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Care – Max for Drowsiness Detection and Notification

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ABSTRACT

This project proposes drowsiness detection and notification system for vehicles and a mobile application for car maintenance. The major objective of the system is to prevent the road accidents caused by driver falling asleep during the travel. The system for drowsiness detection has a camera that monitors the driver's eye continuously. It calculates the eye aspect ratio to detect if the driver is drowsy. If found drowsy, alarm rings. In this project, a Raspberry Pi board is used for drowsiness detection and alerting the driver. The IoT based mobile application built using android studio proposed here has certain settings like next service date, interval for wheel air checking, interval for wheel alignment. The app is connected to the system using IoT. The information is sent to the system. These settings are notified to the driver through a voice module.

KEYWORDS: *Raspberry Pi, Open CV, Android Studio*

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INTRODUCTION

Every year the amount of deaths and injuries are increasing drastically by road accidents. Mostly they are due to human errors like drinking & driving, over speeding, drowsiness etc. People can avoid the accidents caused by drinking alcohol. Unfortunately, not the accidents caused by drowsiness, as it is uncertain. People who drive long distance tend to fall asleep during less traffic hours or when travelling on straight roads. **Drowsy Driving Prevention Week is Nov. 1-8, 2020**. Though government is spreading awareness it is difficult to avoid this. Hence a system like this is needed to monitor the driver's state continuously. Care-max for drowsiness detection and notification to address this issue. The proposed system involves a camera which continuously monitors the eyes of the driver. There are already existing solutions for this challenge. But they result in more computational complexity and are costly too. The algorithm they use is also not very efficient and is not accurate. But our proposed system uses two vertical eye landmarks to find the aspect ratio. This is done using computer vision. The level of drowsiness is determined and alerts the driver by the alarm sound. This promises accuracy and cost efficiency. This will be very helpful in reducing the amount of accidents caused by driver falling asleep.

In addition to drowsiness detection and alerting, this system comes as a package that includes a mobile application. This mobile app has some settings that user enters for the first time only. The settings include interval of wheel air checking, wheel alignment, radiator check and service date of the car. This app sends the configured information to the system. The system uses a voice assistance module that remind user when to check air or when to put car under next service. This app communicates to the system using IOT. Hence, our system "CARE-MAX for drowsiness detection and notification" promises to give better results.

All the objectives are shown below:

A. To design and develop a system that detects drowsiness and alerts the driver, controlled by Raspberry pi.
B. To design a mobile application for vehicle maintenance using android studio.
C. To implement the drowsiness detection algorithm and successfully calculate the eye aspect ratio.
D. To develop the prototype of this system.

I. LITERATURE REVIEW

In this paper[1], Driver Drowsiness Detection requires a video sensor to detect the faces of drivers. If the face doesn't match the template the concerned authority will get a notification and inform the particular driver about the intrusion taking place. The GPS/GPRS module is connected to the controller and the location of the driver is send to the medical assistance. Accelerometer sensors are used in the system to record the speed of the person driving the car. All these are notified through the application. The camera can detect the face of the driver, we calculate the drowsiness level of the driver based on eye blink rate. If drivers blink their eyes more frequently, the authors assume that the drivers are drowsy.

In this paper [2], In order to find the drowsiness the eye blink sensor is used. A spectacle with eye blink sensor is used to detect the driver drowsiness and alerts the driver with buzzer, if driver is affected by drowsiness. They used the sensor like tilt sensor, eye blink sensor to detect and process.

In this paper [3], They illustrated that there are several methods to detect the drowsiness of the person driving the car. Drowsiness detection can be categories based on the vehicle, behaviour of the driver and sometimes the physiological factors. Detection technique based on the vehicle deviation from the lane or pressure on acceleration portal and also through pulse rate, heartbeat etc. The drowsiness detection is focuses on the behavioural factors of the driver. It includes the head tilting, eye blinking, eye closure, yawning. Author uses image processing to provide a solution to detect the drowsiness at the earliest and get time to avoid the danger.

II. MATERIALS

The drowsiness detection system reduces the count of accidents by the driver due to sleepy state. The group of hardware components is used for the detection of drowsy and android application is used for the notification which involves interval of wheel air checking, wheel alignment, radiator check and service date of the car. The various components are listed below:

1. Raspberry pi 3b+
2. Logitech Web camera
3. Speaker/buzzer
4. 5V Adapter

A. Hardware components:

Raspberry Pi 3 b+:

The Raspberry Pi 3 b+ is used to control the functionality. The program for drowsiness detection and notification is dumped into it. The Raspberry Pi 3 b+ is connected to the app through IoT.

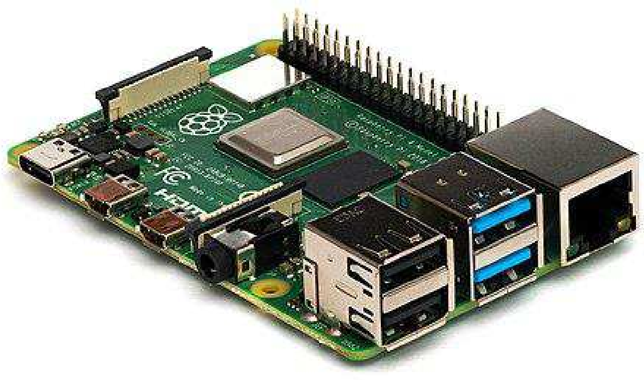


Figure1. Raspberry pi 3 b+

Web Camera:

The Web Camera is used to monitor the eyes of the driver during travel. This is given as input to the raspberry pi for processing as a live video.

Figure2. Web Camera

Speaker:

The Speaker is connected to the raspberry pi in one of its output port. It is used to alert the driver if he is drowsy. And also notifies the user of car maintenance intervals using a voice module.

Figure3. Speaker B. Overview:

In our proposed method, we have decided to use logi tech web camera along with raspberry pi 3b+ since it supports the library file well and has good speed rate. This method eliminates the use of sensors. The block diagram of the proposed is shown in figure 4

Power supply:

In this system, power supply of 5V with 2.5A is used for raspberry pi 3b+ by micro USB port. The power requirement is increased when it has the maximum interfaces. In our proposed system, Camera module requires only 50mA.

Figure4. Block diagram

Controller section:

Here raspberry pi 3b+ section is the control unit of the entire system. It is a single board system and has many ports including the USB port. Raspberry pi 3b+ has 1GB RAM with 64 bit processor. It is the fastest and most powerful device with quad-core ARM cortex.

Logitech web camera is connected to raspberry pi 3b+ and placed so that it has a clear vision of the face of driver without causing any interference. If the sleepiness of the driver is detected through camera it causes an alarm/buzzer sound.

Application:
Android app is created using android studio. It will have a login of the person having the vehicle. This mobile app has some settings that user sets for the first time only. The settings include interval of wheel air checking, wheel alignment, radiator check and service date of the car. The system uses the voice assistance module that reminds the user. Raspberry pi 3b+ connects with application using IoT.

III. ARCHITECTURE OF THE SYSTEM

A. Face detection:
To detect the face of the driver, a live video captured through web camera is given as an input to the raspberry pi 3b+. The stream of face in video is monitored and processed by the raspberry pi 3b+. The facial landmark detection with Dlib and Open CV is used. Dlib 5-points facial landmark detector is a technique that reduces the 68-point detector localizes regions which includes eyes, eyebrows, nose, mouth and jawline to 2 points for the left eye, 2 points for the right eye and 1 points for the nose. It also increases the speed of detection up to 8-10 % than the original version. But to build face detection for the drowsiness detection we use 68- point detector to get more points on eyes where only two points per eye in 5-point detector. It increases the accuracy of the detection.

The face detection model:
1. ***Haar cascades***: It is fast but have less accuracy.
2. ***HOG + Linear SVM detector:*** It is more accurate than Haar cascades with less false positives and also requires less parameters.

The Facial landmark detector is loaded and live stream is initialized. The each frame from the live video stream is processed and converted to grayscale image. We use haar cascades model to detect the faces in grayscale image. Each face is detected and visualized.

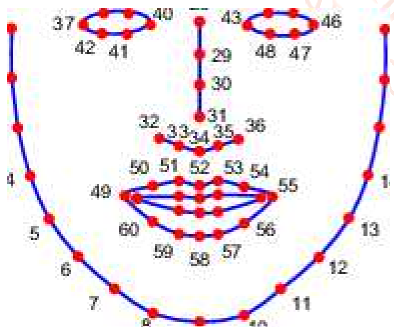


Figure5. Facial landmarks

B. Eye Extraction:
The face of the driver is detected. The drowsiness level of the driver is predicted by the eye blink rate. The eye landmarks should be extracted to calculate blink rate. The landmark points of the left eye and right eye is extracted by using facial landmarks indexes. The extraction points of the left eye and right eye is achieved easily.

C. EAR processing:
The face is detected and the eyes are extracted from the image. To find the eye blink rate and to predict the drowsiness eye aspect ratio (EYE) is calculated. Eye aspect ratio is the ratio of distances between the vertical eye landmarks and the distance between the horizontal eye landmarks.

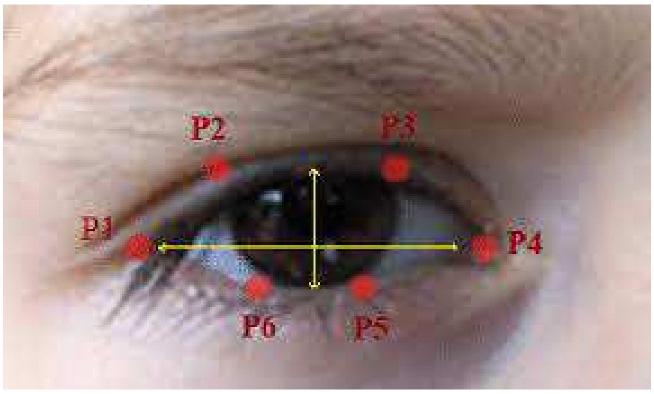
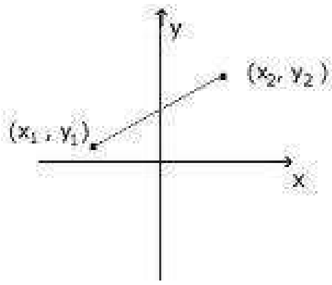


Figure6. Eye Aspect Ratio

The Euclidean distances between the two sets of vertical eye landmarks are calculated. The Euclidean distances between the horizontal eye landmarks are calculated. Then the (EAR) eye aspect ratio is computed.

Euclidean formula:

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$



$$d(p,q) = d(q,p)$$
$$= \sqrt{(q_1 - p_1)^2 + (q_3 - p_3)^2 + \cdots + (q_n - p_n)^2}$$
$$= \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2}$$

If the state of eye is open, the value of (EAR) eye aspect ratio will be constant. For every blink, the value of (EAR) eye aspect ratio will be a rapid decrease towards zero. If the state of eye is close, the value of (EAR) eye aspect ratio will be constant but smaller than when the eye is open.

$$\text{EAR} = \frac{\|p_2 - p_6\| + \|p_3 - p_5\|}{2\|p_1 - p_4\|}$$

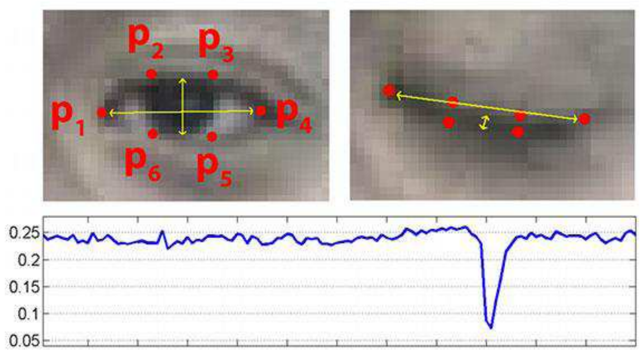


Figure7. EAR processing

Hence by the value of eye aspect ratio (EAR) the drowsiness can be detected.

D. Application:

In addition to drowsiness detection, this system comes as a package that includes a mobile app. This mobile app has some settings that user sets for the first time only. The settings include interval of wheel air checking, wheel alignment, radiator check and service date of the car. This app sends the configured information to the system. This application does the work of alert to the driver regarding the services of the car. The system uses a voice assistance module that remind user when to check air or when to put car under next service. This app communicates to the controller using IOT.

IV. METHODOLOGY

The camera along with controller is placed in front of the driver. So that the face of the driver is clear and they are no disturbance in driving. The driver sign into the application and configured all the setting. Through the live video the face is detected and eye is extracted. Considering the value of eye aspect ratio (EAR) the drowsiness of the driver is detected and alarms with a sound if the value of EAR is decreased. The controller connects with application through IoT. The remembrance of the details such as services and maintenance will be intimate via voice command.

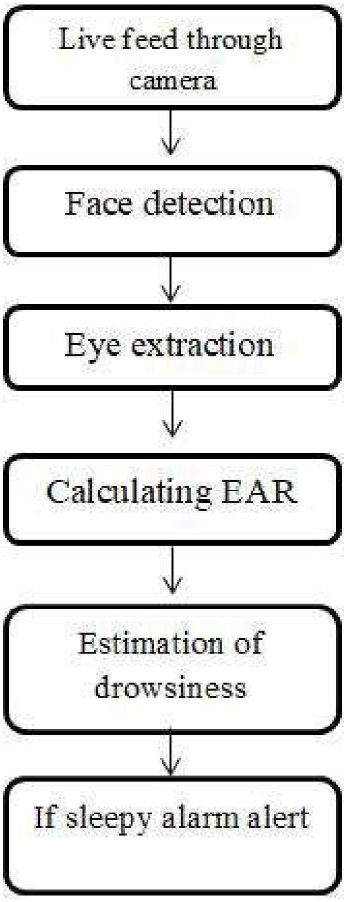


Figure 8.Flow chart of system

V. EXPERMENTATION RESULTS

This section provides the experimentation results of the drowsiness detection. Getting the highest accuracy is the challenge due to the poor lighting and unclear frame.

The camera detects the face of the driver and continuously monitors the state of eye. The eye aspect ratio is calculated for each frame which is used to find the state of the driver is detected.

Figure9. Eye extraction

In figure 9, The eye blink rate is normal and the person is in normal state. The eye is extracted and eye aspect ratio is calculated. Since the eye aspect ratio is constant and high, the system doesn't give the drowsiness alert with the alarm sound.

Figure10. Drowsiness detection

In figure 10, The eye blink rate is abnormal and the person is in drowsy state. The eye is extracted and eye aspect ratio is calculated. The eye ratio is reduces largely and stays constant. If it remains for some seconds, the system gives the drowsiness alert with the alarm sound.

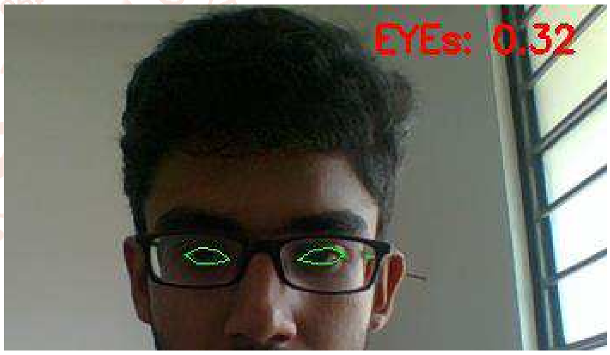


Figure11.Eye extraction from the frame

In figure 11, the eye is extracted from the frame though he wears specs. The drowsiness of the person is detected though the person wears specs.

A. Detection percentage in normal conditions

This section focuses on the observation of success rate in the normal condition.

Normal condition	Number of attempts	Success counts	Percentage
Eye blink	20	15	75

Table1. Detection percentage in normal conditions

B. Detection percentage for other parameters

This section focuses on the observation of success rate with some special condition such as person wearing glasses and hair covering the person

Parameter	Number of attempts	Success counts	Percentage
Person wearing glasses	20	7	35
Hair covering the person's face	20	5	25

Table2. Detection percentage for other parameters

VI. CONCLUSION

This project focuses on the drowsiness detection and notification regarding the wheel air checking, wheel alignment, radiator check and service date of the car. The system gets the live video as the input and detects the facial landmarks in the each frame. The eye is extracted and monitored. Depends on the eye aspect ratio state of the person is detected. If the person is in drowsy state system alerts by the alarm sound. According to the experimental results, the size of the model used to detect the face and eye is small. Hence, it can be integrated into car for the advanced automation. The future work will be focusing on the estimation of human behaviour such as yawning and distraction of the driver. Also the system can be integrated with the braking system to slower the speed of the vehicle when the drowsiness is detected.

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