A Review Paper on Visual Analysis of Eye State using Image Processing for Driver Fatigue Detection

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Abstract - *Driver's fatigue is one of the major causes of traffic accidents, particularly for drivers of large vehicles (such as buses and heavy trucks) due to prolonged driving periods and boredom in working conditions. In this , propose a vision-based fatigue detection system for driver monitoring, which is easy and flexible for deployment in buses and large vehicles. The system consists of modules image acquisition , image resize, Haar Cascadec Classifier, dlib facial landmark detector, 68 landmark, eye region, eye region of interest, eye aspect ratio (EAR). A robust measure of eye aspect ratio (EAR) on the continuous level of eye openness is defined, and the driver states are classified on it. In experiments, systematic evaluations and analysis of proposed algorithms, as well as comparison with ground truth on EAR measurements, are performed. The experimental results show the advantages of the system on accuracy and robustness for the challenging situations when a camera of an oblique viewing angle to the driver's face is used for driving state monitoring.*

Key Words: Haar cascade classifier, dlib face detector , eye aspect ratio (EAR), openCV, fatigue detection.

1. INTRODUCTION

Fatigue, drowsiness and sleepiness are often used synonymously in driving state description. Involving multiple human factors, it is multidimensional in nature that researchers have found difficult to define over past decades. Despite the ambiguity surrounding fatigue, it is a critical factor for driving safety. Studies have shown that fatigue is one of the leading contributing factors in traffic accidents worldwide. It is particularly critical for occupational drivers, such as drivers of buses and heavy trucks, due to the fact that they may have to work over a prolonged duration of the driving task, during the peak drowsiness periods (i.e., 2:00 A.M. to 6:00 A.M. and 2:00 P.M. to 4:00 P.M.), and under monotonous or boredom working conditions. Drowsy driving is becoming one of the most important cause of road accidents. According to many surveys around 30% of road accidents is due to the driver fatigue and the percentage is increasing every year.

Drowsiness can be due to the adverse driving conditions, heavy traffic, workloads, late night long drive etc. Lack of sleep, absence of rest, taking medicines are also causes for drowsiness. When driver drives for more than the normal period fatigue is caused and the driver may feel tiredness which will cause driver to sleepy condition and loss of consciousness. This results road accidents and death of driver or serious injuries and also claims thousands of lives every year. Drowsiness is a phenomenon which is the transition period from the awake state to the sleepy state and causes decrease in alerts and conscious levels of driver. It is difficult to measure the drowsiness level directly but there are many indirect methods to detect the driver fatigue. Driver drowsiness detection can be measured using physiological measures, vehicle-based measures, behavioural measures.

Physiological measures include the sure of brain wave, heart rate, pulse rate, and using the physiological signals like ECG (Electrocardiogram), EOG (Electrooculogram), EEG (Electroencephalogram) etc. Though this method measures the drowsiness accurately but it requires a physical connection with the driver such as placing several electrodes on head, chest and face which is not a convenient method and also discomfort for the driver in driving condition. Vehicle measures includes deviations from lane position, pressure on acceleration pedals, movement of the steering wheels, etc. These are constantly monitored and any change in these which crosses a threshold indicates a probability that the driver is drowsy. Behavioural measures monitors the behaviour of the driver, which includes the yawning, eye closure, eye blinking, head pose, etc. These are monitored through a camera and these drowsiness symptoms are detected. Behavioural state detection system helps to detect the drowsy driving condition early and avoid accidents. In this paper real time drowsy detection is used which is one of the best possible method to detect driver fatigue early. Real time driver detection system using image processing captures driver eyes state non- intrusively using a camera and raspberry pi is used for this.

2. LITREATURE REVIEW

Drowsiness detection can be mainly classified into three aspects such as:-

1. Vehicle based measures.

2. Physiological measures.

3. Behavioral measures.

Vehicle based measures is one of the method which is used to measure driver drowsiness. This is done by placing sensors on different vehicle components, which include steering wheel and the acceleration pedal. By analysing the signals from the sensors the level of drowsiness can be determined. Commonly using vehicle based measures for detecting the level of driver drowsiness are the steering wheel movement and the standard deviation in lateral position. A steering angle sensor which is mounded on the steering of vehicle is used to measure the steering wheel movement. The number of micro-corrections on the steering wheel reduces compared to normal driving when the driver is drowsy. Based on small SWMs of between 0.5° and 5°, it is possible to determine whether the driver is drowsy and thus provide an alert if needed. Another vehicle based measure used to measure the drowsiness of driver is SDLP. Here the position of lane is tracked using an external camera. The main limitation of this method is that it dependent on external factors such as road markings, lighting and climatic conditions. Therefore, these driving performance measures are not specific to the driver's drowsiness.

Physiological measures are the objective measures of the physical changes that occur in our body because of fatigue. These physiological measures can be utilized to measure the fatigue level and can provide alert for the drivers. These physiological changes can be simply measured by respective instruments such as (ECG), electrooculography (EOG), electroencephalography (EEG) and electromyogram (EMG). Electrocardiogram is one of the physiological measures which can be utilized to measure the fatigue of driver. Here ECG electrodes are used to collect ECG signals from the body which provides the critical parameters related to Heart Rate (HR), Heart Rate Variability (HRV) and respiration rate or breathing frequency. Each of these are related to drowsiness [4]. Electroencephalography (EEG) is one of the most reliable physiological measures for drowsiness detection. EEG electrodes are placed at correct place and get data from brain. After preprocessing the data, which is acquired from the EEG electrodes can be divided into different frequency bands. The preprocessing involves artifact removal and filtering. Commonly used frequency bands include the delta (0.5–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), beta (13–30 Hz), and gamma (greater than 30 Hz) bands [5]. Power spectrum of EEG brain waves is used as an indicator to detect the drowsiness of the driver.

Here, EEG power of the alpha, theta bands increases and the power of the beta bands decreases. The EEG based drowsiness detection is not easily implementable. Because the driver has to wear an EEG cap while driving a vehicle. These devices are being distractive and this is the main disadvantage of this method. Behavioral changes take place during drowsing like yawning, amount of eye closure, eye blinking etc. In normal condition the rate of yawning will be less. When the driver is in fatigue the rate of yawning will be far higher than the normal. So by observing this yawning rate we can detect whether the driver is in fatigue or not. In eye closure method the count of eye blink of the driver is measured for obtaining the condition of the driver. The average duration of a normal eye blink is 0.1s to 0.4s. That means, in one second the eye will blink at least 2 or 3 times. This is observed for a few seconds. When the driver is in fatigue the count will be far less compared to the normal condition. Thus we can detect whether the driver is in fatigue or not.

The main techniques used for eye blink detection is Eye Aspect Ratio (EAR) method. The Ear method is done by calculating a quantity named EAR. In normal condition the value of EAR is almost constant. If the driver is in fatigue the EAR value will be approximately near to zero. Thus we can detect whether the driver is in fatigue or not. Thus we can detect whether the driver is in fatigue or not.

3. PROPOSED SYSTEM

To improve the accuracy as well as to reduce the execution time of fatigue, drowsiness detection system. Following are the steps takes place for fatigue detection –

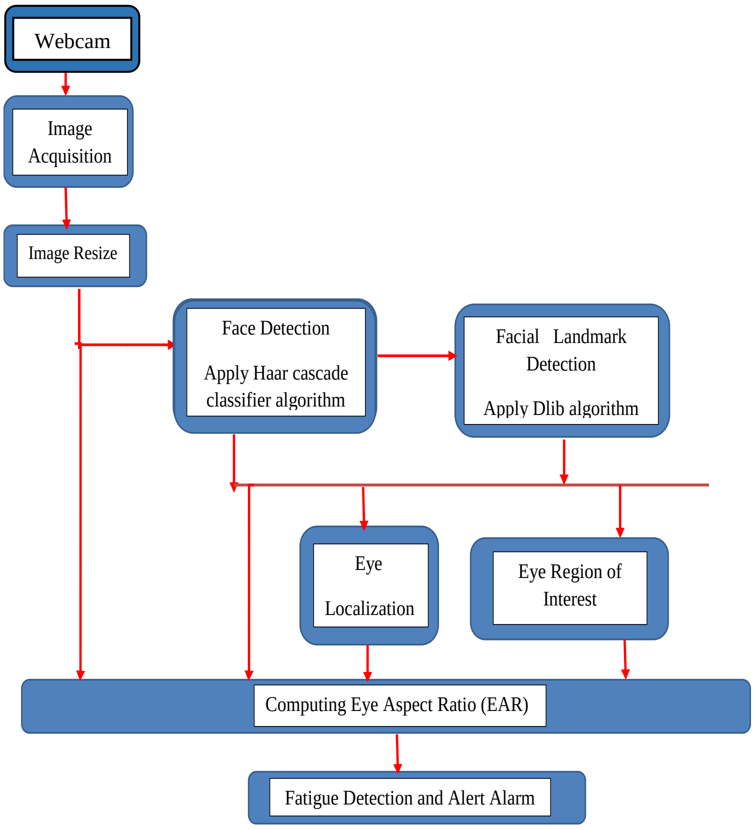

Fig -1: Framework Of proposed system

3.1. Webcam –

Webcam is used to take an input image.

3.2. Image Resize –

It is used to resize input image into standard image format.

3.4. Haar Cascade Classifier –

A Haar cascade classifier is a algorithm which is used to detect the object for which it has been trained for, from the source. The haar cascade is by superimposing the positive image over a set of negative images. The training is generally done on a server and on various stages.

3.5. Dlib face detector –

It is used to find and locate the face in the image. It initializes dlibs pre-trained face detector based on a modification to the standard histogram of oriented gradients (HOG).

3.6. Facial Landmark 68 R.O.I. –

The pretrained facial landmark detector inside the dlib library is used to estimate the location of 68 (x , y)-coordinates face that map to facial structures of the face. These annotations are part of 68 point shape predictor 68.dat which the dlib facial landmark predictor was trained on.The facial landmark detection is used to localize each of the important regions of face.

3.7. Eye Region of Interest –

Extracting exact eye locations takes place. Image cropping is employed to restrict the area of work nearer to the eyes since the activity of the eyes we concentrate on. The total area of picture is reduced by cropping the image to two fifth to three fifth of the total area of the picture on the upper region with the result that the separation of eyes is performed.

3.8. Eye localization and fatigue detection –

It is used to compute the ratio of distances between the vertical eye landmarks and the distances between the horizontal eye landmarks. The return value of the eye aspect ratio will be approximately constant when the eye is open. The value will then rapidly decrease towards zero during a blink.

3.9. Eye Aspect Ratio(EAR)-

In this technique, we are using different landmarks to detect the opening and closing of eye. This landmark detector that capture most of the characteristic points on a human face image. It is used to compute the ratio of distances between the vertical eye landmarks and the distances between the horizontal eye landmarks. The return value of the eye aspect ratio will be approximately constant when the eye is open. The value will then rapidly decrease towards zero during a blink.

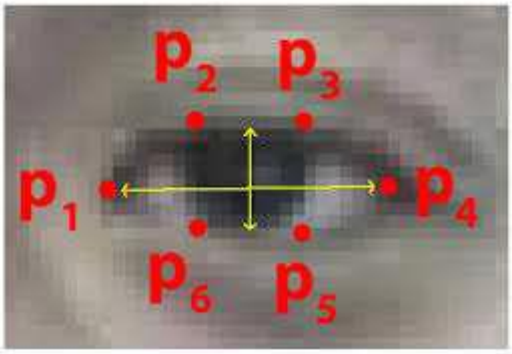

Fig .2 Landmarks obtained in EAR

The eye blink is a fast closing and reopening of a human eye. Each individual person has a little bit different pattern of blinks. The pattern differs in the speed of closing and opening of the eye, a degree of squeezing the eye and in a blink duration. The eye blink lasts approximately 100-400ms. From the landmarks detected in the image, we derive the eye aspect ratio (EAR) that is used as an estimate of the eye opening state. For every video frame, the eye landmarks are detected. The eye aspect ratio between height and width of the eye is computed. From the fig. 2 P1,P2,…,P6 are the landmarks on the eye.

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

where P1,…..,P6 are the 2D landmark locations on the eye. The EAR is mostly constant when an eye is open and is getting close to zero while closing an eye. Since eye blinking is performed by both eyes synchronously, the EAR of both eyes are taken and it is averaged. After getting the EAR value, if the value is less than the limit for 2 or 3 seconds the driver is said to be drowsy. After detecting fatigue , drowsiness with EAR threshold value the alert alarm runs and shows the message as “Drowsiness Detected”.

3. CONCLUSION

Driver Drowsiness Detection was built to help a driver stay awake while driving in order to reduce car accidents caused by drowsiness. This paper was concerned with drowsy drivers and their potential to cause car accidents. . The driver fatigue detection system calculates drowsiness level from the driver using a combination of webcam, haar cascade classifier, facial landmark detection is used to calculate whether or not a driver is drowsy. At the same time, it retrieves images from the camera, which is fast enough to detect a driver’s features in real time. The system uses open source software called as open cv image processing libraries, the captures images are processed in this. Webcam and open cv makes the overall system to a low cost drowsiness detection system.

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