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Real Time Alert System for Drivers

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***Abstract*—The significant causes of road accidents are fatigue and drowsiness of drivers. The usage of a driver drowsiness system will help in reducing the accidents which occur by driver's tiredness and resulting in more enhanced vehicular safety. This paper helps in presenting a system which can detect the drowsiness using facial movements such as eye blinks and yawns and alerting the driver about possible accidents using Raspberry Pi. The system will monitor the driver's frame continuously with the help of a Raspberry Pi camera. Then the captured frame is processed first using Viola Jones Algorithm to detect the face, eyes and mouth and eventually drowsiness and yawning. In the system, Eye Aspect Ratio (EAR) is calculated with the help of facial coordinates to detect the drowsiness. And yawn value (distance between upper lip and lower lip) is calculated to detect the yawning. And if drowsiness or yawning is discovered then an audio alarm using the "simple-audio" library in the python will be produced. System is tested with more than 25 videos and generating audio alert as expected.**

***Index Terms*— Face Detection, Drowsiness, Yawning, Driver Safety, Viola Jones Algorithm, Eye Aspect Ratio.**

I. INTRODUCTION

Drowsiness is defined as feeling abnormally sleepy during the day. There are chances that drowsy driver fall asleep in inappropriate situations or at inappropriate times. And it can be one of the reasons for road accidents. Drowsiness is mainly caused when the person is tired, not getting enough sleep. Falling asleep is not in the driver‟s hand so there is a need of a system to help the driver to stay awake. There are many methods for drowsiness detection for example, using body sensors, vehicle steer positioning, and lane object detection, but there are some disadvantages of using the above methods such as cost factors, accuracy. Detecting the drowsiness using facial features is accurate and cost is also low. There are four prominent measures to detect the drowsiness and those are duration of eye closure, eye blinking frequency, detecting the yawn and head rotation.
This paper is about the system which we have designed to accurately monitor the yawn as well as the drowsiness in real time. The system only uses eye blinks and yawns. since the detection of drowsiness should be fast. There would be no use of raising an alarm after the accidents have occurred. In this paper we are presenting a system which is used to monitor driver‟s drowsiness based on eye and yawn detection. Using the Raspberry Pi camera we continuously capture the driver‟s frame and process it first using the viola jones algorithm to detect the face, eyes and mouth and then discover whether the person riding the vehicle or the operator is drowsy ? by calculating the eye aspect ratio using facial coordinates and the yawn value (distance between upper lip and lower lip). And if the driver is found drowsy then the system will generate an audio alarm using the "simple-audio" library in the python and the alarm will stop automatically in a few seconds.

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The presentation of this paper in sections is as follows:
In section 2, literature survey of our topic real time alert system for drivers is discussed. Section 3 describes the motivation of the project. Section 4 gives the problem domain. In section 5, we have mentioned the problem definition. Section 6 describes the design. Section 7 describes the solution methodologies. Experimental results and analysis is shown in section 8. Also we have added figures of our output in section 8. Figure 8.1 shows the face detected by the Pi camera. A „Drowsiness alert‟ message is displayed on the output frame in figure 8.2 when a consistent drop in eye aspect ratio is found. In figure 8.3, a „Yawn Alert‟ message is displayed on the console when a person is found yawning. And Section 9 describes the data model. Section 10 gives the justification of results. Section 11 presents the conclusion and finally section 12 presents the references.

II. Literature Survey

For a literature survey of our project “Real Time Alert System for Drivers” we have considered below papers -
Paper[1] describes the system called Dricare using the analogue camera, vehicle device and a cloud server. The camera captures the driver‟s portrait and sends the video to the server accordingly. Then the server evaluates the video and there by detects the drowsiness of the driver. In order to meet the real time performance of the system, they have developed new algorithm called MC-KCF which optimizes KCF algorithm to improve poor face-tracking accuracy of the KCF algorithm.Once it is done,the cloud server sends the result to the driver‟s cell phone and a warning tone is transmitted if the driver is observed or happens to be drowsy. Disadvantage of this system is to alert the driver need to have a cell phone. In our system we are using buzzer to alert the driver which will remove the above disadvantage.
Paper[3] describes the drowsiness detection system which is based on eye closure and yawning. System will be alerting the driver immediately when the drowsiness conditions are met. They have used the image processing based techniques and they have used a template matching method for face detection and to detect eyes and mouth they have built eye map and mouth map images based on chrominance component. They accordingly have applied the algorithm to more than 100 images which are having different attributes. The images have been taken in different possibilities also.This system fails to detect skin when the lighting condition is dark.
Paper[5] describes the system which can help in detecting the driver's tiredness or drowsy problem that will help to avoid the necessary road accidents which will help saving the lives. The Raspberry Pi 3 is placed into the vehicle. A camera is mounted in front to monitor the driver‟s condition and the buzzer helps in giving a buzzing sound if the driver happens to be in the drowsy state. Gas Sensor is putted in order to sense the presence of alcohol and the vibration sensor to detect if an accident has happened or not. The sensors and camera are connected with the Raspberry Pi which is placed into the car and a notification message is sent using the IOT module.
Paper[7] describes the system which uses the front camera of the driver‟s mobile phone which has been placed on the windshield of the vehicle which constantly evaluates the behavior of the driver i.e. whether the driver‟s eyes are closed or not. The front camera which constantly captures the front image of the driver ie face of the driver,eyes and mouth and with the help of facial expression detection technique it helps in checking whether the eyes of the driver are closed or not. The image captured is then compared with thousands of previously stored expressions in the database to give the best result using machine learning algorithms. And if the driver is found to be drowsy then a timer is started and after some instance alert is also activated. This alert is then used to trigger an external low powered buzzer which is activated with the help of Bluetooth signal sent via mobile of the driver. Drawback of the system is it is implemented on the driver's phone which is not a feasible solution in every case. In our system we are using Raspberry Pi to remove the above drawback.

III. Motivation

The significant causes of road accidents are fatigue and drowsiness of drivers. The usage of a driver drowsiness system will help in lowering the accidents which occur due to the driver‟s tiredness and will eventually result in increase of vehicular and individuals safety. So we have developed a system called “Real Time Alert System for Drivers” which will help to reduce the number of accidents.

IV. Problem Domain

Artificial Intelligence and IOT

V. Problem Definition

The significant cause of road accidents is drowsiness of drivers. The usage of a driver drowsiness system will help in lowering the accidents which occur due to the driver‟s tiredness and will eventually result in increase of vehicular and individual safety. So we have developed a safety system which is used to monitor the driver's frame continuously with the help of a Raspberry Pi camera. Then the captured frame is processed first to detect the face, eyes and mouth and then to detect drowsiness and yawning. And if drowsiness or yawning is detected then the audio alarm will be generated which will wake up the driver and possible accident will get prevented.

VI. System Design

Figure 6.1 shows various blocks of the proposed system and their specifications. The system is composed of 5 different modules namely (a) Video acquisition and Dividing into frames, (b) Face detection, (c)Eye and Mouth detection, (d)Drowsiness Detection, (e) Alerting the driver. Along with these, there is one external hardware component, Raspberry Pi camera for video acquisition.

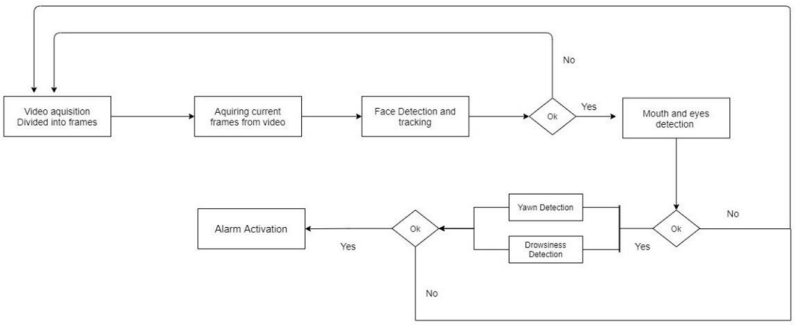

Figure 6.1 System Architecture

A. Video acquisition

Video acquisition involves acquiring the stream of the driver. For this Raspberry Pi camera is used.

B. Dividing into frames

In this module the live feed is taken as input and is converted into a sequence of frames or images, these are then processed later.

C. Face detection

In face detection, each frame is processed at a time and in each and every frame the face of the vehicles driver is detected by the function. This is achieved by using a set of predefined samples.

D. Eyes detection

After the face detection the next step is to detect the eyes of the automobile driver.

E. Mouth detection

Next step is detecting the mouth of the driver to check whether he/she is yawning or not. The mouth detection is also achieved using predefined samples.

F. Drowsiness detection

The next step is to detect drowsiness. It is accomplished by taking into discussion several parameters like the eyes state, whether it is open or closed and the yawns that is distance between upper and lower lip.

G. Alerting the driver

Once a driver is caught as drowsy, a voice alert will be given to wake him/her up

VII. Solution Methodologies or Problem Solving

In the proposed system, the algorithm used for detection is Viola Jones algorithm.

A. Viola Jones algorithm for face detection

First the faces are extracted from the images of the driver with the help of already inbuilt object detector i.e.cv2.cascadeclassifier(„Haarcascade_frontalface_default.xml‟). Once the face gets detected, it is passed to the predictor which will detect different landmarks such as eyes and mouth.

B. Viola Jones algorithm for eyes detection

The eyes detection is done with the help of already inbuilt system object detector for eyes in the image. Using the Viola jones Haarcascade features the system is detecting the eye of a driver.

C. Viola Jones algorithm for mouth detection

The detection and extraction of the features from the mouth region is based on the Haar features to encode the details of the mouth. The region of the mouth may be detected based on the already stated location of the eyes ,nose, lips that will be detected using this algorithm.

D. Drowsiness Detection

After successfully passing the above modules, the next step is to detect drowsiness. It is achieved by taking into account several paarmeters like Eyes state whether it is open or closed. The technique which is being used here for drowsiness detection is EAR i.e. Eye Aspect Ratio. It works on the already specified coordinates mentioned in the algorithm, accordingly which detects drowsiness.

E. Yawn Detection

The technique which is used here is calculating the distance between upper lip and lower lip and setting at threshold value. If the distance exceeds the given threshold value, yawn is detected.

Viola Jones Algorithm

The Algorithm we have used in our project is Viola Jones[9]. It is learning based algorithm primarily used for object detection. As an input we are taking live video from the Raspberry Pi camera and using the technique we are taking the current frame from the video and there from detecting the face of person. If the face is detected then we go on to the second stage i.e. Face feature extraction (eyes and mouth region). We are validating whether the face detected from the image is valid face or not, so face feature extraction helps in doing that. Viola Jones Algorithm uses Haar-like features (Haarcascade) to detect the faces.

The Haar features are calculated by Integral image. This algorithm works on grayscale images. It contains variety of options of the face, like height, breadth and thresholds of face colors. The algorithm first detects the face on grayscale image and then the location of the face is pointed on the colored image. The algorithm outlines a box and then searches for a face within that box. It is searching for haar- like features. If all the stages are passed then the output is passed to the last stage i.e. Classification technique there by giving us the required output whether the driver is drowsy or not.

The algorithm for the proposed method is as follows:

1. Video streaming begins.
2. Setting the threshold parameters with default values such as THRESH_TO_CHECK_EAR = 0.3
   FRAMES_TO_BE_CHECK = 35
   THRESH_TO_CHECK_YAWN = 20
3. After setting the threshold parameters we are setting the number of frames to which these default parameters are applicable i.e. as per mentioned above the FRAMES_TO_BE_CHECK = 35 will be continuously checked for these many types of frames and if the default parameters are less than the mentioned then the respective drowsiness, yawn function will be invoked.
4. Accordingly we are setting the alarm_status = False to two different functions of drowsiness and yawn and when the certain function will be invoked the status will be turned to True respectively. This will activate the alarm/buzzer and that will be automatically deactivated when the driver will wake up.

OpenCv in Python

In OpenCV, there are many trained Haar Cascade models and these are saved as XML files. Instead of creating and training the model from scratch, we used this file. Due to this it becomes more easy to detect the features. As OpenCV mainly focuses on image processing, video acquisition including features like face detection and object detection that is why we have used it in our project.

VIII. Experimental Results and Analysis

The consequential outcomes consist of the obtained images after completing the above mentioned process. Figure 8.1 shows the face detected by the Pi camera. The face which has been detected is being pointed out with points and landmarks such as eyes and mouth.

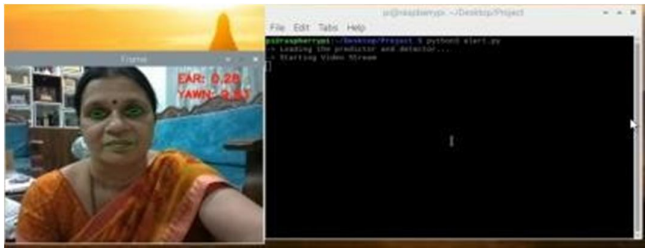

Figure 8.1: Eye Aspect Ratio and Yawn Value

Since eye aspect ratio (EAR) is calculated consistently for both the eye points and calculated EAR for those points are displayed on the screen. A „Drowsiness alert" message is displayed on the output frame figure 8.2 when consistent drops is found. An woke up alarm is buzzed along with the notification in the background, which cannot be captured at this moment.

Figure 8.2: Drowsiness Alert Message

In figure 8.3, a „Yawn Alert" message is displayed on the console alongside which the buzzer is ringing in the background as the yawn value fell below the specific value given for a frame and hence driver is noticed drowsy.

Figure 8.3: Yawn Alert displayed on screen

IX. Data Model

As we are taking Live video of the driver in our project, so we are not storing our data anywhere in our project and because of this reason there is no use of database anywhere. In our system, the video is continuously searching for a face and its face features too and alerting the driver whenever he/she is found drowsy.

X. Justification of Results

In this system we have taken various inputs from various people. This system detects the eye, mouth region and based on that detects the drowsy state of driver and alert them. Using Viola Jones algorithm we detect face and then we are calculating EAR which is vary from person to person. After conducting this system on different sets of people we have set an average EAR. We have done same with yawn value. If EAR is less than threshold value (<0.3), it will generate an audio alarm by using "simpleaudio" library in python. And also if yawn value is greater than threshold (>20) it will generate an alarm. In this way it will awaken the drowsy driver.

XI. Conclusion

In this paper, a real time alert system for drivers is developed which can predict drowsiness and wake up the driver while driving in order to reduce accidents caused due to the drowsiness. The Raspberry Pi camera is utilized to capture the driver‟s frame continuously. Sleepiness is estimated by extracting eye and mouth from the face utilizing a shape-indicator and calculating Eye Aspect Ratio (EAR) and yawn value. At the point when the system detects drowsiness, the driver will be alerted by the voice which will wake the driver up from the rest state. The system can be further made better by using an infrared camera for efficient picture quality so that it can be used for people with brown complexion and for the people with small eyes.

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