DRIVER DROWSINESS DETECTION USING FACIAL FEATURE RECOGNITION

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Abstract : **In this paper we propose a system which can detect fatigue of a driver and can give an audio/visual alert when the driver's fatigue is detected. The drivers who travel long distances without taking any breaks during the journey have a high risk of becoming drowsy, and in most cases they fail to recognize this early enough. According to studies it was noted that one-fourth of the motor accidents are related to sleepy drivers that were in need for rest. Our system will monitor the driver's eyes and mouth continuously using a camera and will detect the symptoms of fatigue before the person falls asleep. So in this proposed system, symptoms of drowsiness will be detected and the driver will be alerted by a warning in the form of an audio-visual alarm. The alarm would continue to beep until the driver awakes, and once the driver is awake the alarm will stop. This process continues.**

Index Terms **- Drowsiness detection, Haar cascade, Machine Learning**

I. INTRODUCTION

Drowsiness in a driver can be in the form of yawning, eyes closing, head nodding and brain activity. So we can either measure the psychological signals like heart rate and brain waves to monitor drowsiness, or we can consider the physical changes like head leaning and the state of eyes if they are open or closed. The former technique is more accurate than the latter but is not realistic as electrodes will be attached to the driver's body and it may be possible that it may lead to distraction or may cause irritation to the driver. The latter method is good for such conditions as there is no physical contact, there is just a camera to monitor and detect the changes. Thus by continuously monitoring the eyes and mouth of the driver and detecting sleepiness and sounding alarm we are saving the life of the driver.

II. PROPOSED ALGORITHM

To solve the problem statement, we have created an application in python that detects the drowsiness of the driver. Our objective is to sound a visual alert & audio alarm when driver is drowsy. We use an external approach i.e. without any motion sensors or any other equipment attached to driver, instead monitoring the driver through camera. The only requirement for the application to run is a camera attached to the dashboard and a processor that can run the application. Our project will detect if the driver is drowsy or not by live recording him with a camera and analyzing his facial features and then sound the alarm when driver shows signs of drowsiness. To list the algorithms: we have used Haar cascade to identify facial landmarks, apply analysis on it using Dlib & then after certain calculations with Scipy we sound the audio alert using Pygame.

III. METHODS

A. Face Detection: For the facial recognition, we have used Haar feature-based cascade classifiers. Haar cascade is an effective object detection method proposed by Paul Viola and Michael Jones in their paper, "Rapid Object Detection using a Boosted Cascade of Simple Features" in 2001. It is a machine learning based approach. It uses a cascade function, which is trained from a lot of positive and negative images. It then detects objects in other images. Here we will work this in face detection.

Initially, the algorithm requires a lot of images, both positive (images of faces) and negative images (images without faces) to train the classifier. It can then extract the feature of face from the image. We feed each frame from our video stream to algorithm to detect the face.

B. Eye Detection: For the eye detection, we have used facial landmark prediction for eye detection. In this system, facial landmarks are required to localize and represent certain regions of the face.

Detecting facial landmarks is a two-step process:

- Localize the face in the image.
- Detect the key facial structures on the face Region of Interest(ROI)

Localize the face in the image: Haar feature-based cascade classifiers localizes the face image which was discussed in the first step of our algorithm i.e. face detection.

Detect the key facial structures on the face ROI: The facial landmark detector included in the dlib library is an implementation of the One Millisecond Face Alignment with an Ensemble of Regression Trees paper by Kazemi and Sullivan (2014). This method starts by using:

1) A training set of labelled facial landmarks on an image. These images are manually labelled, specifying specific (x, y)
2) Priors of the probability on distance between pairs of input pixels. The pre-trained facial landmark detector inside the dlib library is used to estimate the location of 68 (x, y)-coordinates that map to facial structures on the face. The indexes of the 68 coordinates can be visualized on the image below:

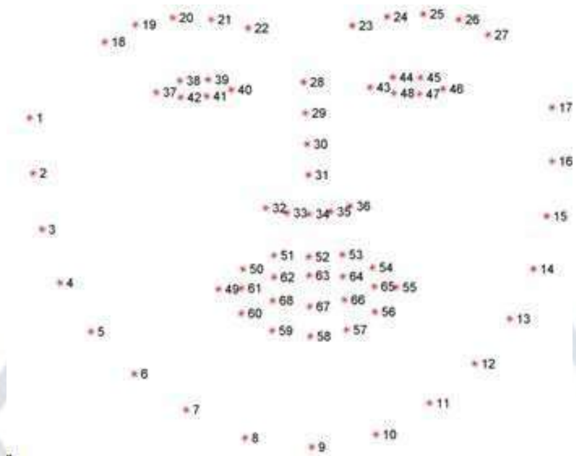

Fig. 1. Dlib facial landmark with 68 points

We can detect and access both the eye region by the following facial landmark index show below

1) The right eye using [36, 42].
2) The left eye with [42, 48].

These annotations are part of the 68 point iBUG 300-W dataset on which the dlib facial landmark predictor was trained on.

C. Recognition of Eye's State: To calculate the state of the eye i.e. open or closed. We need to calculate the eye aspect ratio on image obtained.

D. Eye Aspect Ratio Calculation: For every video frame, the eye landmarks are detected. The eye aspect ratio (EAR) between the height and width of the eye is calculated.

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

Fig. 2. Formula to calculate Eye Aspect Ratio

where p1, p2, p3, p4, p5, p6 are the 2D landmark locations as can be seen in Fig. 2. The EAR for an open eye is mostly constant and it gets close to zero while closing an eye. Since eye closing is performed by both eyes synchronously, the average value of EAR of both eyes is taken into consideration.

E. Eye State Determination: The final decision for the eye state depends on E.A.R. calculated in the previous step. The eye state is classified as "closed", if the distance is zero or is close to zero otherwise the eye state is identified as "open".

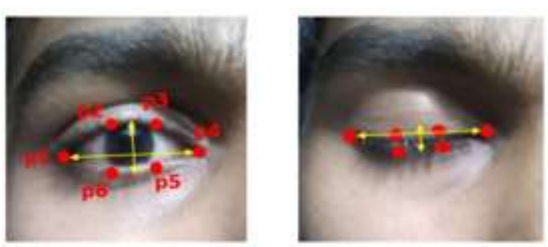

Fig. 3. EAR of open and close eye

F. Yawn Detection: Another facial feature we've used for detection of drowsiness is the yawning of the driver. In our system, a sound alert is played once the driver yawns 3 times. This is because excessive yawning is a sign of oncoming sleep and by sounding the alarm the driver can take a break or drive alertly. The detection of yawn is done by creating a contour around the darker open mouth with the lips as the border.

We create a threshold value of mouth openness which will qualify as a yawn. The threshold is put on the perimeter of the contour of open mouth. Thus, if perimeter is small, it means driver is just talking and if perimeter is very big, the driver is yawning.

Fig. 4. Determination of contour of open mouth

IV. TESTING

A. Unit Testing: During the development phase the testing of each phase has been done which can be seen in the images below:

i. Eyes only ii. Yawn only iii. Head tilt moment

B. Integrated Testing: After testing each module separately, the testing of system as a whole has also been done to verify the perfect working of the system.

V. RESULTS AND DISCUSSION

Successful implementation of eye closing, yawn detection and head moment to detect the driver drowsiness is done. The sound alarm sounded on detection is also clearly audible.

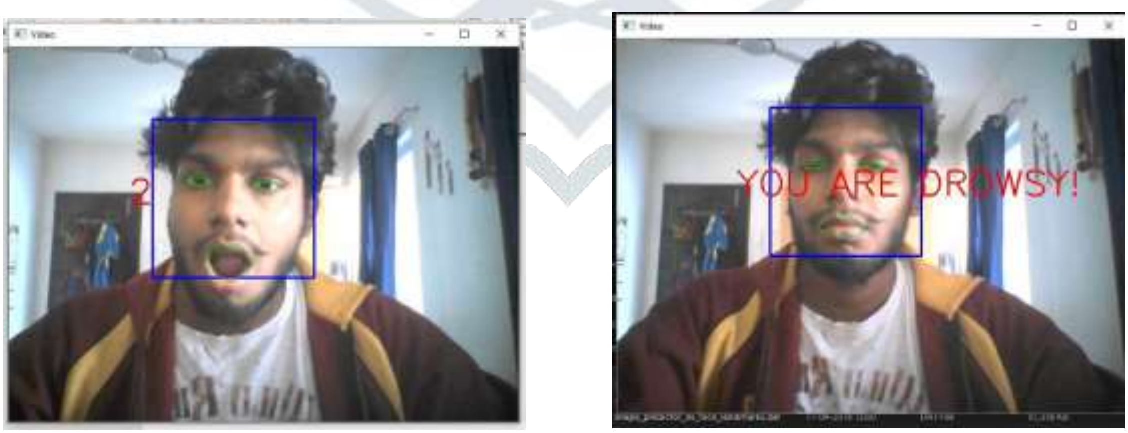

Fig. 6. Determination of Drowsiness State

A real time driver drowsiness detection system is presented which detects drowsiness by considering eye blinks and yawn to trigger the alarm and thus alert the driver. We demonstrated that Haar feature-based cascade classifiers and regression-based facial landmark detectors are generally enough to detect the alertness of a driver while driving.

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