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Implementing Driver Drowsiness and Attention Detection System

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A B S T R A C T

This paper is a follow up to our previous survey paper on driver drowsiness and attention detection techniques. After considering both advantages and disadvantages of various methods of drowsiness and attention detection. We found out that a system with image processing techniques was more suited for building an accurate and a cost effective system. In this system we will use something known as Haar Cascade classifier to detect the face in a video frame which is obtained from a dashboard camera present in the user's automobile.In the next step we will extract various facial landmarks form the detected face using facial landmark predictor.After that we will be determining the state of various facial landmarks like eyes,mouth,lips etc. Comparing these states with the predetermined thresholds we will determine whether the user is drowsy or not and whether he's attentive or not. On detection of either of these based on severity we will play different alarm sounds or send text alerts/notifications to users cell phone or any emergency contacts if specified. So by implementing this system we aim to prioritize human safety and reduce accidents as much as possible.

Keywords: Face detection, Facial feature extraction, Attention Loss detection,Drowsiness detection.

1 Introduction

Car accidents are a major problem in the community, with statistics on the rate of injury or death due to a rising car accident. There are many non-driver-related causes in car accidents including road conditions, weather and mechanical operation. However, a large number of car accidents are caused by driver error. Driver error includes drunkenness, fatigue, and drowsiness. There are several methods used to detect driver's drowsiness. The first category is based on vehicle data such as vehicle position in lane monitoring and Steering pattern monitoring. The advantage of this method is that data can be easily collected if it is available on Controller Area Network without need of any additional piece of hardware. The disadvantages of this approach is that road conditions and driver behavior can lead to false detection or may not detect micro sleep depending on calibration parameters. The second category involves methods that are based on driver's physiological measurements such as electrocardiogram (ECG), electromyogram (EMG), electroencephalogram (EEG) and electro-oculogram (EoG). To implement this method, an electrode needs to be attached to the driver's body. But this may not be acceptable to automobile companies as well as to the drivers. Thus, this has not been effectively used so far. The third category involves methods that are based on driver's eye/face monitoring.

In 2009, Mercedes-Benz launched a program called Attention Assist that monitors driver fatigue and drowsiness depending on his or her driving input. It gives a visual and audible alarm to alert the driver when he is asleep so that he can continue driving. It is connected to the car's navigation system, and uses that information to tell the driver where to find coffee and gasoline. Volkswagen has developed a driver fatigue system, which can automatically monitor the driver's driving features and detect drowsiness. In this paper, the drowsiness is detected using the state of eyes and mouth of the driver. A camera is utilized to capture the driver's face. Haar cascade classifier to detect and crop the face from the frame. A pre-trained model of the dlib library called shape predictor 68 face landmarks to predict facial landmarks trained on iBUG 300-W dataset. This method is effective as compared to others as the sleepiness of the driver can be captured through their eyes and mouth.

2 Problem statement

Drowsiness is a process where one level of consciousness decreases due to lack of sleep or fatigue and it can cause the driver to fall asleep quietly. When the driver suffers from drowsiness he lose control of the car, therefore he may suddenly deviate from the road and strike an obstacle or the car might roll over. Although automobiles changed people's way of life and improved the ease of use of performing daily activities, it is also combined with various side effects, such as road accidents. In these accidents,fatigue driving created an almost hidden danger from road accidents. In recent years, the discovery of driving fatigue has become a hot topic of analysis.

In the proposed driver drowsiness detection system, the sequence of images are acquired by the proposed hardware and are injected as input to the system. For

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image processing they have used binary eye image data. We have used matlab to convert the RGB image to grayscale and grayscale image to binary image. From the binary image they crop into the eye region and check for the presence of eyeball in the eye region(to detect closing of eyes),Using this data they are detecting the closeness/openness of eyes.Using this data they are predicting the drowsiness of the driver.

3. Materials and Methodology

The implementation of this system is done by splitty the system into various modules. The system mainly consists of four basic modules the first one is the prepossessing module which is used to capture the and enhance the live feed of the user. The next one is the facial feature extraction module which uses face detectors and facial landmark predictors to predict facial features. The third is the drowsiness detection module which is used to detect drowsiness.The fourth module is attention detection module to detect loss of attention.In addition to this there is also an alert module which is used to alert the user of detection of drowsiness or loss of attention. Once the face of the user is detected in the frame the information is passed on to the image processing module for the detection of eye and mouth and then to the drowsiness detection module from there alert module is used based on detection..The flow of system and modules is shown in fig4.

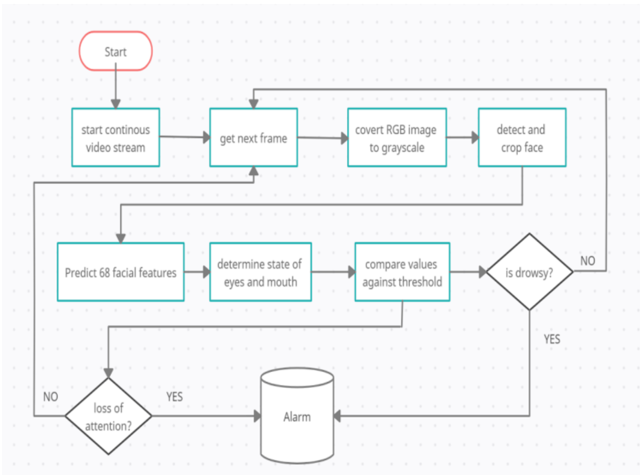
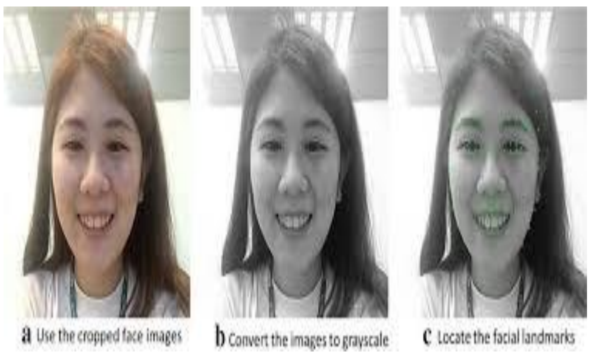


Figure 4, System Architecture

A. Image Preprocessing Module

During the image acquisition process, the image quality is affected and the system may not be able to extract facial features. For accuracy of detection, we use a lighting enhancement method to process images before following the driver's face. After illuminating the image we can also convert the image into grayscale images. A basic approach to convert RGB images to grayscale images is by taking the average of RGB values for every pixel. By using grey scale images we can reduce processing time thereby making the system work in real time.



B. Implementation of facial feature extraction

In this step the state of various facial features like the eye, mouth of the driver is detected. Then, we use 68 facial landmark prediction models of the dlib library to locate 68 facial key points on the driver's face.

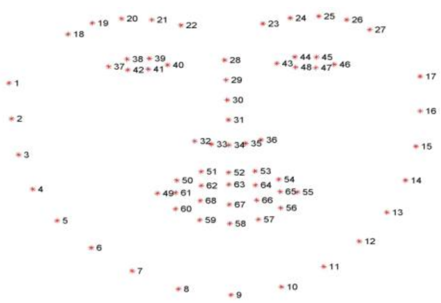


Figure 5, 68 facial landmarks

C. *Driver Drowsiness detection*

Eye status Recognition based on Euclidean Distance: The Euclidean distance of horizontal and vertical distance of eyes are considered. To detect if the eye is closed we wish to compute the ratio of the gap between the horizontal eye landmark and so the space between the vertical eye landmarks.We will achieve this by using the points present in and around the eyes.

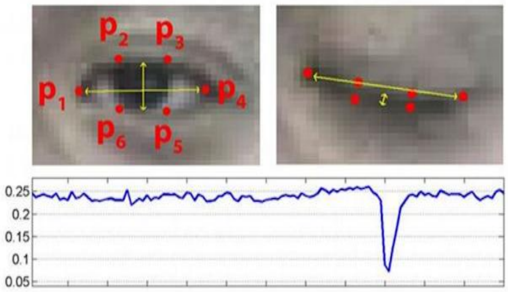


Figure 6, Eye aspect ratio.

Based on Soukupová and Čech's work in their 2016 paper, Real-Time Eye Blink Detection using Facial Expressions, in which case we can find the equation that shows this relationship called the eye aspect ratio (EAR).The equation considers six points in and around the region of interest that is eyes.

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

Where p1, …, p6 are the coordinates of facial landmark locations. The divisor is that the distance between horizontal eye landmarks weight the divisor suitably. Similarly, the dividend of this equation is the distance between the vertical eye landmarks.

Mouth State detection Based on Width and Length:
In order to detect yawning, the gap between the upper lip and lower lip is taken into consideration. There are 20 key points around the mouth, but only 6 points around the top and 6 points around the lower lip are considered. So the point of reference will be taken around the upper lip and lower lip for a yawning effect. Broadly speaking if the space between the standard points is greater than the given time limit, we will come to the conclusion that the person is yawning and is drowsy.

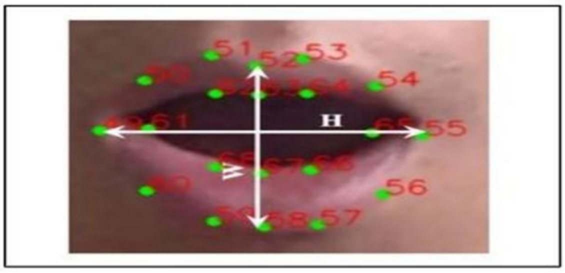


Figure 7,coordinates around the mouth

D. *Attention detection*

For attention detection the system will track the position of eyeballs continuously from the facial features that were extracted using sixty eight facial landmark predictors in the drowsiness detection module itself. So the task of this module is reduced only to attention detection. If the eyeballs are offset from their original position then the system recognizes this as classifies the user as loss of attention and the system sends an alert to the user.

Figure 8, Eyeball tracking to detect loss of attention of the driver.

E. Alert Module

After drowsiness is detected, the system will alert the driving force by a sound inside the vehicle. It might be a buzzer playing through the cars speakers.Simultaneously alert notifications will be sent as a SMS to predefined mobile numbers, along with the message, these coordinates of the actuation are going to be sent along.The user/driver can turn off the alarm and the messages.

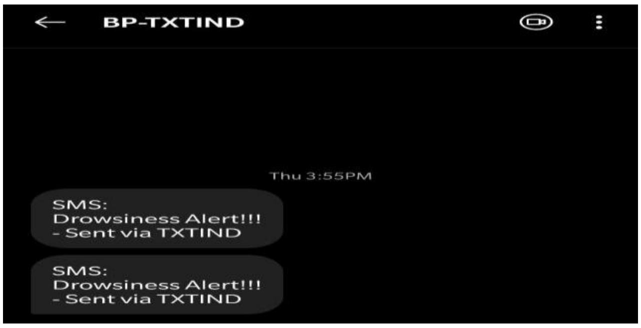


figure 10, Text alert sent on detection of Drowsiness

4. Results

The system showed accuracy of 99.59% in face and eye detection in well lit environments. As our system is highly reliant on detection of facial features this accuracy shown by the system plays a key role in detection of drowsiness and attention detection. The system was also able to predict drowsiness and attention of drivers at an accuracy of 85%. We found out that drop in accuracy was due to multiple reflections caused by lenses present in the spectacles. But the system was not effective in low light conditions as the camera was unable to pick up facial features. We believe that a camera with night vision capabilities would prove to be effective in these conditions.

TABLE II. ACCURACY RATE OF FACE AND EYE DETECTION

Gender	Accuracy Rate of Face and Eye Detection			
	Total Blinks	*True Positive (%)*	*False Positive (%)*	*False Negative (%)*
Male 1	95	100.00	0.00	0.00
Male 2	103	99.03	0.00	0.97
Male 3	100	99.00	1.00	1.00
Male 4	83	98.80	1.20	1.20
Male 5	88	100.00	11.36	0.00
Female 1	99	98.99	0.00	1.01
Female 2	100	100.00	3.00	0.00
Female 3	100	100.00	1.00	0.00
Female 4	100	100.00	0.00	0.00
Female 5	98	100.00	5.10	0.00
Total	**966**	**99.59**	**2.17**	**0.41**

5. Conclusion

The drowsiness detection system that takes live images from the continuous video feed to detect the difference between the open and closed eyes of the driver has been successfully implemented. In addition to that Attention detection by tracking the movement of eyeballs is also implemented.To detect drowsiness, three or more consecutive open or closed eyes states are considered. If this occurs, it is an indication that the driver is drowsy and then the system gives a warning signal to the driver. The system can detect the condition of the eyes with or without normal glasses. The system can give inaccurate results in certain situations due to the effect of light, the position of the driver. With future improvements, the system can be made more robust so that these three things may not be a hindrance to captivity accurate results. The system can be set to read automatically to set the limit values for continuous improvement. In addition to this, in turn, can be read from one or more of the data other things like steering wheel, track clock, and gas Step etc.

FUTURE SCOPE

Future work might concentrate on the use of outer factors like vehicle states, sleeping hours, climatic conditions, mechanical information, etc, for fatigue activity. Observing the driver's state of sleepiness and vigilance and providing feedback on their condition so they'll take applicable action is one crucial step

during a series of preventive measures necessary to handle this drawback. presently there's no adjustment in zoom or direction of the camera throughout operation. Future work could also be to
mechanically pore on the eyes once they're localized. This project is often enforced within the kind of mobile application to scale back the price of hardware.

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