ALERT SYSTEM FOR DRIVER DROWSINESS USING RASPBERRY PI

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Abstract- Driver's drowsiness is identified as one of the main reasons for road mishaps. It leads to severe physical injuries, loss of human life, and loss of money. It is estimated that 40% of highway accidents occur due to driver dozing off [1] while driving. The usage of driver drowsiness detection system will help in evading the significant mishaps. This paper presents a system to identify driver's drowsiness and raise an alarm to wake him. It is an attempt to avoid an accident caused by the inevitable sleep as early as possible by alerting the driver when he falls asleep. The symptoms of driver drowsiness can be detected more precisely and within a short time to avoid a car accident by just monitoring eyes. The proposed method involves continuous monitoring of driver's face with the help of a Raspberry Pi camera which is then processed to detect eye landmarks. The eye aspect ratio is calculated with help of the obtained eye coordinates to detect closure of the eye. If the closure of the eye is detected for a threshold number of times, the driver is drowsy. A 2 Volt buzzer connected to Raspberry Pi is automatically activated and alerts the driver.

Keywords: Drowsiness, OpenCV, EAR, Raspberry Pi 3b+, Pi camera, Buzzer.

1. INTRODUCTION:

Drowsiness is defined as an abnormally sleepy feeling which cannot be controlled by the person. It is identified as one of the reasons for road accidents especially on highways. Drowsiness is mainly caused when the person is not getting enough sleep, is tired, on night drives or if the person is under medication. Since falling asleep is not in the driver's hand an external entity is required to help him stay awake. This paper is about one of such entities using Raspberry Pi toolkit. Although there are many other methods for drowsiness detection such as using body sensors, vehicle steer positioning, and lane object detection, there are disadvantages such as cost factors, accuracy, equipment that makes it difficult to use in majority vehicles. Detecting drowsiness using facial movements is accurate with low cost. These facial movements include eye blinks, yawn and head tilts. The focus is placed on designing a system that will accurately monitor the open or closed state of the driver's eyes in real-time. The proposed system only uses eye blinks since the detection of drowsiness should be fast. There would be no use of raising an alarm after the accident has been occurred. Using Raspberry Pi toolkit we continuously capture the driver's face and process it to detect the drowsiness of the person. The driver will be alerted by an alarm from the buzzer connected to the toolkit if drowsiness is detected by the system. It does not cause any hassles to the driver as there are no connections required to be provided externally and the alarm will stop by itself in few seconds after the driver's eyes are wide open. Therefore, all one needs to do is start the Pi.

1.1 Related Work

There are several methods for drowsiness detection. They consist of monitoring of steering, vehicle-positioning, driver face, and also by using sensors to measure brain activity, heart rate, muscle activity. The method preferred in this model is by monitoring of face. Monitoring of eyes is considered suitable as the closure of eye for more than a certain amount of time will cause an accident. In this method one needs to detect the face in the image. The several methods to detect face are feature-based, knowledge-based, appearance-based, template-matching, Eigen face-based, neural network, distribution-based. Typically other methods depends on the set of rules, extracting structural features, correlated features etc. Here, neural network is the method used to detect face from the image. It detects the faces by returning a bounding box around the face. The bounded face is now used to identify the landmarks with the help of landmark detector which produces 68 coordinates for the facial structure. The 68 coordinates are obtained by training the model on iBUG 300-W dataset. The mappings are encoded in a dictionary and are assigned to various features of face like nose, eyes, mouth, face, etc. The dataset consists of different poses, illumination, subjects, occlusions, etc., of over 300 images. The identified face with the landmarks is further processed for detection.

2. PROPOSED ALGORITHM

In this project a Pi camera is connected to a Raspberry Pi 3b+ kit. The camera continuously captures the upper body of the driver. A 2 Volt buzzer is also connected to the GPIO pin of the Pi. It is used to alert when drowsiness is detected. The essentials of the project are as follows:

Raspberry Pi 3b+: The Raspberry Pi 3b+ Model features 1.4GHz 64-bit quad-core processor, a Secure Digital(SD) card slot which acts as memory for pi, 4 USB ports to connect hardware devices, a port to support Ethernet, GPIO(General-purpose input/output) pins to support input and output and power connecter port.

Raspberry Pi camera: We used a Raspberry Pi Camera of 5 megapixel native resolution, sensor capable of 2592x1944 pixel static images. It supports 1080p30, 720p60 and 640x480p60/90 video.

Buzzer: A buzzer is an audio signalling device used to wake up the driver. A 2 Volt buzzer is required to satisfy our need.

OpenCv: OpenCv(Open Source Computer Vision) is a python library which mainly aims at real time computer vision. It is used to do all the operation related to Images in our model.

shape_predictor_68_face_landmarks.dat: shape_predictor_68_face_landmarks.dat.bz2 is trained on the iBUG 300-W dataset [2]. The dataset consists of around 300 faces at different angels to identify the facial landmarks.

Figure 2.1 shows the entire Raspberry Pi toolkit used. The Raspberry Pi is connected to a power source. A 32GB SD card is inserted into the SD card slot. Keyboard, mouse, monitor are connected to the Pi. Pi camera is connected to the camera port and the buzzer is connected to the GPIO pin of the Pi.

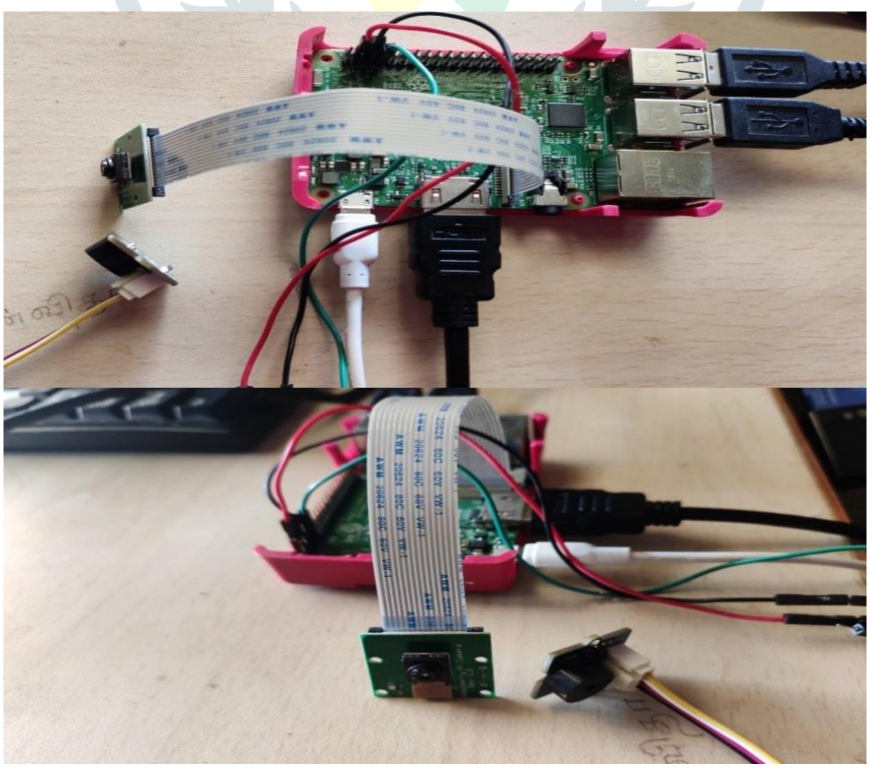

Figure 2.1: Raspberry Pi on work

Raspberry Pi camera is positioned in front of the driver behind the steering. The Pi camera should be positioned such that the driver's face takes up the greater part of the image and also that the driver's face should be more or less in the centre of the image. The Pi camera will be taking continuous video of the driver's face. OpenCV library gives the software support to the Pi camera to capture the video. The video is divided into frames. It is observed that around 4 frames are captured in a second. Each frame is converted into a grayscale image. Converting an RGB image into grayscale image reduces the noise in the image. The face is then extracted from the gray scale image. The facial landmarks such as face shape, eyebrows, eyes, mouth and nose are identified on the face using 68 coordinates as shown in the figure 2.2 using the trained dataset, "shape_predictor_68_face_landmarks.dat". The coordinates 1-17 represent face shape, 18-22 and 23-27 represent two eyebrows, 28-36 represent nose, 37-42 and 43-48 represent two eyes, 49-68 represent mouth. Since in the proposed system eye blink pattern is considered, only the eye points coordinates i.e., values of coordinates at 37-42 and 43-48 are extracted from the face. For each eye these 6 coordinates are represented by p1, p2, p3, p4, p5 and p6 as shown in the figure 2.3.

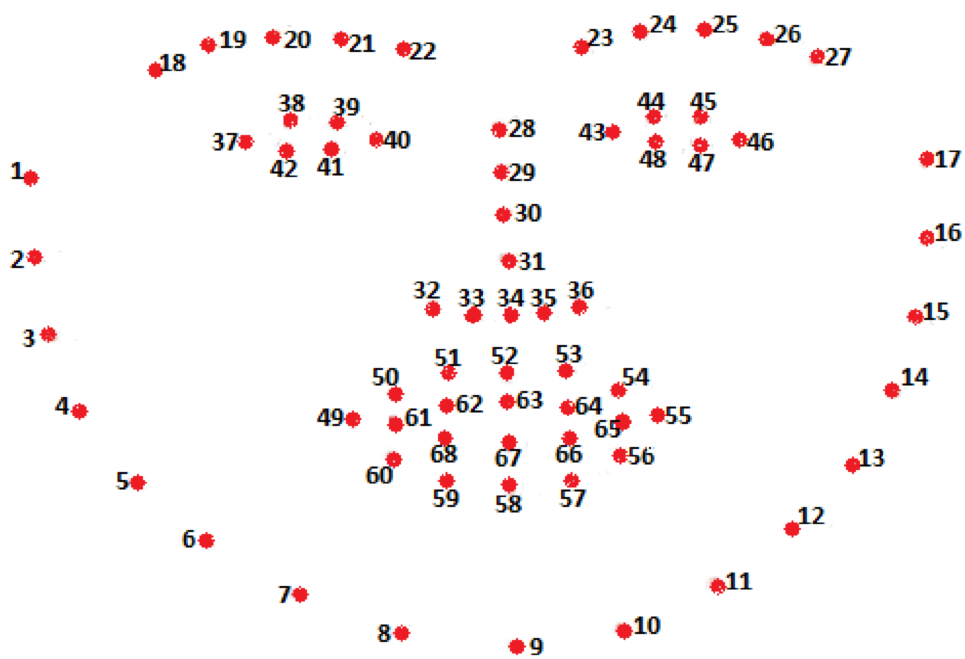

Figure 2.2: Facial landmark coordinates

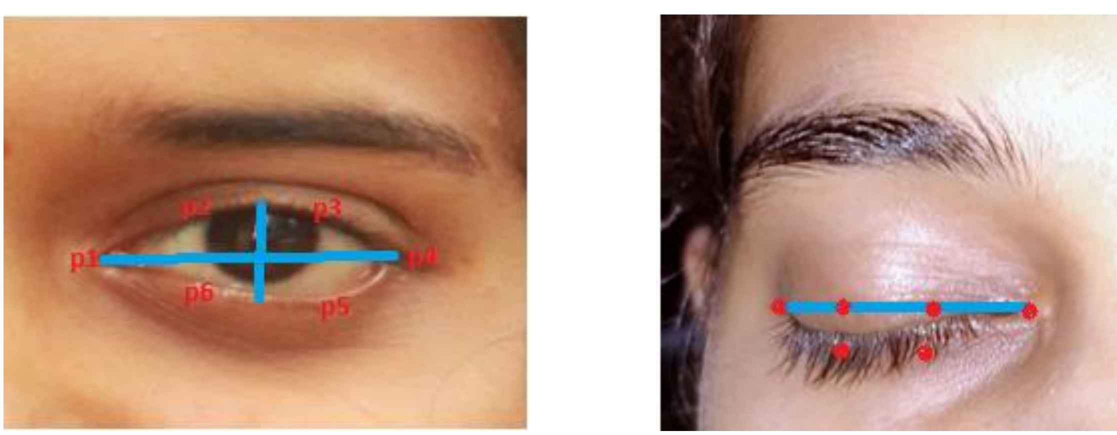

Figure 2.3: Eye points when eyes are open and closed

The eye aspect ratio is used to determine the eye state. It is the ratio of difference between the coordinates on the edges of the eyes. The Eye aspect ratio is calculated using the formula.

$$\text{EAR (Eye Aspect Ratio)} = \frac{\|p2-p6\|+\|p3-p5\|}{2\|p1-p4\|}$$

A blink threshold is a value that is used to determine if the eye is closed or open. The blink threshold has been observed as the minimum ear threshold for many people and worked well while testing on different people to identify blink. The value of blink threshold is 0.3. EAR is calculated for both the eyes in each frame. If the calculated value for both the eyes is less than the blink threshold, then it is considered as a blink.

A frame threshold is considered since a normal blink of a person should not be considered as a drowsy state. The frame threshold can be varied depending on the device and it's processor on which it is being implemented.

A counter is initially taken as 0. If a blink is detected for a frame, counter is incremented. If blink is not detected, the counter is again set to 0.This is a continuous process and if the counter value reaches the frame threshold value, it is identified that the driver is drowsy and the buzzer is activated. The counter sets itself to 0 after the buzzer goes off and the video continues to record. The buzzer goes off by itself when the ear is above the threshold i.e., when the driver is awake for a certain time. There is no external force required to stop the buzzer.

The above process is continuous. The drowsiness is detected and buzzer is activated. Buzzer stops after waking up the driver and again monitoring driver continues. The Pi stops with the vehicle.

3. EXPERIMENTAL RESULTS AND ANALYSIS:

The results section consists of the obtained images after completing the above mentioned process. Figure 3.1 shows the face detected by Pi camera. The face detected is marked with points marked at facial landmarks such as eyes, eyebrows, face shape, nose and mouth.

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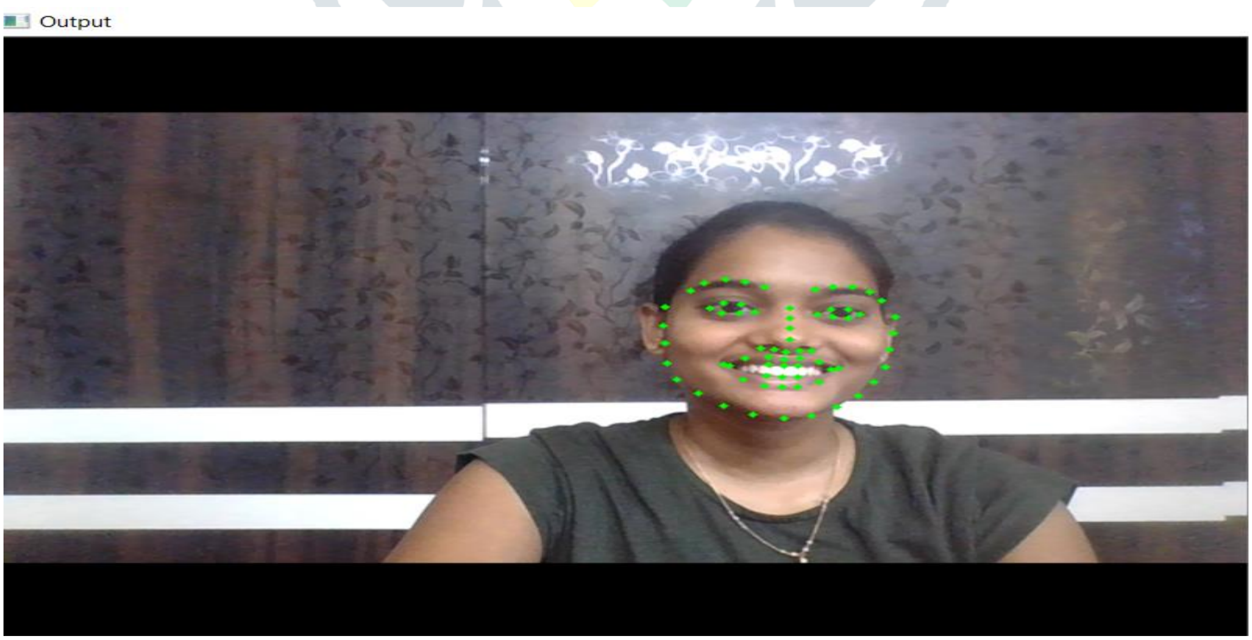

Figure 3.1: Facial landmark coordinates Detection

Since eye aspect ratio is calculated consistently for both eyes in every frame, the left and right eye points, calculated ear for those points are displayed on the console along with video as shown in the figure 3.2 and figure 3.3.

A wake up alert message is displayed on the output frame and the console as shown in figure 3.3 when consistent drops in the values are identified. An alarm is buzzed along with the notification in the background. As it cannot be captured, the alert message is only shown in this section.

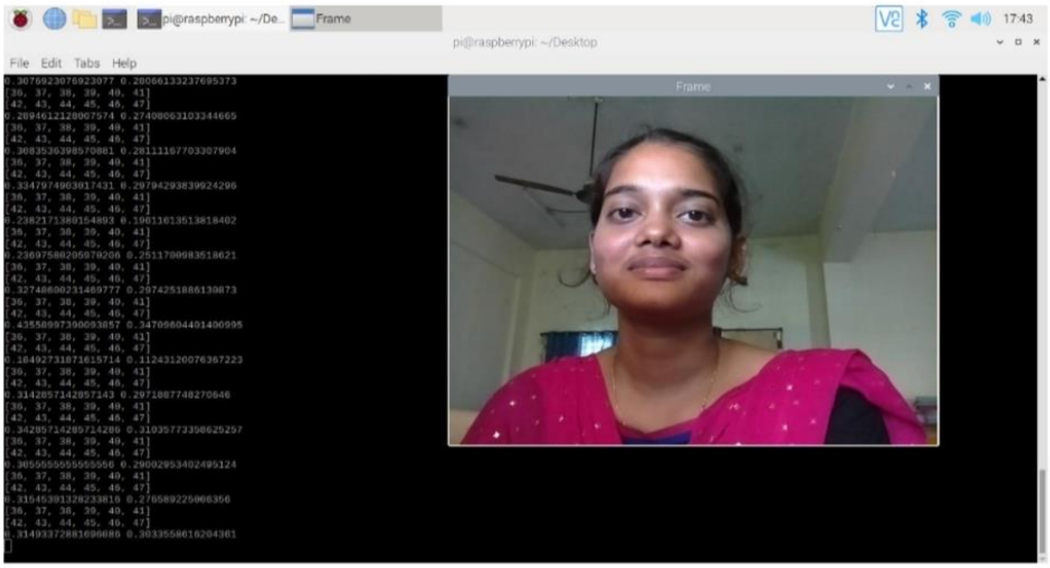

Figure 3.2: No alert is generated if driver is not drowsy

In figure 3.3 , a 'WAKE UP!!' alert message is displayed on the frame along with the buzzer ringing in the background as the eye cordinates fell below the threshold value for a frame threshold number of times and hence driver is noticed drowsy.

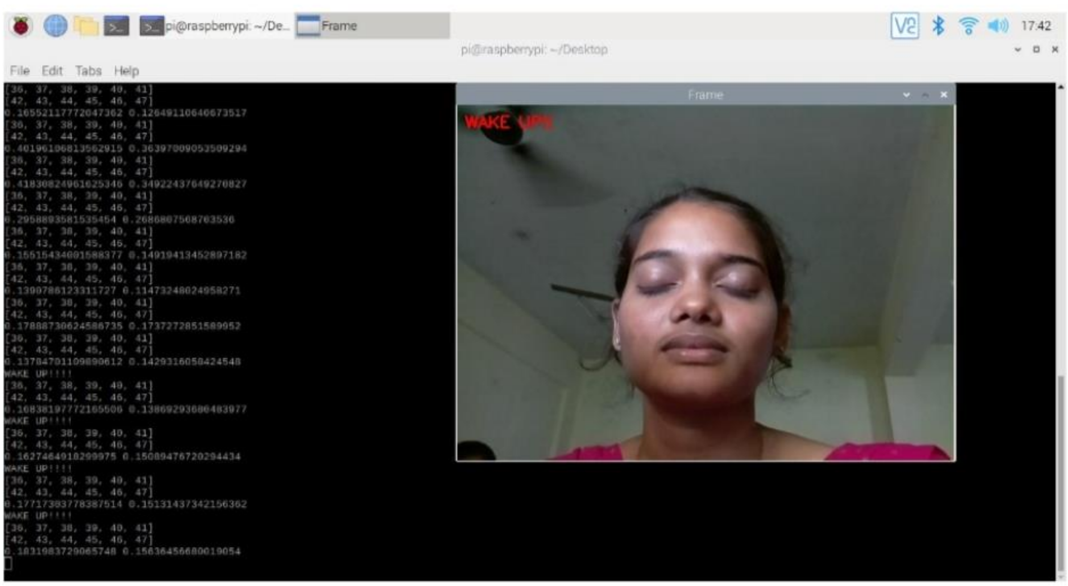

Figure 3.3: Buzzer is activated and alert message is displayed

4. CONCLUSION:

In this paper, driver drowsiness detection system is built to identify driver's drowsy state and make him conscious while driving in order to reduce accidents caused due to drowsiness. The Pi alongside Raspbian camera is utilized to capture the driver continuously. Sleepiness is estimated by extracting Eye from face utilizing shape-indicator and calculating Eye Aspect Ratio (EAR). At the point when the system detects drowsiness, the driver will be frightened by a noisy notice that will awaken the driver from the rest state.

5. FUTURE SCOPE:

This device can be connected to the vehicle's engine such that it starts with the vehicle and it stops by itself with vehicle and the alarm too stops when the driver wakes up, thereby making it hands free operation. The device can also be connected to the accelerator to slow down the speed of the vehicle to reduce the impact of the accident. The system can be further enhanced by using an infrared camera for more efficient picture quality at various lightening conditions and furthermore for the people with brown complexion and for the people with small eyes. A high voltage buzzer can be connected for louder sound. The performance time of the system can be increased to be used for longer hours as the driver travels for farther distance.

6. REFERENCES:

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