International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 06 | June 2020 www.irjet.net p-ISSN: 2395-0072

DRIVER DROWSINESS DETECTION AND ALERT SYSTEM BASED ON BEHAVIOURAL MEASURES

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Abstract - *In this busy and hectic world, driver drowsiness is becoming a major factor for the road accidents, mainly for the drivers of large vehicles due to the long drive and boredom working conditions, so the driver may feel fatigue while driving. So it is salient to design a driver drowsiness detection system based on the drowsiness which determines the driver's inattentiveness and give a warning when the driver is in drowsy state to reduce those accidents. In this paper, the fatigue is detected based on behavioral changes which includes eye blinking and yawning detection which comes under the image processing. The proposed system is implemented in Raspberry Pi and programmed using python. It utilizes Open CV library and dlib library. The eye region and mouth region is extracted from the face using the facial landmarks. Eye closure and mouth openness is identified for drowsiness detection. Real time tracking is done by a web cam, which is kept in front of the driver. An alert is used to give warning to the driver if drowsiness is detected.*

Key Words: **Driver Drowsiness, Image processing, Face detection, Eye Detection, Mouth Detection, Alert Drowsiness detection techniques**

1. INTRODUCTION

Drowsiness usually occurs due to insufficient sleep or due to boredom caused by driving vehicles for longer period of time. Driver is unable to concentrate on driving in drowsy state. Car accidents associated with driver fatigue are more likely to be serious, which leads to heavy injuries and even deaths [1]. To alleviate this problem, it is important to track drowsiness detection and alert the driver at the same time to prevent such fatal accidents and loss of life. The measures that have been employed for drowsiness detection can be divided into three basic categories: physiological, behavioral and vehicle based measures[2].

This paper explains about the behavioral based approach of drowsiness detection. It is an image processing technique which is done by OpenCv library.

In this paper we propose a method to increase drowsiness detection efficiency, merging the eye closure and yawn detection which results in more intelligent decision. The proposed method is based on the facial features of the driver captured by a camera installed in front of the driver[3].

The paper is organized as follows. Various drowsiness detection techniques is explained in Section 2 Proposed method is explained in section 3. Experimental results are explained in section 4. Future scope is explained in Section 5 and the paper is concluded in Section 6.

2. VARIOUS DROWSINESS DETECTION TECHNIQUES

The most important approaches for drowsiness detection can be divided into three categories: (1) Steering motion based approach, (2) Driver face monitoring-based approach, (3)Bioelectric-signal based approach [4] Steering motion based approach is a vehicle-based approach in which variations of steering wheel is monitored . Collecting vehicle signals is convenient but it is slow to detect driver drowsiness. In bioelectric signal based approach, physiological signals from body such as electroencephalogram(EEG) for brain activity, electrooculogram(EOG) for eye movement, and electrocardiogram(ECG) for heart rate are evaluated.[5] This approach has very good speed and accuracy but they are usually intrusive[4]. Driver face monitoring approach include visual analysis of eye blinking, eye closure time, yawning etc through a camera directed towards driver's face . This approach has moderate accuracy compared to other approaches but can detect driver drowsiness earlier. These approaches are compared based on fatigue detection, distraction detection, accuracy, simplicity and detection speed in Table 1[4].

The vision based systems on behaviour analysis are attractive to automobile industries as they are non-intrusive to the driver and the measures are effective and reliable to predict driver drowsiness[5].

Table -1

	Approaches based on Bioelectric Signals	Approaches based on Steering Motion	Approaches based on Driver Face Monitoring
Fatigue Detection	Yes	Yes	Yes

Accuracy	Very Good	Good	Moderate
Simplicity	Difficult	Relatively Easy	Easy
Detection Speed	Very Fast	Slow	Fast

3. PROPOSED METHOD

The proposed method is based on eye blinking and yawning of the driver which are behavioral measures. The objective of the work is to detect closed eye or opened mouth, that is yawning and to alert the driver. This is done by placing a camera in front of the driver and capturing real time video continuously using openCv and dlib. The application is implemented in python and processing is done in Raspberry pi 3.

The work is mainly divided into three steps:

1) Face , eye and mouth detection
2) Eye closure detection
3) Open Mouth detection

3.1 Face, eye and mouth detection:

In this step face is detected using dlib library. Shape estimator that is implemented in dlib library based on papers [6][7] is used to find facial landmarks. The estimator gives 68 landmark points that can be applied to localize regions of face such as eyes, eyebrows, nose, ears and mouth. Figure 2 gives the full set of facial landmarks that can be detected via dlib. Therefore by applying facial landmark detection eyes and mouth can be localized and detected.

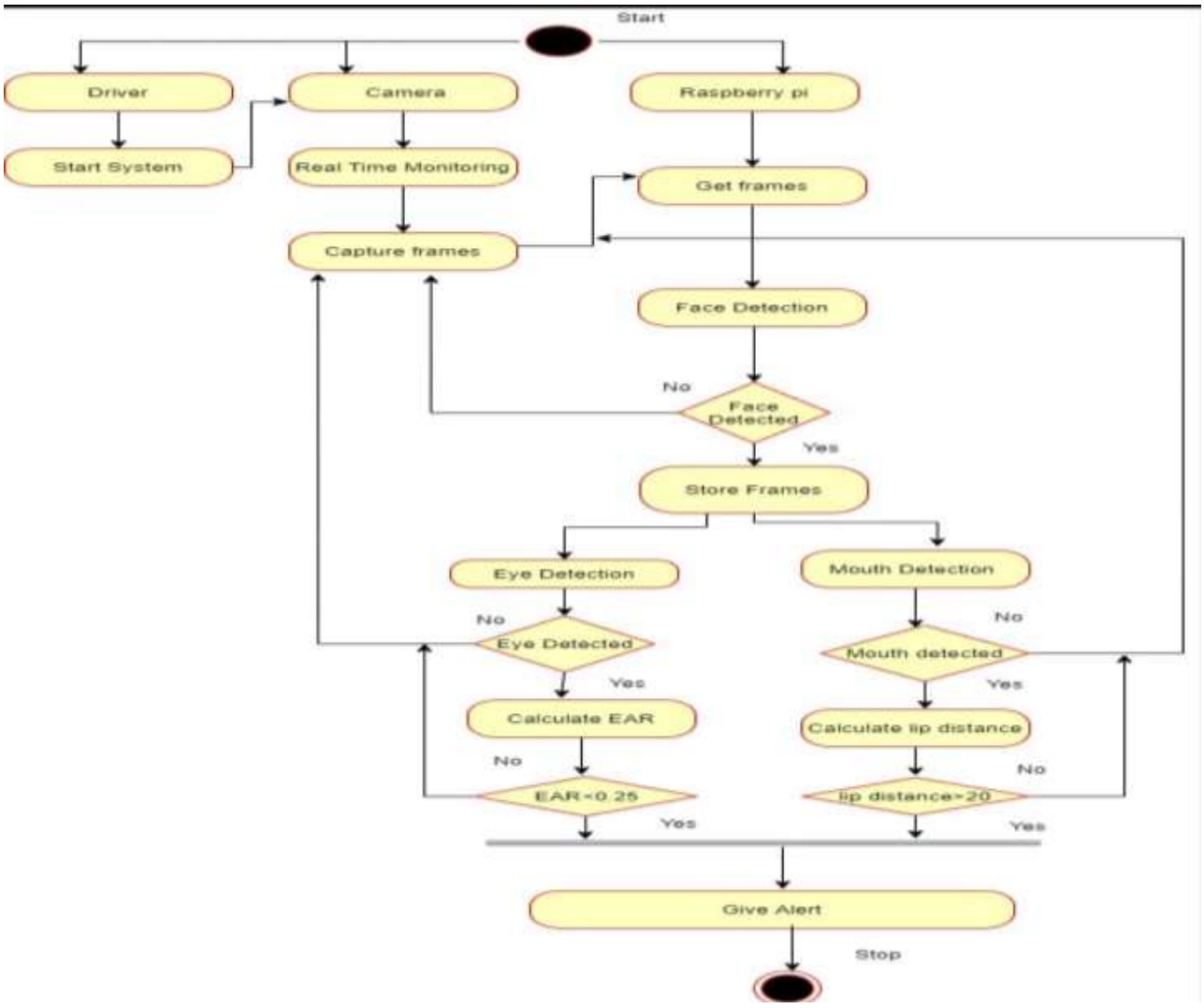

Fig -2 : The proposed method

3.2 Eye closure detection:

Each eye is represented by 6 coordinates as in figure 3. An equation called Eye Aspect Ratio (EAR)[8]which reflects the relation between width and height of coordinators can be derived.

$$EAR=\frac{||p2-p6||+||p3-p5||}{2||p1-p4||}$$

The distance between vertical eye landmarks are computed in numerator and those of horizontal eye landmarks are computed in denominator.

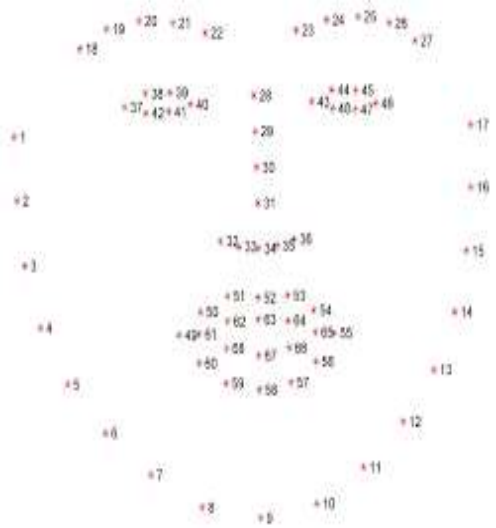

Fig 1: Landmarks as depicted by dlib facial predictor

This ratio of eye landmark distances can be used to determine whether a person is blinking.

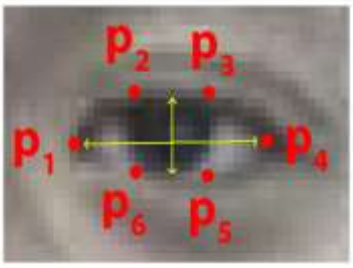

Fig - 2: The 6 facial landmarks associated with eye.

Consider the figure 4 [8]. When the eye is fully open eye aspect ratio would be large and relatively constant over the time and when the person closes the eye, eye aspect ratio decreases approaching zero. The graph shows that eye aspect ratio is constant and then decreases to zero representing a blink. If the state of the eye remain closed for a certain period of time(2 seconds) an alert alarm will be given.

3.3 Open mouth detection:

Yawning is characterized by wide opening of mouth. Facial landmarks can be used to detect an open. mouth. Mouth is represented by 20 coordinates as shown in figure 5[9].

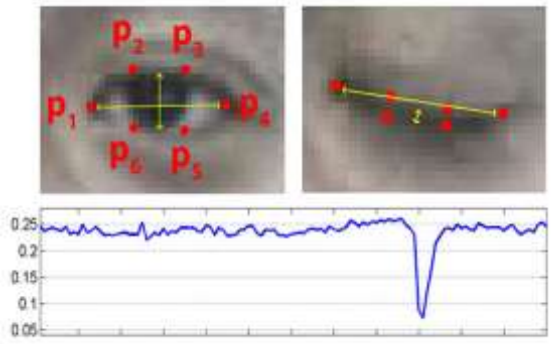

Fig- 3: Top left: Eye landmarks when eye is open. Top right: Eye landmarks when eye is closed. Bottom: Plotting the EAR over time. The dip indicates blink

Using this coordinates, lip distance is calculated which is the difference between top lip and bottom lip and this lip distance is used to determine whether the driver's mouth is open.

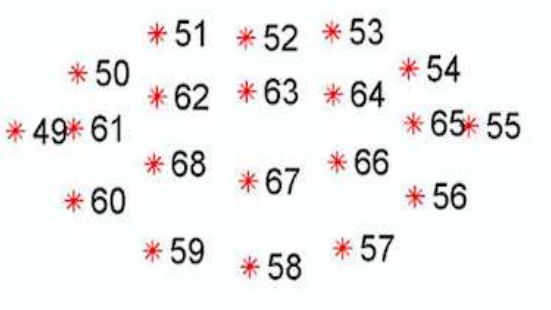

Fig - 4: 20 landmarks associated with mouth

If the lip distance is greater than a threshold amount the subject is determined to be yawning and an alert is given accordingly. The number of yawns will be counted, each time the subject is determined as yawning and this count will be also mentioned in the alert. For mentioning yawn count, text to speech is incorporated in the program.

4. EXPERIMENTAL RESULT

The proposed method was initially implemented using a laptop with attached webcam of 15 fps. Later the proposed technique is implemented in Raspberry pi 3 b to which the same webcam is connected. The system was tested with

different subjects of varying age group, some wearing spectacles and some without spectacles. Figure 6 shows the output when the subject is yawning.

Fig-6: Left: System output while the subject is yawning Right: Detected facial landmarks

The system was tested with different subjects of varying age group, some wearing spectacles and some without spectacles. Figure 6 shows the output when the subject is yawning.

Fig-5: System output when eye is opened

Fig 6 : System output when eyes are closed

The visual output contains yawn count and the audio output is an alert message which include the yawn count. Facial landmarks are detected and displayed as shown in figure 6. In figure 7 the eyes of subject are open and corresponding EAR value and status is displayed. Figure 8 shows the output when the eyes are closed. The EAR value and status is displayed and an alert alarm was also generated as audio output. The proposed system produces same output when implemented in Raspberry pi but with a small amount of time lag which is acceptable to an extend.

5. FUTURE SCOPE

There are many future scopes for driver drowsiness detection system. Here, the system cannot not detect drowsiness accurately when the driver puts hand on his mouth while yawning .So the mouth cannot be captured at that moment and when the driver puts off his hand, the yawning gesture gets over. Hence, some technique must be included to eliminate such situation. Also the future system can include an external alert part , giving a text message to a known person about driver's drowsiness. The lag produced by Raspberry pi can be avoided if the system is implemented in micro processors having high processing capabilities especially developed for machine learning algorithms.

By adding more features such as finding fatigue by the amount of thrust the driver applies on the steering wheel, while rubbing the eye or making automatic vehicle control will be more effective. Parameters must be added in such a way that it should not decrease the overall performance of the system such as speed and accuracy.

6. CONCLUSION

This paper discusses a real time detection of driver's drowsiness by considering eye closure and yawning. The advantage of this system is detecting drowsiness in early stages and activate an alarm before the accident occur. From the design of proposed work it is expected that usage of raspberry pi and OpenCV will be more suitable for this application as it satisfies the necessary requirement like cost, power and size. This system detects face, eye and mouth easily and these are captured with the help of a webcam. While monitoring, the system is able to decide whether the eyes and mouth were opened or closed. When the eyes have been closed for too long or when yawning is detected a warning alert will be issued. The result may varies due to uneven lighting conditions and this could be extended to eliminate the difficulties posed by bad lighting conditions.

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