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Drowsy Driving Detection System – IoT Perspective

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Abstract: This paper proposes a true time Drowsy Driving Detection System for the prevention of road accidents using IOT. One among the main issues for the traffic collision is Sluggishness Driving. An outsized number of road accidents occur due to this which ends up in severe injuries and deaths. For this reason, various studies were wiped out designing systems which will examine the sluggishness of driver and alert him before the accident occurs, thus preventing him to fall sluggishness and cause an accident. The measurements are highly influenced by structure of road, sort of vehicle and driving skills. These are the vehicle based (traditional approaches) measures who designs the system. Other approaches used are psychological measures for his or her system that tend to provide better accuracy in monitoring the drowsiness of the driver. However, in this techniques we use intrusive such as electrodes are required to be placed on the head and body. Furthermore, there are few existing researches during which subjective measurements are used because the input for the system, but, these sorts of methods can distract the driving forces and lead to an ambiguous result. In this paper, we proposed a framework that is absolutely non- intrusive and real-time. Our proposed framework uses the attention closure ratio as input parameter to detect the sluggishness of the driver. If the attention closure ratio deteriorates from the quality ratio, the driver is alerted with the help of a buzzer, water sprinkler on the drives face, back indicator. For our framework, a Pi camera is employed to capture the pictures of the eye of driver . Alcohol detection Sensor is used to detect the Alcohol level consumed by the Driver. Thus, the whole system is incorporated using Raspberry-Pi.

Keywords: Drowsy Driving; Eye Aspect Ratio; Facial Landmark; Computer Vision; Raspberry Pi; Pi Camera Module; Buzzer and water sprinkle; Alcohol sensor

I. INTRODUCTION

There are many other issues concerning traffic accidents in this world, one of the major issues which has to be considered is Drowsy Driving. In the year 2014, 846 passings happened because of lazy driving., 83000 accidents for each year was distinguished somewhere in the range of 2005 and 2009. A yearly normal joins roughly 886 passings , 37000 wounds, and 45000 property harm just because of vehicle crashes. This happens when the driver is amazingly worn out while driving, making the difficult to remain alert. This can happens when the driver doesn't get adequate measure of rest or he is under prescriptions, likewise happen at the point when he experiences rest issues, for example a sleeping disorder move work rest issue. Thus, the driver will in general have a mellow intellectual weakness and furthermore response time. In the most critical situation, the driver may nod off in the driver's seat. A few endeavors were taken to identify the languor of the driver by thinking about different boundaries. Many existing strategies actualized vehicle-based estimate which include mounting sensors on directing segments of the vehicle [3,4]. The sensors are normally positioned on speeding up pedal and directing wheel, to assess the force of the sluggishness. The way toward executing vehicle-based measures can be additionally stalled into two classes. The assessment can be performed dependent on two methodologies, in particular Controlling Wheel Development (SWM) and Standard Deviation of Path Position (SDLP). So as to quantify SWM, an edge sensor is used decide the driver degree of laziness dependent on a guiding example (5,7). Then again, SDLP execute an author camera which is utilized to decide if the vehicle is floating out of its path (8). Be that as it may, assessments based vehicle-out together boundaries exceptionally depend with respect to the physical paths of the general condition and the driver himself. These components fundamentally include the structure of the street, the kind off vehicle utilized and the driving example of the driver which influence the exactness of the assessment (line). In addition, such estimations are additionally used to identify different well strings of auto collisions, for example, the tiredness dependent on liquor utilization. Therefore, vehicle-based estimation would not have the option to recognize the reason for the sleepiness especially (10,11). Aside from this a few methodologies actualized mental measures to screen the drivers weakness status which is executed by recording mental science utilizing either electroencephalogram (EEG), Electrooculography (EOG), Electromyography (EMG) or Electrocardiography (ECG) [12-15]. One bit of leeway of utilizing mental estimations is that the assessments dependent on such boundaries can anticipate tiredness with better exactness since the mental science can well speak to the subjective exercises of the cerebrum [16]. Be that as it may, such procedures are noisy since sensors are required to be set on the driver's body so as to gather the information. This may cause the drivers to feel awkward and furthermore redirect his consideration from driving [17]. Hardly any current methodologies utilized emotional estimations which are let through self-rating of the driver or through survey [18] by and by, such strategies can prompt abnormal outcome as the self-evaluation strategy can alarm the driver subliminally, diminishing the force of sleepiness[17]. Besides the most noticeable downside of abstract estimations would be that.

One might neglect to accurately predict his own level of drowsiness simply based on self-assessment in a real-time scenario. Some current work provided model-based movement tracking based on optical flow by analyzing the eye state and the head position of the driver [19]. This approach proposes high accuracy rate with acceptably low errors and false alarms for people of various ethnicity and gender. In any case, this has a burden of higher computing capability requirement and the side-effect of being sensitive to noise [20].

Considering to the previously specified issues [9-11, 17, 20]; we have proposed a strategy, which is based on the behavioral measurements, in which the eye closure ratio is used as the input parameter for detecting driver's drowsiness. strategies relied upon behavioral measurements involve monitoring the eye blinking pattern, yawning, eye closure, facial movements and head pose via an external camera [21, 22].What's more, as the framework is planned considering the conduct boundaries, it fills in as a non-meddling strategy of deciding the driver's sluggishness as it doesn't require any positions of sensors on the driver's body and in this way doesn't interfere with him while driving. In our proposed structure, the face of the driver was persistently recorded so as to recognize the eye developments utilizing a Raspberry Pi camera. So as to recognize the eye developments utilizing a Raspberry Pi camera. So as to successfully catch the face, the Pi camera is mounted on the vehicle dashboard and is kept 20cm far[23]. This Pi camera is associated with the Raspberry Pi with the help of a flexible cable and the Raspberry Pi itself, are often placed anywhere inside the vehicle, out the human eyesight. Initially, the detection of facial landmarks was performed using the Haar Cascade classifier. Once the various areas of the face were detected, the eye regions were extracted to measure the eye closure ratio. If the eye closure ratio of the driver increases from what is considered to be the standard ratio of an individual in a normal state, the diver is instantly alerted with the help of the buzzer, water sprinkler, LED, E-mail. An Alcohol detection is used to detect the alcohol level consumed. The entire system was integrated using a Raspberry Pi and a Pi camera was used for tracing the eye movements.

The subsequent sections of the paper have been organized as follows: Section II illustrates proposed model with block diagram and flowchart. Section III describe the working of the individual components present in the system. Section IV represents the system implementation of our proposed model. Section V focuses on the experimental results along with the related discussion. Section VI concludes the paper and is followed by the description of future work in section VII.

II. PROPOSED SYSTEM

The proposed system has been planned to defeat the downsides of the past transportation and drivers' management systems and to decrease the number of accidents occurring every day around the globe. The target of our framework is to make a sensible system which will operate fully automatically for handling the drowsy driver detection problem. This is finished by awakening the driver up using a buzzer, water sprinkler, back indicator when he is recognized with sleepiness and advising the proprietor of the vehicle so that the vital advances can be taken.

A natural eye without the impact of sluggishness has a Eye Aspect Proportion (EAR) above 0.25, which is the edge esteem. At the point when a driver is in a progress to rest his eyes will consequently tend to close down consequently diminishing his EAR, when the EAR esteem falls beneath the limit esteem, the length of eye conclusion is thought of. So as to recognize according to the driver from the ordinary eye squint example, a limit esteem, speaking to the all out number of video outlines the driver has shut his eyes, is utilized. In case outperforms that cutoff then the owner of the vehicle will be educated to let him/her understand that the driver fell asleep for on various occasions while driving. As the system is related wit IOT, it will make a buzzer sound then the water is sprinkled on the drivers face and email is sent to the Android device of the affirmed owner when sluggishness is perceived. This will caution the owner about the driver's driving model and will help him with taking further decisions subject to driver's exercise. Fig 1 shows the square framework and Fig 2 shows the flowchart of the proposed outline work.

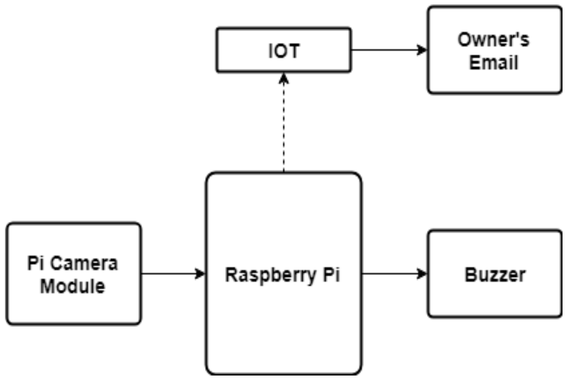

Fig 1. A Block Diagram of the Proposed System

III. COMPONENT DESCRIPTION

The proposed system consists of the following major components:

A. *Raspberry Pi 3 model B*

The Raspberry Pi that is designed for the Linux operating system which is a microprocessor. In our proposed framework, Raspberry Pi 3 Model B is used with Raspbian OS integrated into it [24, 25].

B. *Pi Camera Module*

The Pi camera module can take high-definition video along with still pictures and can support 1080p30, 720p60, and VGA90 video modes [26].It can capture image even in dark mode.

C. *Ringer, Water Sprinkler, Alcohol Sensor*

The Ringer is utilized to create signal sound when the voltage is provided. For our proposed framework, the ringer is utilized as an alarm , water sprinkler to create ceaseless signals when the driver is identified with drowsiness [27].

IV. WORKING PRINCIPLE

A. *Detection of Face*

In our proposed framework the Pi Camera module was integrated for Raspberry Pi camera module so as to continuously scan the face of the driving force. This process is carried out in 2 stages.

a) *Constructing a picture dataset*

To construct a picture data set a 300-VW . Dataset was used. [28]. The info set contains 20 recordings during which each edge is commented on which a particular arrangement of facial milestones. The structure of the 300-VW data set is as per the following: an organizer containing the packed video records and an envelope containing the relative explained milestone documents. For our research, we've only used the video files. On the idea of EAR we constructed the training dataset, using a subset of the 300-VW, containing sample images with both open and closed eyes. To be more precise, 20 frames were captured with eyes wide open (highest EAR), 20 frames were taken with mostly eyes tightly shut (lowest EAR), and 20 frames were sampled randomly. Haar Cascade classifier is employed to detect the facial landmarks. Facial tourist spots are only the key highlights that build the essence of an individual's what's more, these incorporate the eyes, eyebrows, nose, mouth and jaw line.

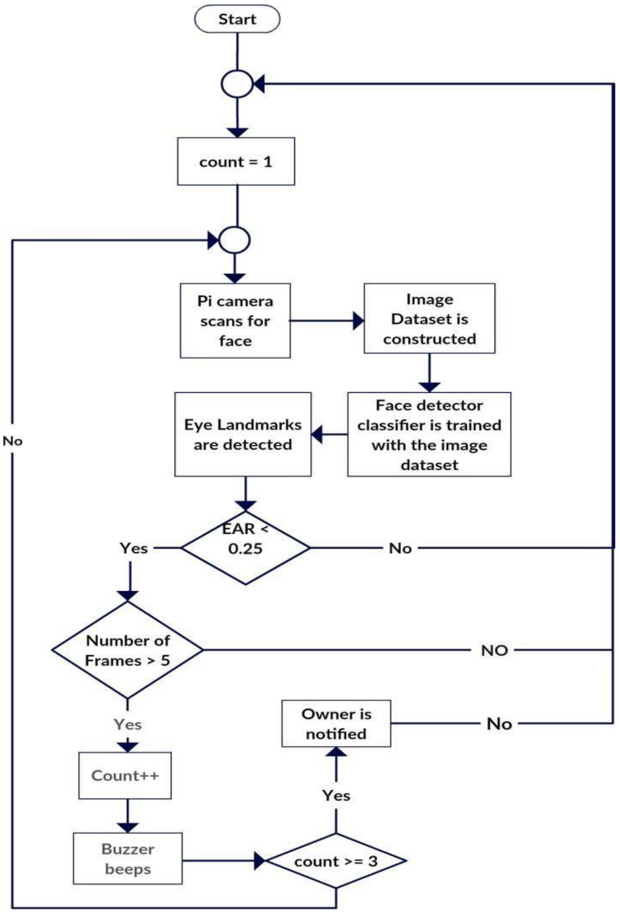

Fig 2. A Flowchart of the Proposed System

To detect these features, the Haar Cascade classifier first requires to be trained [29]. For the way towards preparing the classifier, a preparing dataset was first built utilizing 1500 images as portrayed above and a brief time, the facial tourist spots of those pictures were named demonstrating the particular 68 (x, y)-directions of zones covering all the facial highlights.

b) *Training the face detector classifier photographs within the dataset*

After the completion of constructing the preparing dataset, it had been then made use to extract the highlights. Few of the simple rectangular highlights that were extracted from the way towards preparing dataset of images are shown in Fig. 3 and Fig. 4.

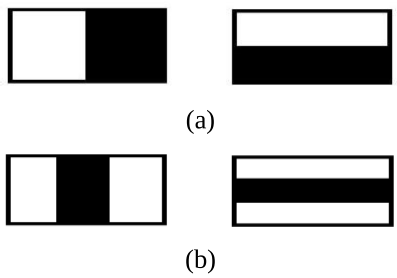

Fig 3. Examples of rectangle Haar-like features. (a) may be a 2-rectangle feature (edge feature) and (b) may be a 3-rectangle feature (line feature)

The rectangle features are often calculated very fastly using an intermediate representation for the image which was called the integral image [30]. The aim of introducing the integral picture was to scale back the computations for a given pixel to an operation involving just four pixels. Once computed, any of those Haar-like features are often computed at any scale or location in constant time. For calculating each feature, the sum of pixels under the white rectangle is subtracted from the sum of pixels under the black rectangle. Once the features were extracted, feature selection process was executed to pickup the important features. For each feature, the classifier finds so only simplest threshold which may classify the faces as either positive and negative. So, the features with minimum error rate are selected implying that these can most accurately classify the face and non-face images. For creating the classifier more efficient, the concept of cascade of classifiers was used.

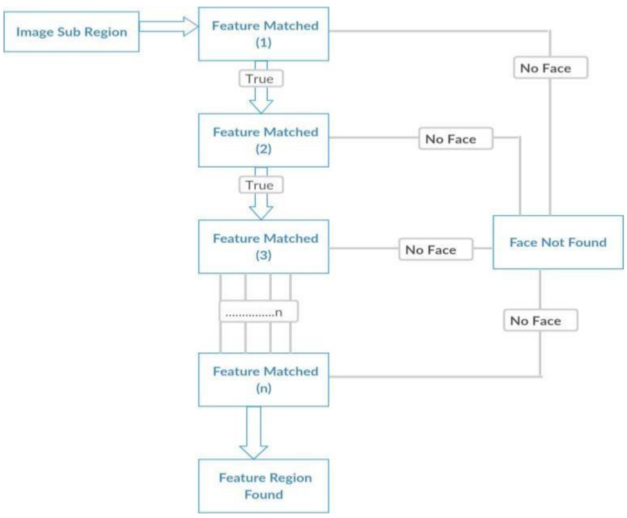

Fig 4. Finding face from different sub region

In order to remove the background regions of the picture, the cascade of classifiers is used so that we can focus on many calculations on face-like regions background regions.

This is done by grouping the features into different levels of classifiers and then applying them on them consecutively as illustrated in Fig. 4. It can be observed from Fig. 4 that if a window fails to exceed the feature on the first stage, it is immediately discarded without even considering of applying the next feature of the second stage. If a window can successfully exceeds all the stages of features, it is considered as a face region.

B. Determining the Eye Aspect Ratio (EAR)

Preceding deducting that a driver is sluggish, the eye aspect ratio (EAR) is calculated to detect the driver with drowsiness.

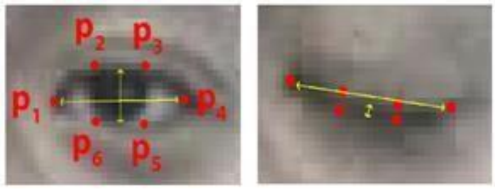

Fig 5. Six landmarks of the eye before and after closing eyelids [33]

When the facial landmarks are detected, the pictures of these faces are converted to grayscale format. This is because it is inherent complexity of gray level pictures which is lower than that of the color pictures [31, 32]. Once the facial landmarks of the driver were detected, the eye regions are extracted using the 6 (x, y)-zones of the eye structure as shown in Fig. 5.

We now define the eye viewpoint proportion work which is utilized to figure the proportion of separations between the vertical eye tourist spots and the separations between the flat eye tourist spots. In order to calculate distance, the Euclidean Distance of the eye region is used.

$$D(P,Q) = \sqrt{\sum_{i=1}^{n}(Q_i - P_i)^2} \qquad (1)$$

where D(P,Q) is the Euclidean distance between points P and Q. In Cartesian coordinates P_i and Q_i are two points in Euclidean n-space.

Eye of a human corresponds to 6 (x, y)-coordinates as described in Fig. 5. The EAR determines how far the eyelids of each eye are apart from each other. However, once a person blinks, the EAR diminishes significantly, moving toward zero. The average duration of single eye blink of each individual ranges approximately from 100 to 400 ms according to [34]. From this statistics, it can be deduced that the duration of eye closure must be greater than 400 ms for a person who is detected with drowsiness. In our work, four frames were considered to represent this 400 ms, indicating that four successive frames with an eye aspect ratio less than 0.25 must occur in order for a blink to be registered. Thus, it is possible to distinguish the eye closure pattern between the eye blink and drowsy eyes.

In order to calculate the EAR, the eye landmarks are detected for every video frame. The eye aspect ratio (EAR) between height and width of the eye is computed using,

$$EAR = \frac{(X_2 - X_6) + (X_3 - X_5)}{2(X_1 - X_4)} \qquad (2)$$

where X_1, X_2, X_3, X_4, X_5, and X_6 are the 2D landmark locations, as represented in Fig. 5. The EAR is irrespective of the head and body position. Since eye blinking is performed by both eyes synchronously, the EAR of both eyes is averaged.

C. *Turning on the Buzzer, Water sprinkler, LED*

When the eyelids are kept open the EAR remains constant, when eye closure rapidly approached to zero it increases again, indicating a blink has taken place. The EAR is constantly monitored to track for a similar pattern implying that the driver has shut his eyes. For the EAR the threshold value considered to be 0.25 and any other above value which mean that the driver's eyes are open. In our framework, the number of video frames is taken into account rather than the duration of eye closure. Firstly, the total number of successive frames is preset to 20, representing the eyeblink. If the EAR value drops less than threshold value, then the number of frames the person has closed his eyes for is considered. If the number of frames exceeds 20, then the buzzer is turned on, water sprinkler, LED is displayed.

D. *Notifying the Owner*

The Raspberry Pi is programmed to operate as a drowsy driving detector system in which it detects the drowsiness of the driver and alerts him with the help of a buzzer, water sprinkler, LED is displayed. If he falls asleep for more than 3 times then the system sends an email alert to the owner for him to take further action. The subject, message content, and Email ID are all entered into the system through python scripts [35].

In order to send emails, Simple Mail Transfer protocol (SMTP) is used by implementing a native library in Python. The port numbers 587 (for SMTP GMail server) is used for sending emails to the owner or the concerned persons.

V. RESULTS AND DISCUSSION

On finishing this work, our framewrok could successfully detect the drowsiness of the driver based on the eye aspect ratio (EAR).

The figures below show the experimental results of how the system could successfully recognize the eye tourist spots and then we calculate the EAR value before and after closing the eyelids.

In Fig. 6, it can be noticed that the framework could effectively detect When the eyes are kept open when the EAR value is found to be more than 0.25. The EAR value can also be graphically represented over the times the eyes are kept open, as shown in Fig. 7.

Fig 6. The EAR value before closing the eyelids

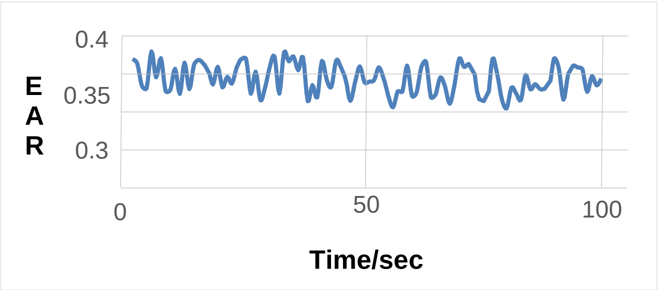

Fig 7. EAR plotted when the eyes are open

Moreover, it is observed from Fig. 8 that the system displays a drowsiness alert when the EAR value quickly falls below 0.25, indicating that the eyes are closed. This was also graphically represented over the times the eyes are kept closed, as shown in Fig. 9.

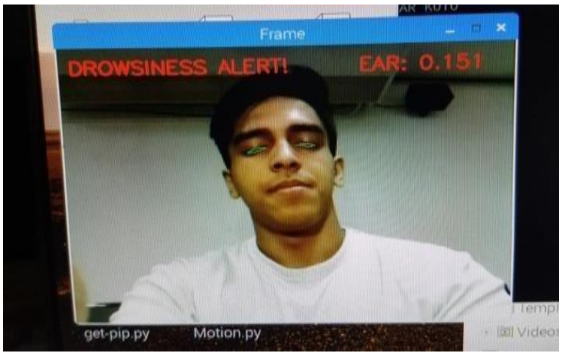

Fig 8. The EAR value before closing the eyelids

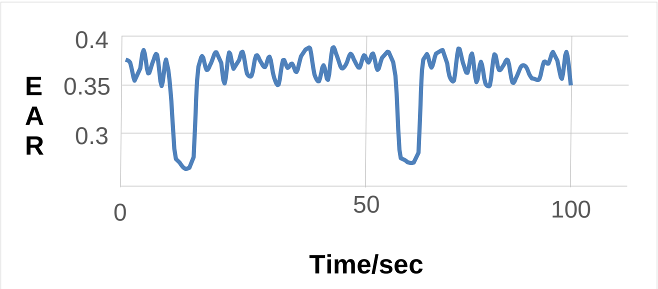

Fig 9. EAR plotted when the eyes are closed

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Once the driver is detected with potential sluggishness, the system alerts him and at the same time, takes an attempt to wake him up with the help of a buzzer, water sprinkler, LED to display. Furthermore, if he falls asleep for more than 3 times, an email notification is sent to the owner or concerned person of the vehicle as a warning for the driver to wake up.

So that he can recover himself from falling asleep repeatedly. Fig. 10 shows a snapshot of the owner's Gmail account after the email is sent.

Fig 10. Result displayed on mobile through email

The way towards preparing dataset used to train the Haar Cascade classifier was not appropriate for all types of environmental conditions. It consisted of pictures that were taken only in daylight. However, while carrying out the experiment at night, it was observed that the Haar Cascade classifier was not able to detect the facial landmarks from the video frames of the driver. As a result, the system could not calculate the EAR value of the driver's eye. This brought drawbacks for our system as it could only serve its purpose during the daylight.

VI. CONCLUSION

The main aim of this research is to provide a drowsiness detection system and a method to detects the driver's drowsiness in real-time scenario. Present approaches have used vehicle- based and psychological measurements to detect the sluggishness of the driver. However, these techniques are highly intrusive and depend on the physical characteristics of the surrounding scenario. In addition to the beforehand determined issues, we have proposed a framework that implements a non-intrusive technique for determining the driver's sluggishness. Our system comprises of a Raspberry- Pi and a Pi Camera module that persistently continues examining for facial tourist spots. These tourist spots are localized using facial landmark detector and then the eye landmarks are used to measure the eye aspect ratio (EAR). If the EAR value is less than the threshold value and the eyes remain closed for too long then the system immediately alerts the driver with the aid of a buzzer, water sprinkler, LED display. Moreover, to ensure that the problem has been taken care of, a notification is sent to the owner of the vehicle through e-mail when the driver dozes off for more than a couple of times. This process is useful to people in the car rental and driving business such as truckers and taxi cab drivers etc. However, there is one issue that remains to be addressed in the system, which is its incapability to serve its purpose at night.

VII. FUTURE WORK

In future, we would like to improve our system by attaining a compact design and also by making it appropriate to serve under any physical scenarios. Aside from this, we would likewise like to take a shot at perceiving the rest example of the driver for identifying his weakness level in advance later on. We believe, if the sleep pattern can be recognized and combined with the eye closure pattern, it is possible to make a direct correlation between these two patterns which can help us design a near perfect drowsy detection system. In future we would like to detect the sluggishness even in dark conditions.

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