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Driver Drowsiness Detection Using Machine Learning Algorithm

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***Abstract*— It is just a short time until self-driving vehicles become omnipresent; be that as it may, human driving management will stay a need for quite a long time. Driver Drowsiness is one of the significant reasons of roadways accidents these days. Hence fatigue and drowsiness detection play a major role in preventing the road accidents. Every year, because of this there is an increase in the number of deaths and injuries globally. Recently, in this decade, many images processing-based approaches were created and used to detect driver's drowsiness status. To minimize the number of accidents, a method is proposed in this paper. The algorithm focuses on the eye closure and yawning ratios. The driver is alarmed, if he/she is feeling sleepy.**

***Keywords*— driver drowsiness, eye aspect ratio (ear), yawn detection, harr-cascade classifier**

I. INTRODUCTION

One of the major reasons behind the road accident is driver's drowsiness. After continuously driving for long time, driver easily get tired which leads to driver fatigue and drowsiness. After lot of Researches, it is found that major reason behind the accidents is driver's drowsiness. Different countries have different stats for accidents. From all the stats the main cause for accidents is driver fatigue. Developing a device which detects the driver fatigue is challenge. A report by "Ministry of Road Transport & Highways" there were 15231 accident in India in 2019.Thousands of people lost their lives because of sleepy drivers. Many vehicles are driven at night which includes heavy trucks[1]. The drivers of these types of vehicles who drive for such continuous long time become more susceptible to these kinds of situations.

But drivers have developed some strategies to keep them alert. The most common strategy is to use tea stops or coffee stops to keep them alert whenever they feel drowsy. The other strategies include GPS systems that recognize when a driver starts getting out of their lane because of inattentiveness[2]. Some methods also include using of Electrocardiogram machines, in this, the heart rate of the driver is measured to detect the drowsiness status of the driver.

One of the major goals of the Intelligent Transportation Systems (ITS) is to increase public safety and reduce the number of accidents. One of the major factors of accidents, mostly in rural roads, is driver drowsiness and monotony[3]. The deciding capability and consciousness to manage the vehicle reduces due to fatigue. Some researches show that, the drivers get drowsy within one hour of driving, mostly during early afternoon hours, after having lunch and during late night time, driver's fatigue level is highest and state of mind is far from alternative times. Fig 1. Additionally, hypnotic medicines and drinking alcohol causes loss of driver perceptions[4].

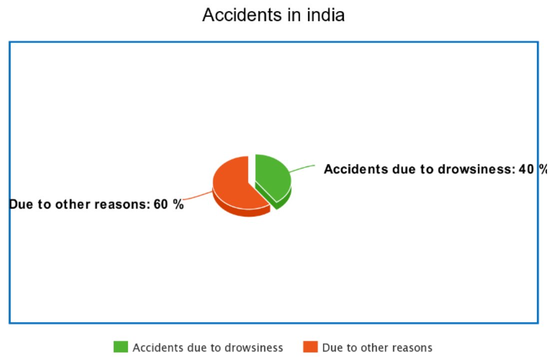


Fig.1. Ratio of accidents due driver drowsiness.

In other countries, completely different type of statistics were rumoured concerning accidents that happened due to driver drowsiness and distraction. The most common reason of concerning 2 hundredth of the accidents and other fatal crashes is lack of concentration and driver's temporary state[5]. When there are single vehicle accidents (crashes in which only single vehicle gets damaged) or accidents which involve significant vehicles, up to five hundredth of crashes are associated with driver hypo vigilance. Studies show that the number of accidents are greatly reduced by 20% by using drowsiness detection systems[6].

To detect driver drowsiness, a series of pictures of the face are captured, and the eye movements and blink patterns are monitored. The face pattern analysis may be a fashionable analysis area with applications such as face recognition, human identification security systems and virtual tools[7]. This paper work focuses on locating the eyes of the person, which is done by capturing the complete image of the face, and then detecting the location of the eyes, by the use of an efficient image process algorithm. After the location of the eyes are detected, the system checks whether the eyes are closed or not.

II. VARIOUS DRIVER DROWSINESS SYSTEMS

Various types of methods have been used to minimize the accidents caused due to driver drowsiness systems. Some of the methods are: A) Image Processing based techniques, B) EEG and EOG based techniques, C) Physiological and Visual Signal based techniques, D) Simulator based detection techniques. Some of these techniques are a bit expensive and most of the drivers couldn't afford these systems.

Image Processing Based Techniques

In image processing-based techniques, many different types of methods are used to detect the driver's drowsiness. These methods are 1) PERCLOS, 2) Eye Aspect Ratio (EAR), 3) CNN.

1) PERCLOS

Its stands for percentage of eye closure. In this method the system keeps track of the amount of time within a minute when the eyes are 80% closed. This percentage is less when the driver is alert and more if the driver is feeling sleepy. It focuses on slow eye closure rather than blinks.

2) Eye Aspect Ratio (EAR)

In [10]this method is used, in this system firstly marks the 6(x, y) coordinates on the eyes in such a way that whole eye gets covered Eye aspect ratio is basically a measure of ratio of the Euclidean distances between the (x, y) coordinates of the vertical eye and the distances between the (x, y) coordinates of the horizontal eye.

3) CNN

CNN stands for Convolutional Neural Networks. Generally, CNN is combined with some algorithm to optimise the algorithm. In [11] they proposed a new algorithm by combining Multiple CNN with KCF algorithm to improve performance of the system in low light conditions. It's also used to measure the state of the eye, whether it's open or not.

EEG and EOG Based Techniques

EEG stands for Electroencephalography and EOG stands for Electrooculogram. By using these signals, we can measure the drowsiness level of a driver. In EEG, brain activity is monitored by the system through a sensor placed on the scalp. In EOG, eye movement is being tracked by monitoring the signals we are receiving from the muscles which are acting on the eye. This method is not cost efficient as it requires costly equipment, which are not affordable to everyone. And it's also not comfortable for drivers to have this many sensors on their body.

A.Physiological and Visual Signals Based Techniques

In this method data is compared from physiological sensors such as palm electrothermal activity(pEDA), breathing, heartrate and visual sensors such as eye tracking, nasal electrothermal activity(nEDA), pupil diameter, emotional activity. Facial action such as head movement and number of eye blinks are also monitored. The lane in which the vehicle is driven is also monitored. Different deep learning algorithms are used to find the reason behind driver drowsiness. The results of this technique depend upon the type of distraction the driver faced and the emotional activity of the driver[12].

B. Simulator Based Detection Techniques

In this, simulator-based approach is followed. In this, a simulator is used to find drowsiness of a driver. A driver is given a car simulator and he/she have to drive on that simulator for some hours[13]. Then through camera, video images of driver's face are taken and then drowsiness level is calculated and through this they try to justify the reasons of driver drowsiness. This method is for research purpose to find out the reasons for distractions and drowsiness of a driver. But environment have an impact on driver's drowsiness and distractions. So, the reasons found with this method are not fully justified.

Limitations of Present System

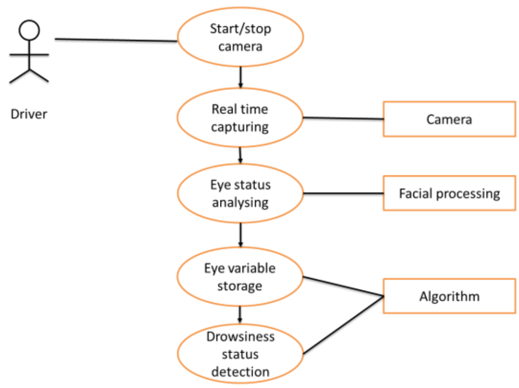
- Current drowsiness detection systems uses complex methods and expensive equipment, such as Electrocardiography, which uses rhythm of heart to detect drowsiness.
- Some of the current drowsiness detection uses Support vector machine (SVM) to identify the components in the captured video stream. In this system, only components that are needed are taken and that is inaccurate.
- There is some chance that it will show wrong regions. To find the location of the eyes, boundary lines are created first and a classification algorithm is used. The algorithm of support vector machine will be inaccurate.

Purpose of the Project

- This Project focuses on immediately detecting and alerting the driver when he/she is feeling drowsy and this prevents or minimizes the road accidents.
- This system involves the use of webcam which allows us to detect real-time driver drowsiness.

III. METHODOLOGY

The proposed block diagram as shown in the figure 3 clearly explains the working steps in the driver drowsiness system. The operation is explained using an use case diagram in which the input is captured through camera which is fixed in front of the driver which is an real time video. Fig 2. Then the next step is eye status analysing which is nothing but processing the facial expression of the driver and confirming the action. [8] This proposed algorithm then analysis the eye variable storage based on which its updates the status of the driver and its alerts the driver if he falls asleep. The above process is detaily explained step by step.



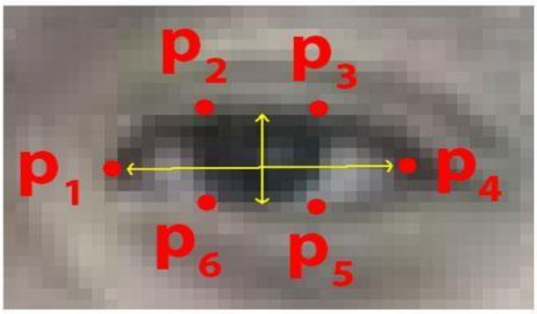


Fig. 2. Operational diagram for driver drowsiness system

To scale back the amount of road accidents caused due to driver's fatigue, it's of great importance to use automotive systems that would effectively monitor the signs of a fatigue and prevent any mishaps. A system that supports analysis of face over time could be one of the best approaches for detection of fatigue symptoms. There are many issues related to this style such as monitoring the uneven face of the driver or choosing the most appropriate algorithm, etc. Such issues can be eliminated by using advanced technology such as video-based monitoring systems. It is believed that these systems would increase rode safety incredibly. The diagram of the hypothetic system, and principle of its operation is given in Figure 2.

Fig. 3. Block diagram for driver drowsiness system

a. STEP1:

- In first step, according to our algorithm, camera will be turned on to capture video images of the driver.
- Then the driver's face area will be detected, this can be done by using the default Harr Cascade frontal face detector present in the OpenCV library, but detecting only the face is not enough as we need more information about the face like mouth, eyes, nose, etc.
- To detect these things, we have used the pre-trained landmark detector present inside the dlib library.
- It is used to estimate the location of 68 points which map to facial structures. These 68 coordinates are shown in the fig. 4, below.

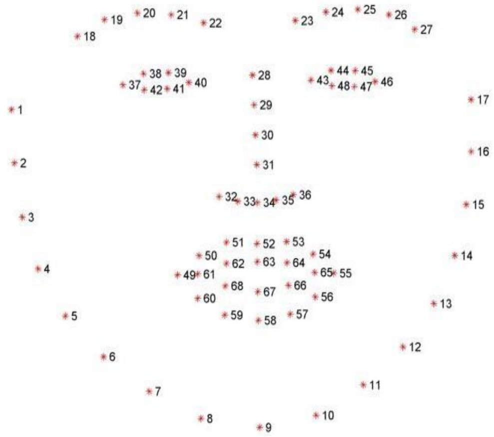


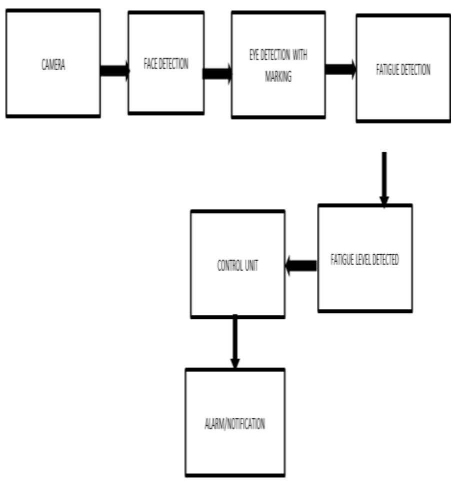
Fig.4. 68 points that map to facial structure

b. STEP2:

- Now as we have detected the face and marked the 68 points, but we only need the coordinates of the eye and the mouth.
- Each eye is visualized by 6 (x, y) points. Now we [9] have found the eye region, which will help in determining the eye activity.

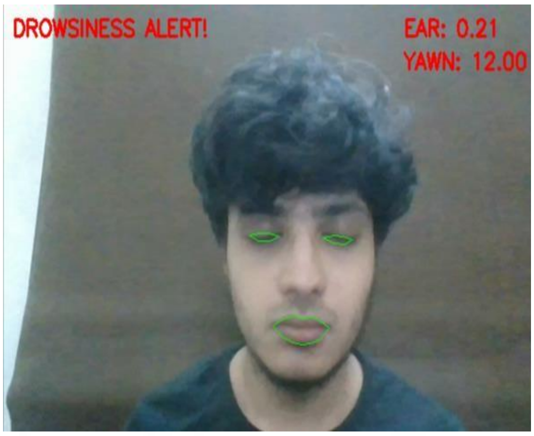
Fig.5. Eye marked with 6(x, y) coordinates.

Fig. 5 shows the points marked when the eyes are open and Fig. 6 shows the points marked when the eyes are closed. Similarly, we need to represent the (x, y) coordinates of the mouth.



c. STEP3:

- Now to calculate the EAR (Eye Aspect Ratio), We need to calculate the distances between the coordinates of the points that we have marked.
- The formula to calculate Eye Aspect Ratio is, the ratio of Euclidean distance between the (x, y) coordinates of the vertical eye points and 2 times the distance between the (x, y) coordinates of the horizontal eye points.



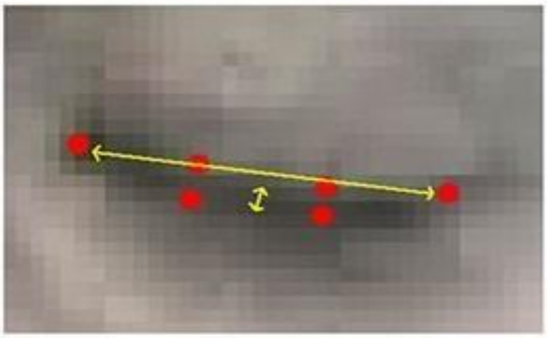


Fig.6 Markings when the eye is closed

- Similarly, we will calculate the Yawn threshold by finding the distance of coordinates of upper lip and lower lip from the axis (0, 0).

- Then we will find the mean of distance of upper lip and similarly lower lip. Then we will apply the yawn threshold formula i.e., subtracting upper lip min from lower lip mean. And this is how we will get the value of the yawn threshold.

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

The yarn threshold is calculated based on the below formula:

Yawn Threshold = Mean of upper lip distances from the axis – Mean of lower lip distances from the axis

d. Step4:

- Now we will calculate the eye aspect ratio and the yawn threshold for each frame.
- Then we will continuously monitor the eye aspect ratio to see if the value of the ratio is less than 0.3 for continuously 25 frames, thus implying that the eyes of the person has been closed.
- Now we will assume that the user is sleeping and to grab their attention an alarm we would sound an alarm.
- Similarly, we will be calculating the yawn threshold value for each frame, and if its value exceeds 30 then the driver is warned through the alarm.

As per Fig.7, we can see that when the eyes are open, the EAR value is 0.33 i.e., greater than 0.3, and the yawn threshold value is 11.00 i.e., lower than 30, so this frame captured will be classified as a negative image by the Harr-Cascade classifier.

Fig.7 EAR and Yawn threshold value when eyes are open

Fig. 8 Driver is alerted when he/she is sleeping.

As per Fig. 8, we can see that when the driver closes his/her eyes, the EAR value drops from 0.33 to 0.21 i.e., lower than 30, and hence this frame will be counted as positive image by the classifier. So, when the EAR value is below 0.3 for continuous 25 frames, the system will assume that the drive is sleepy and as shown in Fig. 8, a drowsiness alert will be displayed and the driver would be alerted through the alarm.

Fig. 9 Driver is alerted when he/she is yawning

As per the fig. 9, its seen that when the driver starts yawning, the yarn threshold value increases and when its value exceeds 30, the frame will be counted as positive image by the classifier and the driver will be alerted.

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