International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 09 Issue: 05 | May 2022 www.irjet.net p-ISSN: 2395-0072

Driver's Drowsiness Detection by Analyzing Yawning and Eye Closure

Rahul K[1], Raj Suriyan G[2], Rajesh S[3], Udhayakumar G[4]

[123] Student, Department of Electronics and Communication Engineering & SRM Valliammai Engineering College
[4]Associate Professor, Department of Electronics and Communication Engineering & SRM Valliammai Engineering College

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Abstract - *Driver's drowsiness is the major cause of accidents. In this project, we are addressing this issue by creating a system that would alert the driver if he is drowsy or sleepy. At first, The face region is detected and tracked in the captured video sequence utilizing computer vision techniques in the first step. The eye and mouthparts were extracted and analyzed for drivers' drowsiness. It is done by calculating the Eye aspect ratio(EAR) and Mouth aspect ratio(MAR). Both EAR and MAR has threshold value, The EAR value will decrease if the eyes were closed and the MAR value will increase if the mouth was opened for a yawn. When these values cross their threshold the buzzer starts to alert the driver.*

Key Words: Open-CV, Dlib, Shape-predictor-68-face-landmarks ,EAR, MAR

1. INTRODUCTION

Driving drowsy is a major problem in today's world. About 12% of the major motor vehicle accidents were caused by driving drowsy. In this paper, we address this issue by creating a system that would alert the driver if he/she was found to be sleepy. Our system analyses both the eye and mouth to detect drowsiness. As the drivers found midnight to be a great time to drive, as there will be no traffic. As it takes a toll on their sleep cycles which is significantly causing them to fall asleep while driving.

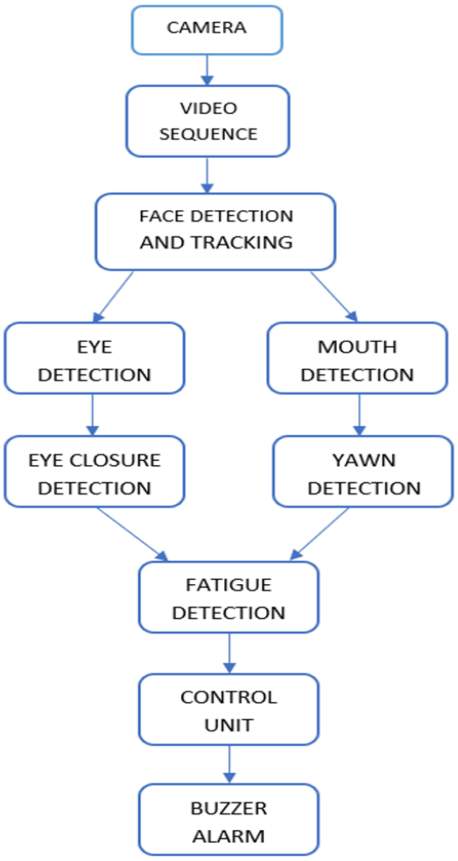
So this system will alert them if they fell asleep while driving. Our system is independent of the subject so it can be employed in commercial systems. The eye closure can be detected by analyzing the eye aspect ratio and the yawing can be detected by analyzing the mouth aspect ratio (MAR). The EAR threshold is set to 0.2 and the MAR threshold is set to 30. We can detect the early signs of fatigue if there is any change in these values. If the value of EAR keeps decreasing it means that the driver is closing his eyes and if the MAR value increases it means the driver is yawing. We implement this logic to detect the driver's fatigue in this project.

1. RELATED WORK

In previous works[3], the computational needed to detect drowsiness are quite large, also they use only static images which is rather time-consuming. Eye detection through EEG signals is fast but they lack accuracy. Usage of large neural networks is accurate but those algorithms took a long time and they do a lot of math calculations which will increase the time of execution of the program as it will cause a significant delay in creating an alert signal.

3. METHODOLOGY

3.1. Flowchart



3.2. Video Sequence

The input video sequence from the camera is analyzed in the first step. The input can be from a webcam or CSI camera in raspberry pi. In this step the video sequence got from the camera is processed in the open-cv environment. The video sequence is converted from color to black and white, as the black and white images can be processed at a higher speed. This video sequence is now will be processed in the open cv environment.

3.3. Face Detection

The dlib facial landmark detector marks the face into 68 points. These points will be used to measure the EAR and MAR ratio (Eye Aspect Ratio and Mouth Aspect ratio). Points from 37 to 42 mark the right eye and 43 to 47 mark the left eye. The points from 49 to 60 mark the outer portion of the lips and 61 to 68 mark the inner lips. The face is actively tracked in real-time.

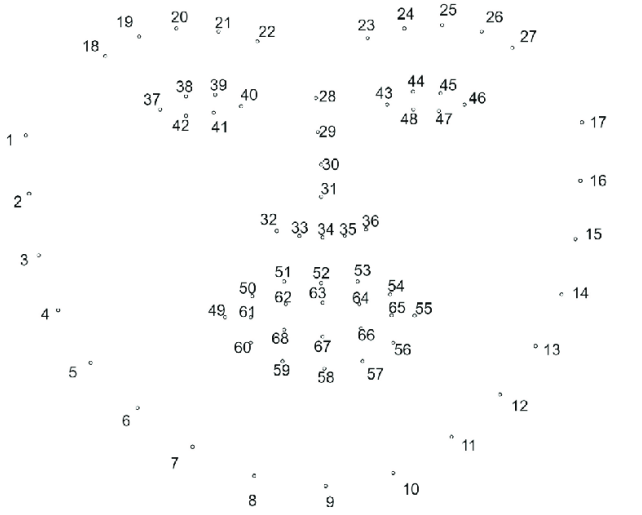


Fig-3.3.1: Shape Detector 68 Facial Landmarks

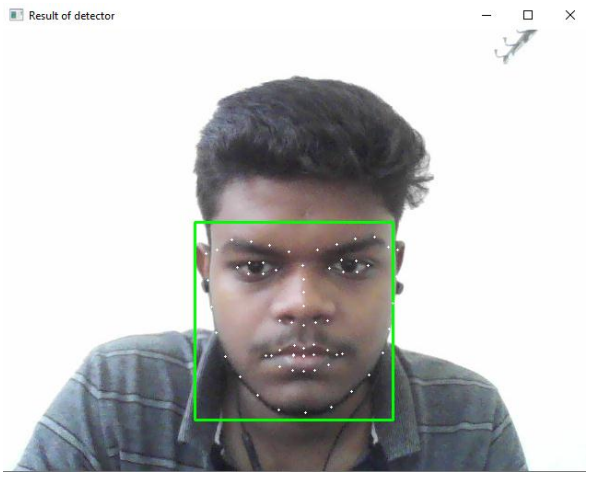


Fig-3.3.2: Result of the dlib 68 facial landmark detector. The face is detected and we can see the salient regions of the face

3.4. Eye Detection

The eye part is detected using the landmarks got from the face detection technique. As we know the number of the respective points in both eyes. We can use the below formula to calculate the EAR ratio.ie,

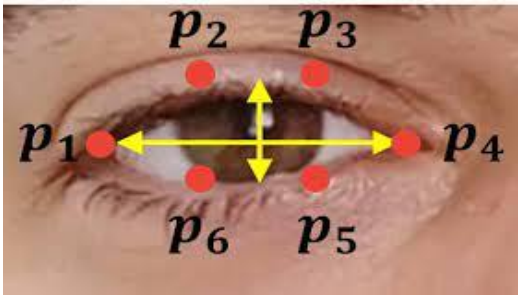


Fig 3.4.1- Eye landmarks when the eyes are open

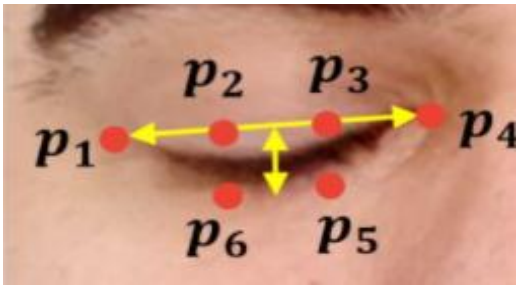


Fig 3.4.2- Eye landmarks when the eyes are closed

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

From the above equation, we are taking an average of two points for more accuracy. In the numerator, p2 and p6 represent the rightmost point, and p3 and p5 are left most points. If the eyes were closed the distance between the points will decrease as a result of this the whole EAR ratio will decrease. The threshold is set to 0.2 if it decreases beyond 0.2 the alert will be given to the driver by the buzzer.

3.5. Mouth Detection

The mouth part is detected by the facial landmark detector and the landmark point ranges from 61 to 68. Here we are only using the innermost landmark points only. These points are displayed below.

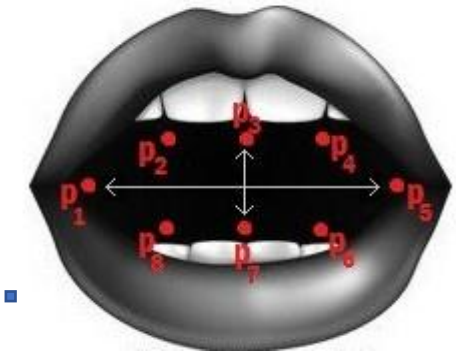


Fig-3.5.1: It shows the landmark points in the mouth region.

From this image, we can calculate the MAR ratio using the formula given below.

$$MAR = \frac{|p2 - p8| + |p3 - p7| + |p4 - p6|}{3|p1 - p5|}$$

In this formula, we are considering both 3 points in the mouth for better accuracy. As we can see if the mouth opened the distance between the points (p2 and p8), (p3 and p7), and (p4 and p6). If the distance between these points increases the MAR ratio also increases. If it crosses the threshold of 30 the driver will be alerted and asked to take some fresh air.

4. RESULT AND OUTPUT

Fig-4.1: When the person is active.

In figure a, we can see the EAR ratio is at 0.32 and the MAR ratio is at 9.33. From the above observation, we can conclude that the person is active, as their eyes are opened and mouth is closed.

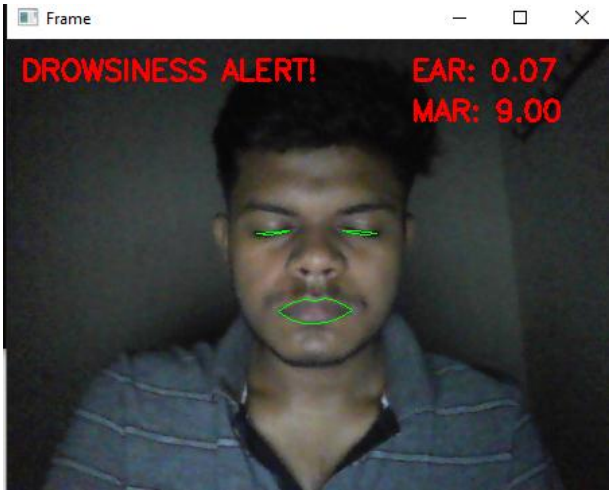


Fig-4.2: When the person's eyes are closed

In figure b, we can see the EAR ratio dropped below the threshold of 0.2. EAR is at 0.07 so the driver is alerted by ringing the buzzer and also sends a voice signal to the speaker asking the driver to wake up.

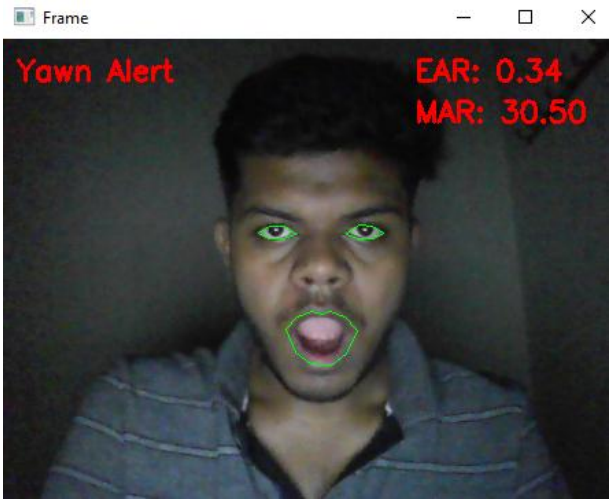


Fig-4.4: When the person's mouth is open

In figure c, we can see that the Mar ratio went beyond the threshold of 30. Hence the driver gets a Yawn alert. At this stage, the system will send an audio signal "GET SOME FRESH AIR SIR" to the speaker.

3. CONCLUSIONS AND FUTURE WORK

The proposed system analyzes the real-time video sequence and it has a high operation speed. As it won't use any complex algorithms. It works fine in low lighting conditions. The system is fast and once it starts capturing frames it continuously detects the face and performs detection till it is stopped. This system is independent of the subject so it can be implemented in commercial systems. It can also be used in the factories to detect the worker's fatigue. In the future, we can add a system that would slow down the vehicle and park it over the side of the road. We can add an accident detection system that will be connected to a GSM module that would send a call to a nearby hospital to send an ambulance. Drowsiness detection ensures the safety of the driver, co-passengers, and goods.

ACKNOWLEDGEMENT

We express our sincere gratitude to our project guide Udhayakumar G for his help in writing this paper.

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