposed system enables to overcome, some of the addressed drawbacks of existing system. System provides non-intrusive method, night based detection, less false positive detection with high accuracy. This system consists four parts: video Capturing, preprocessing, facial landmarks and cues extraction, drowsiness detection .In the first section, real time video of driver records using a digital camera. Using some image processing techniques, face of the driver detected in each frame of video. Facial landmarks points on the driver's face is localized using one shape predictor .And calculating eye aspect ratio, mouth opening ratio, yawning frequency subsequently. Drowsiness is detected based on the values of these parameters.Facial landmarks at the detected face are pointed and ultimately the eye aspect ratio, mouth opening ratio, yawning frequency are computed. Depending on their values, drowsiness is detected based on developed adaptive thresholding.Some machine learning algorithms were carried out in an offline way. The outline of our proposed drowsiness detection system is shown in Fig 1.

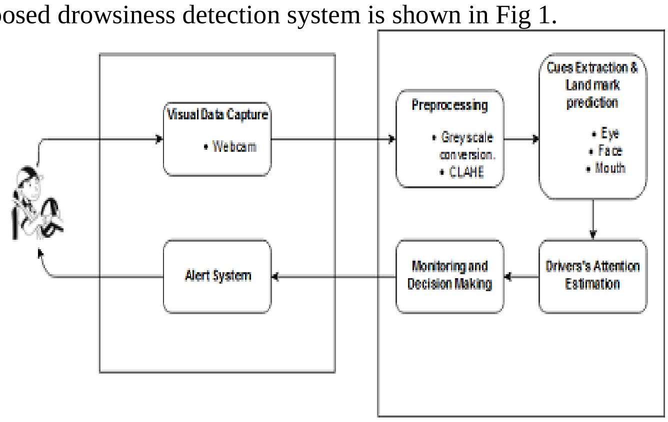

Fig 1. Framework of proposed method

A. *Video Capturing*

Driver's attention focus is captured via a simple webcam in terms of frontal face. Frame by frame extraction is carried out from that video.

B. Preprocessing.

Frames or photos captured during night usually have low contrast and low brightness. So it is very difficult to detect facial expressions of the driver in low lightning condition. Consequently, the frames should be pre-processed to improve their quality of high brightness. Adoption of image preprocessing is important to enhance contrast of frame. Extract frames from a video sequence and performs gray scale conversion. Gray scale images simply reducing complexity from a 3D to a 1D value. On this grayscale image CLAHE method is applied. . Contrast Limited Adaptive Histogram Equalization (CLAHE) method is used to improve the contrast of images. In Adaptive Histogram Equalization, image is divided into 8x8 small blocks .For each block, seperately equalizing its histogram .However there is trouble for this AHE. If noise is there in images, it'll additionally be increase that noise. To keep away from this, contrast restricting is applied. Any histogram bin is above a desired contrast limit; those histograms are clipped and distributed to other bins uniformly before Histogram Equalization. This enhancement enable us to detect the drowsiness in low lightening condition as well as at night.

C. Facial landmarks and cues extraction.

To localize key points of the face region, a facial landmark predictor inside the dlib library is used. Dlib library has trained two shape predictor models on the iBug 300-W dataset that respectively localizes 68 and 5 landmark points within a face image. 68 landmark point predictor used by proposed system. This detector is based on histogram of oriented gradients (HOG) and linear classifier. HOG descriptors contain the various features of image like intensity gradients or edge directions. Those descriptors obtained with the aid of dividing the image into small connected regions which is known as cells. For every cell, computing a histogram of gradient separately. The aggregate of those histograms represents the descriptor. Linear SVM classifier is used to classify these descriptors. This method can be divided into a 6-step process including Sampling positive images contain region of interest, Sampling negative image does not contain region of interest, training a Linear SVM using these images, performing a hard-negative mining ,re-training linear SVM using the hard-negative samples ,evaluating classifier on test dataset, utilizing non-maximum suppression to ignore redundant, overlapping bounding boxes. Fig. 2 indicates the 68 landmark points on face.

Fig 2.The facial landmark points.

Eye is the most important area of the face wherein the symptoms of drowsiness or distraction seem. Calculation of Eye aspect Ratio (EAR) is main cue related to eyes. .Six (x, y)-coordinates of each eye regions are extracted. Figure 3 shows the points of eyes detected by facial land mark predictor. .

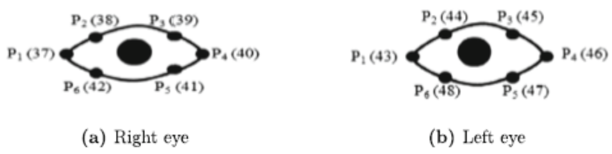

Fig.3The landmark points of left and right eyes

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After detecting eyes regions, they are individually passed to find EAR.EAR is proportional to width and height ratio of eye. Calculating EAR_i using the following equations (1.1) and (1.2),

$$EAR_i = \frac{(|P_2 - P_6| + |P_3 - P_5|)}{|P_1 - P_4|} \quad (1.1)$$

$$EAR = \frac{EAR_{left} + EAR_{right}}{2} \quad (1.2)$$

Six facial landmark points51, 52, 53, 57, 58, 59 are used to decide the mouth opening ratio. For that, average Euclidian distance between two lips calculated. Figure 4 shows mouth points detected using facial land mark predictor .

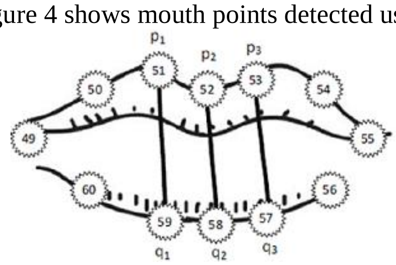

Fig.4 The landmark points of lips.

Similarly, mouth opening ratio is also calculated using the following equation (1.3),

$$MOR = \frac{|P_{51} - P_{59}| + |P_{52} - P_{58}| + |P_{53} - P_{57}|}{|P_{49} - P_{55}|} \quad (1.3)$$

If EAR is less than a fixed predefined threshold (0.3) then eye is in closed state. If MOR is greater than a fixed predefined threshold (0.6) then increment Y_N count. Whenever, a yawning is detected, corresponding yawn frequency is calculated using the following equation (1.5),

$$YF = \frac{Y_N}{T} \quad (1.5)$$

D. Drowsiness detection.

Count the no of continuous frames in which eye is closed.If the no of continuous frames in which eye is closed and YF is greater than fixed predefined threshold(48 frames and 6 yawns respectively) the driver is in drowsiness state and give an alert .

IV. EXPERIMENTAL RESULTS

Video data captured from the real scene. The system using OpenCV Python, with a webcam on PC. To evaluate the performance of proposed system, two Face dataset contain hundred images and two thousand images tested respectively.True rate and false rate of system found where true rate is the no. of frames which detect the drowsiness correctly and false rate is the no. of frames which detect the drowsiness wrongly. Calculate accuracy using the following equation (1.6)

$$Accuracy = \frac{D_F}{T_F} * 100\% \quad (1.6)$$

Evaluation results shown in Table I,

	Total Frames	False rate	True Rate	Accuracy
Opened	49	3	46	
Closed	58	2	56	
Total	107	5	102	95.21%

TABLE I.Evaluation results

So we got 95.21%accuracy for our system. At the same tim we also performed real time test also and got good results.

V. CONCLUSION

A low cost, real time driver's drowsiness detection system is developed with acceptable accuracy. This presents a night based real-time fatigue driving detection system. It makes up the deficiencies of fatigue driving detection during night. In this proposed system, real time video of driver records using a digital camera.Using some image processing techniques, face of the driver detected in each frame of video. Facial landmarks points on the driver's face is localized using one shape predictor .And calculating eye aspect ratio, mouth opening ratio, yawning frequency subsequently. The enhancement using CLAHE enable us to detect the drowsiness in low lightening condition as well as at night. This proposed framework is more accurate and robust. Decreased false rate, less computational cost, easy to use and portable compared to other existing methods. Also possible to implement this proposed system as mobile app in future.

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