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AUTOMATIC DETECTION OF DROWSINESS AND ALERT SYSTEM USING ADVANCED HAAR CASCADE ALGORITHM

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Abstract: Drowsiness among drivers is the main reason for road accidents every year in India. Many of the drivers, especially the heavy vehicle drivers will drive mostly at early morning. The lack of sleep from five to eight hours is one of the main reasons for drowsiness. Drowsiness can imbalance the reaction time and decision making skills of drivers and this can increase the cause of road accidents. These accidents are more likely to result in death or severe injuries, as they tend to be in high speed and the driver in drowsiness state can't able to apply the break. Hence it is essential to create a smart system that will detect and alert the state of the driver while driving. Although there are few solutions available for this system, Most of them remain only in theory and not implemented practically in real time system. In this paper, we propose an efficient drowsiness detection and alert system mainly using camera. This system is implemented in real time and the results are more accurate when compared to the other existing systems.

***Index Terms* - Driver Drowsiness Detection; Yawn Detection; Real Time Implementation; Smart Vehicular Systems**

I. INTRODUCTION

Drowsiness is a state which comes, when a person is not having enough sleep over a specific period of time due to work load or mental sickness. Every person should require at least six to eight hours of quality sleep each night as prescribed by the doctor. Many people can't able to attain this period of sleep due to their profession. Much sensitive profession like driving requires a lot of concentration and good mental strength. Drivers in the drowsiness state can lack the imbalance in reaction time and decision making behind the wheels and this can increase the cause of accidents. This accident not only affects the driver but also the other vehicles in the road. The Traffic survey shows that nearly 20% of the road accidents occur due to driver drowsiness. Hence it is essential to create a smart system that will detect and alert the drowsiness state of the driver and prevent the accidents.

The main purpose of this project is to reduce the number of drowsiness related road accidents. The first phase of this project is the drowsiness detection, which is done by implementing a camera in front of the driver. The camera is angled in such a way that should face the eye region. There exists a fact that every eye should blink with in 0.5 second. If the doesn't blink more than 1.5 second means that would be considered as a sleeping action and it is detected. The Real time captured video is handled by Raspberry pi. The algorithm is processed with Python which is compiled in the platform called OpenCV. The second phase of this project is the yawn detection. Eye and Yawn detection can be done by using Haar cascade algorithm.

This algorithm consists of two main parameters. They are Eye Aspect Ratio and Mouth Aspect Ratio. The EAR and MAR values are initially calculated for the drivers and a threshold level for both the eye and yawn can be obtained. This obtained EAR and MAR threshold value is continuously compared with real time video. If the real time EAR and MAR values jumps the threshold level, drowsiness is detected and it would trigger the alarm and also the vibrator. The vibrator will be placed either at the back side of the seat or under the seat. Similarly for the Yawn detection, if the MAR jumps over the threshold level, the Raspberry Pi sends an alert message to the vehicle owner indicating the state of the driver. Accidents caused by tired drivers will happen mostly around 1 AM to 6 AM. Many of the existing systems are implemented either by using MATLAB or by using a normal camera. Some of the systems will include only eye detection. A proper drowsiness detection system will always consists of both sleep and Yawn detection. In some systems, the camera mistakes speaking of driver as a Yawn wrongly. In order to overcome that problem, we use a 4K ultra HD night vision camera. This camera helps in proper detection of both sleep and Yawn detection even at night.

II. RELATED WORKS

This chapter discusses some of the related works done in this area. The problems and drawbacks are highlighted in this chapter.

A. A Hybrid Scheme for Drowsiness Detection Using Wearable Sensors [1]

This Hybrid scheme for Drowsiness detection with wearable sensors is first implemented by Aqua Mahreen and Syed Muhammad Anwar in 2019. Here a wearable sensor is used to collect the ECG signal directly from the driver for sleep detection. The main limitation of this system is, it always requires the person to wear the head band for all the time and also in this system Yawn is not detected.

B. A Dedicated System for Monitoring of Driver's Fatigue [2]

This system was proposed by Spurjeon and Bahindwar in 2012. This model involves monitoring of a driver and estimating his state. This system is implemented by using Percent of Eyelid Closure (PERCLOS). This system uses the CCD camera for real time video capturing. The accuracy of 0this system is less when compared to other systems and the delay in triggering the alarm is more, Hence it is not practically implemented**.**

C. Automated video based Measurement of Eye Closure for Detecting Behavioural Micro sleep [3]

This system is proposed by Amol M. Malla and Paul R. Davidson in the year 2010. Here the author detects the movement of movement of the head by wearing the sensors fitted band around the neck. The sensors including the IR sensors and flux sensor is used for the detection of the movement of the eye. From the sensors, the degree of freedom known as Eulers angles is found. But from this system only the movement of the head is detected and rather than other important parts like eye and mouth is not detected. Most of the systems available in the market suffer from this drawback. A complete sleep detection system should detect both the movement of the eye and the mouth. Even though the system is cost efficient, this system can't able to predict the results accurately.

D. Fatigue detection system based on yawning estimation [5].

The Fatigue detection system was propped by S. Abtahi and B. Hariri in 2011. This system will detect the movement of the yawn and issues an alert to the driver, whenever the driver feels fatigue state. But it is better to send the alert message to the owner of the car instead of the driver. The model only consists of Yawn detection, but it is not sufficient for the complete detection of the drowsiness. The proposed system detects only the movement of yawn, but not eye.

E. Driver monitoring and event detection system [6].

The above model was proposed by Pelaz et. Al in 2014, which also uses the camera for the detection of eye. Here from the camera, the position of the eye is detected in a 3-D manner and a graph in 2-D format is drawn. From the graph the detection of the head is found. From the 3-D image the important region of the interest are estimated and the detection is made by using the Euler Angles. The Eulers angle is used to find the degree of freedom which is the main parameter of the Eulers angle. With the help of the Eulers angle the detection of drowsiness of the driver is measured but it is not practically implemented and the algorithm used in this model will not produce the accurate results. Most of the proposed systems suffered from few limitations especially in terms of accuracy of the results and delay in triggering the alarm. This type of model is very sensitive and accuracy really matters here. Since this model is going to be implemented in real time applications it is necessary for us to increase the accuracy in order to reduce the drowsiness related road accidents. Our proposed system will utilize all the advantages from the above mentioned systems and will provide a complete real time drowsiness detection system, that will help to reduce the drowsiness related road accidents.

III. PROPOSED SYSTEM

Drowsiness detection of driver is the most important factor for detecting the state of the driver. In the proposed system, the real time video is acquired with the help of web camera which is placed in front of the driver. The camera may be placed on the dashboard of the car or on the top of the steering. Then the video is sent to the raspberry pie for processing. This input is divided in to two segments, the first part of the image consists of the portion of eye and the second part consists of the mouth region. If the eyes have been closed for a specific duration i.e. 1.5 second, we assume that the driver is sleeping and then the alarm is triggered. At the same time the vibrator is placed either on the back side of the seat or in the steering to alert the driver. Similarly the movement of mouth is used for yawn detection and if the yawn count has increased a certain threshold level, the system will send a alert to the owner about the state of driver.

Eye and mouth detection is mainly done by using the Advanced Haar cascade algorithm, which is proposed by Viola and Jones in 2001. This algorithm is mainly based on machine learning. This algorithm mainly consists of two parameters. They are Eye Aspect Ratio and Mouth Aspect Ratio. For the eye region, the Eye Aspect Ratio (EAR) is calculated, which is the ratio of distance between the horizontal and vertical eye landmarks. If the real time EAR and MAR values jumps the threshold level, drowsiness is detected and it would trigger the alarm and also the vibrator. The vibrator will be placed either at the back side of the seat or under the seat. Similarly for the Yawn detection, if the MAR jumps over the threshold level, the Raspberry Pi sends an alert message to the vehicle owner indicating the state of the driver.

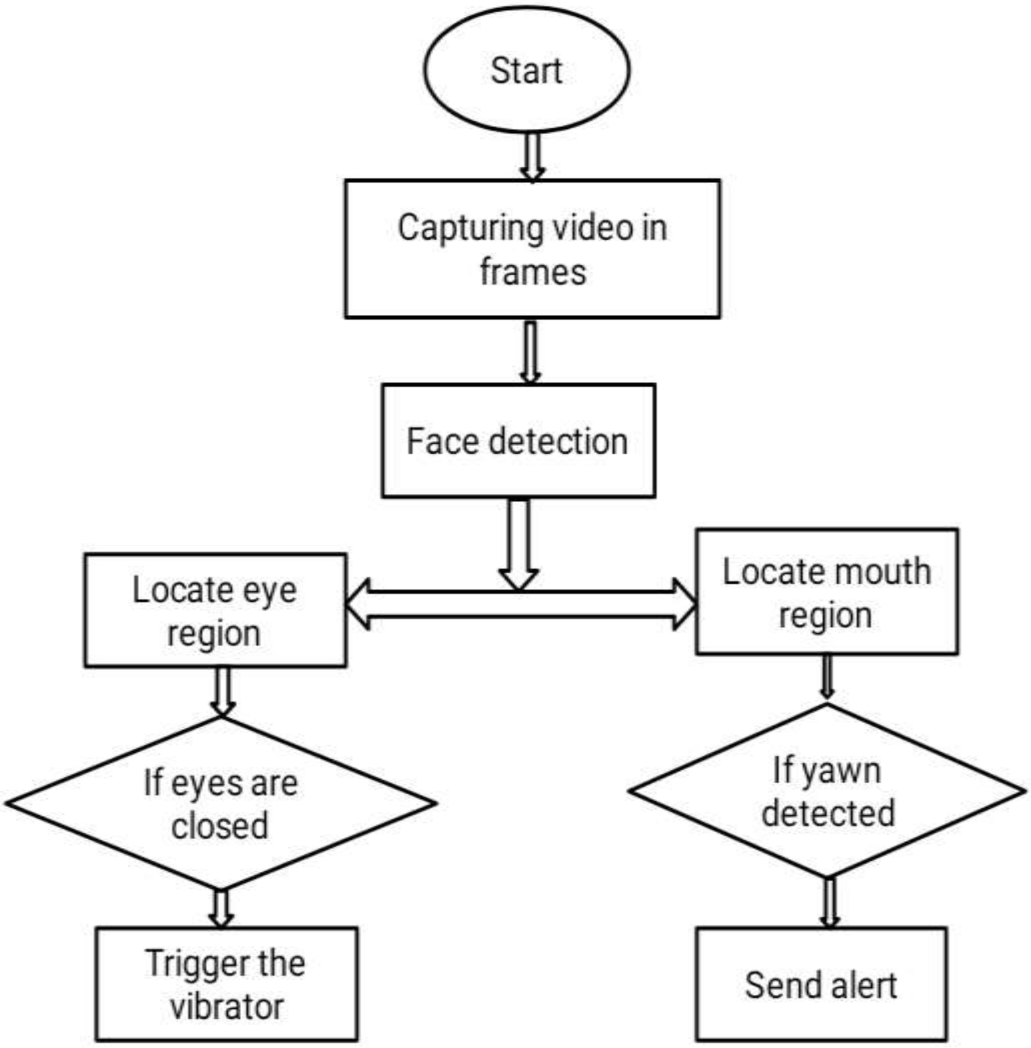

Fig.1. Architecture of the proposed system.

Figure 1 illustrates the architecture of the proposed system. Figure 2 represents the Eye Aspect Ratio of the eye when the eye is open. Figure 3 represents the Eye Aspect ratio at the time, When the eye is closed. In the first figure, the value of Eye Aspect Ratio (EAR) is a constant value which indicates that the driver is in a good mental state. In the figure 3 the value of EAR is zero, which indicates that the driver is in the fatigue state. If the EAR is constant, it indicates that the Eye is open. If the EAR value changes rapidly this indicates that a blink has occurred.

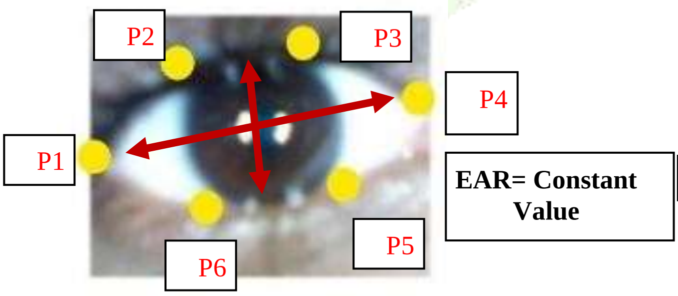

Fig.2. EAR value detected on open eye.

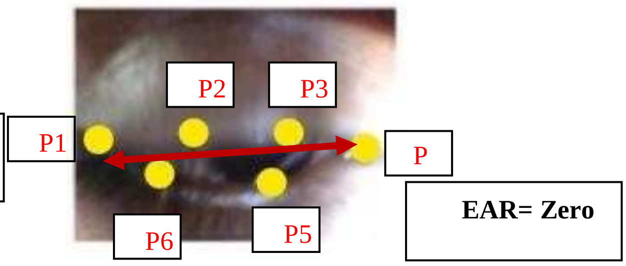

Fig.3. EAR value found on closed eye.

In this proposed system, If the value of EAR goes below a certain value, The number of frames the person had closed the eye will be counted. If the value of EAR is greater than the threshold value, our program will sent an alarm to driver and also trigger the vibrator. Our camera will capture 30 frames per second and we have set a threshold count of 48frames for sleep detection. If the person had closed his eye for a consecutive frame count of 48, then our system will alert the driver.

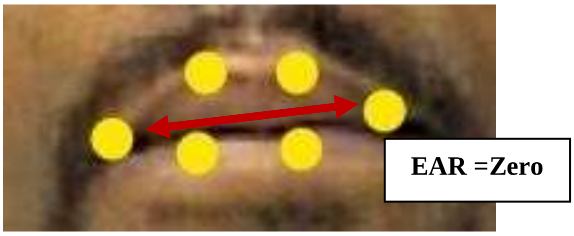

Fig.4. MAR value detected on closed mouth. (normal)

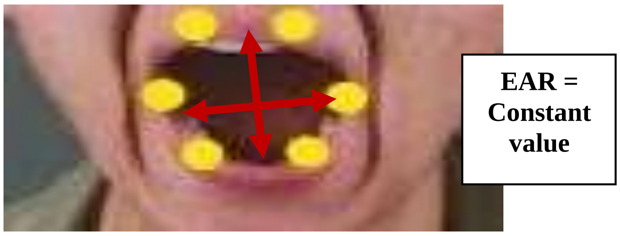

Fig.5. MAR value detected on open mouth. (Yawn)

Similarly for the Mouth Aspect Ratio, same procedure is repeated in a reverse manner. Here the MAR value is calculated, If the MAR value goes to 0, then it indicates the mouth is in normal position. If the MAR value is constant, then the system assumes the mouth is in open position. For MAR we have set a threshold mouth frame count of 120. If the person has open his mouth for a consecutive frame count of 120, then our system will send an alert message to the owner indicating driver's chance of feeling asleep.

IV. METHODOLOGY

The following flow chart will describe the working methodology of our proposed system.

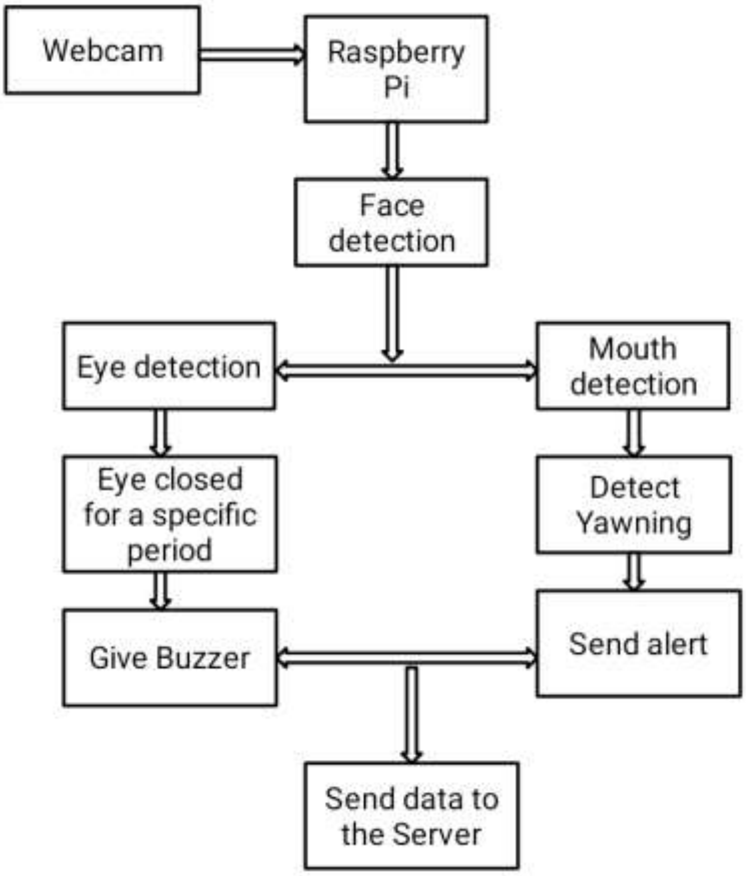

Fig. 6. Architecture of Driver Alert System

Figure 6 shows the overall methodology of the system and the Figure 7 shows the hardware setup of our proposed system. This entire system will function, when the driver starts the vehicle and this system will be switched off by pressing the power button provided in the raspberry pi

V. RESULTS AND DISCUSSIONS

Drowsiness is calculated by detecting the Eye Aspect Ratio and Mouth Aspect Ratio of eye and mouth respectively. This EAR and MAR value is mainly calculated by using the Advanced Haar Cascade algorithm and is implemented in python. Thus our system correctly detects the drowsiness and sends an alarm to driver to awake from his sleeping state. Figure 8 and 9 shows the output of our system in both normal and sleeping state.

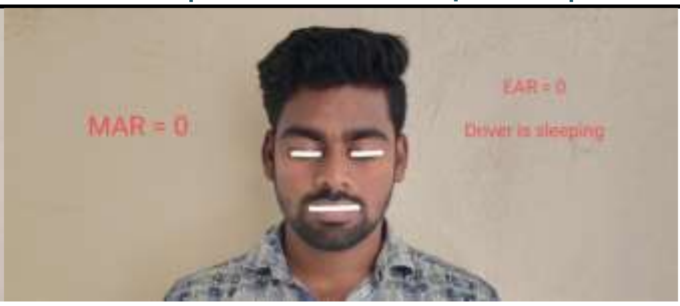

Fig.8. EAR and MAR value detected on open eye. Fig.8. EAR and MAR value detected on open eye.

The both EAR and MAR value is displayed continuously in the monitor and through that the physical state of the driver can be calculated.

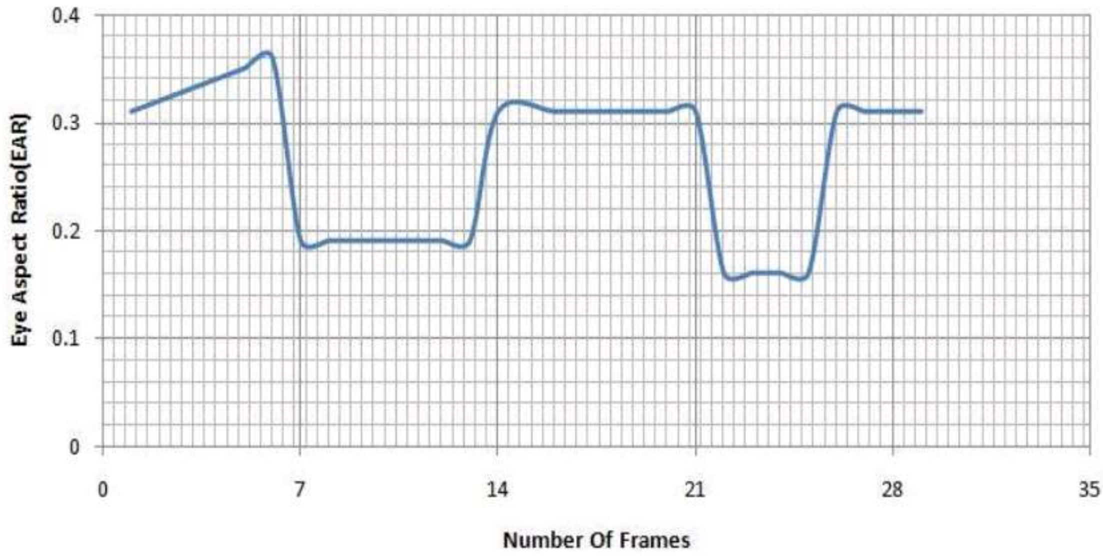

Fig.10. Graphical representation of EAR value in normal state

Figure 10 shows the graphical representation of EAR value in the normal condition. The lower steep denotes the close state of the eye and the top steep denotes the open steep of eye. In this graph the steep is in up down manner indicating the blinking state of the eye. From this graph, we can able to understand that the values of EAR should be increasing and decreasing continuously and if the EAR goes constant for 48 consecutive frames, then our system will send an alert message to the driver. Similarly MAR value ic calculated and a alert message will be sent to the driver.

VI. CONCLUSION

This paper presented the design of smart and efficient real time driver drowsiness detection system. Our proposed system is used to avoid the accidents occurred mainly due to human factor like drowsiness. This system also helps the driver to remain in a normal state by alerting using a alarm and also used to find the efficiency of the driver. Here the camera used with Raspberry pi is used to detect the drowsiness of the driver. The image of the driver is divided in to two parts. They are eye region and mouth region. From the eye region, the landmarks of both the eye is detected and the Euclidean distance between the horizontal and vertical position is detected. If the frame count reaches 48 then our system will trigger the alarm. Similarly from the mouth region the MAR value is detected and if the frame count reaches 120 for 4 times then our system will send an alert message to the owner. This system can be implemented in real time and the results are more accurate, when compared to the other existing systems.

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