Drowsy Driver Detection Based on Eye By Using Digital Image Processing

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ABSTRACT – Driver errors and carelessness are main cause of road accident nowadays. The major errors of drivers are concerned drowsiness, drunken and reckless behavior of the driver. This paper focuses on driver drowsiness detection based on eye by using Digital Image processing technique. The proposed system is a non intrusive driver drowsiness monitoring system that is able to detect drowsiness of driver in wearing spectacles and dim light level. The proposed system is implemented or tested by using webcam to capture image then face and eye detection techniques used. The intensity of eye blinking area is checked to determine whether eye is close or open. A alarm is made on eye close condition. The samples are collected from left side, right side and with spectacles. The accuracy of the system is 98% and time taken to perform a sample is 30-50 sec.. which is quite satisfactory.

Keywords : Digital Image Processing, MATLAB, Face recognition.

1.INTRODUCTION

Drowsiness is one of the difficult issue in road mishaps. The casualty rate due sluggishness is exceptionally higher. The worldwide status give an account of road security distributed by the World Health Organization (WHO) recognized the primary driver of road accident are because of driver slip-ups and lack of regard[1]. A mishap including driver sluggishness has a high casualty rate on the grounds that the perception, affirmation and vehicle control capacities lessen forcefully while driver nodding off. It is discovered that laziness is one the central point that causes latency of the driver. It prompts expanded in number of road mishaps every year. On the off chance that sluggishness is identified sufficiently early, at that point it could spare numerous road accident[2].The developing number of mishap in world as of late has turned into an issue of genuine worry for the general public, so mishaps must be forestalled before they occur and this thing relies on the driver[3]. Anticipating mishaps brought about by sluggishness requires a procedure for distinguishing languor in a driver and a method for exciting the driver from that lethargic condition. The venture portrays a framework that utilizes a picture handling method to perceive the open or shut condition of the driver's eyes as a method for identifying laziness in the driver's seat. The anodes that were connected to the body of the driver were tiring and discomfortable for the driver. The driver was likewise feel uneasy and ready to focus on driving because of this. The cathodes required time to time substitution. There were some different frameworks additionally that were actualized to distinguish the sluggishness of the driver utilized GSR, ECG, EMG[3]. These framework additionally required the connection of the sensors to the body of the driver.

The analysis of face image is a famous research area with applications, for example, face recognition, virtual tools, and human identification security system. This venture is centered around the localization of the eyes, which includes taking at a entire image of the face, and deciding the position of the eyes by a self developed image processing algorithm. When the situation of the eyes is located , the system is designed to decide if the eyes are opened or shut, and detect fatigue.

II REVIEW LITERATURE

This chapter reviews concepts and theories by researchers that are highly related to the area of study. The chapter provides a critical analysis of the views and insights of various researchers on the subject area. This chapter also review of existing work and describe strength and weakness of drowsy driver detection techniques.

Kumar Ashish and Patra Rusha, 2018 explained about a low cost real time drowsiness monitoring system. This system was based on visual behaviour and Machine Learning. They discussed visual features like eye aspect ratio, mouth opening ratio and length ratio are computed from facial images, captured by a webcam. An adaptive thresholding technique was developed to detect driver drowsiness in real time. The features values were stored and machine learning algorithms was used for classification on synthetic data. Bayesian classifier, FLDA and SVM was explored here. The sensitivity of FLDA and SVM is 0.896 and 0.956 respectively , the specificity was 1 for both. As FLDA and SVM gave better accuracy. The system was developed for drowsiness detection online[1]

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Kumari Kusuma B.M., Kumar Ramakanth P., 2017 presented a survey on Drowsy Driver Detection System . They discussed about subjective, vehicle, behaviour, physiological, hybrid based measures for drowsiness detection system[2].

Oraan Khunpisuth, et-al, 2016 proposed Driver Drowsiness Detection using Eye-Closeness detection system. They used Raspberry Pi 3 Model B Raspberry Pi camera to acquire the image. The drowsiness of driver was detected by face, eye blinking, and head level. The face detection was done using the Haar Cascade Classifier with different light conditions. The problem was solved by using geometric rotation. If driver tilts the head, the image could be rotated into an upright face by calculating angle. The rate of blinking of eye indicated drowsiness of driver. If the driver blinked too frequently drowsiness indicated and loud audible warning issued[3].

Chellappa Yogesh, et-al, 2016 explained about driver fatigue detection system. They considered both physiological and physical signs. Physiological factors included like body temperature and pulse rate. Both these parameters decreased during the drowsiness. It was monitored by using somatic sensors and physical parameters were included yawning, drooping eyelids, blinks duration. The over all accuracy achieved about 80.55%. In cases where the driver was not drowsy, recorded 62.5% and in cases where driver was actually failing drowsy, recorded 85.71%[4]

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Ahmed Javed, et-al, 2015 proposed a non-intrusive computer based idea to detect drowsiness of driver. The small camera was used to get the driver's image. The histogram equalization method used to adjust contrast and Haar Cascade is used to detect the features from the image. The reflection of retina was used to check whether eye was closed or not[5]

Clement F.S.C., et-al, 2015 proposed a non intrusive and intelligent soft computing tools. They developed an algorithm for detection of drive fatigue by analyzing the changes of eye status in five phases i.e. judgment of face existence, face location based on mixed skin tone model, eye location and eye template generation, eye state analysis, confirmation of driver vigilance. The fatigue was detected by using Electro OculoGram(EOG), Electro-Encephlogram(EEG)[6].

Kumar Madhan A, et-al, 2019 proposed drowsy driving warning and traffic collision information system using IoT system. In this system Haar Cascaded algorithm was used for eye detection. An IoT based module was used to get location information and to send message. WiFi module was used to update location information in the server[7].

Sasikala R. et-al, 2017 developed a system to detect drowsiness of driver by detecting eye state. They developed real time eye detection system. A special circuit was designed by using different hardware component to notice eye state. At point when the eyes were closed for really long time, warning sign i.e. buzzer was issued to driver and also stop the vehicle, if the driver did not response the buzzer[8].

Vesseleny T., et-al, 2017 developed a system to detect drowsiness of driver, it was based three type of methods i.e. EEG, EOG signal processing and driver image analysis. In this paper the authors have studied the possibility to detect the drowsy or alert state of the driver based on the image taken during driving and by analyzing the state of the driver's eyes opened, half opened and closed. They used ANN to detected driver's eye state. They used two kind of ANN, hidden layer network and an auto encoder network[9].

Panicker Arun D, et-al, 2017 proposed a system, it was based on Open-eye detection using iris-sclera pattern analysis for driver drowsiness detection. This was based on computer vision techniques. This system detect drowsiness in three main stages. The first state was face detection using elliptical approximation and template matching technique. In second stage, the open eye was detected using iris-sclera pattern analysis method. In third stage, the drowsiness state of the driver was determined using percentage of eye closure (PERCOS) measure. The accuracy of system was 93%[10].

III PROPOSED SYSTEM

At first the images are recorded using the Webcam. Further picture changed over in Gray Scale format. After converting in gray scale format first human faces are detected from images. Numerous face detection algorithms are available there. In proposed work Paul Viola and Michael Jones algorithm for face detection are used[11]. By using this algorithm both left and right eyes from face are detected or rectangled. This valuable part which can be said ROI, is cropped. It is observed that if eye is open then white part of this cropped block having some high intensity value comparatively black part and it show some high mean value , if eye is close then there will be only skin part (no white part will be there) and it show some low mean value. This method will decide eye is open or close. If drowsiness is detected, a message or alarm sent to driver. The details of each block are discussed below.

i. Flow Chart of the proposed work

Fig 1. The Flow chart diagram of the proposed drowsiness detection system

Whole functioning of the system is depicted in above flow chart. The first step to read / input image by using camera then it is converted to gray scale format. Again input choice for checking left or right eye. Now apply Haar Cascade Classifier and separate facial feature from the image like eye. After that crop eye block and computer mean intensity value of that block, the mean intensity value decide whether eye is open or close.

ii Step by Step Procedure

Step 1. INPUT Image
Step 2. CONVERT IMAGE to Gray Scale
Step 3. INPUT CHOICE (1 for left and 2 for Right)
Step 4. IF CHOICE ==1
Step 5. COMPUTE (vision.CascadeObjectDetector( ))
Step 6. CROP EYE BLOCK
Step 7. COMPUTE INTENSITY
Step 8. IF MEAN INTENSITY < 75
Step 9. MSGBOX ("EYE Closed") and ALARM
Step 10.ELSE MSGBOX ("EYE Is Open")
Step 11. END
Step 12. ELSE
Step 13. COMPUTE (vision.CascadeObjectDetector( ))
Step 14. CROP EYE BLOCK
Step 15. COMPUTE MEAN INTENSITY
Step 16. IF MEAN INTENSITY < 75
Step 17. MSGBOX ("EYE Closed") and ALARM
Step 18. ELSE MSGBOX ("EYE Is Open")
Step 19. END
Step 20. END

iii Proposed Work

This segment decide the basic steps or functioning of proposed work. We perform the task by executing one by one step.

a. Image Acquisition

In this project the images are captured by using Webcam and directly transferred to PC in to a specific folder.

b. Face and Eyes Detection

After obtaining the image, first the human faces are detected. Numerous face detection algorithms are there. The proposed work used Paul Viola and Michael Jones approach towards "Rapid Object Detection using a Boosted Cascade of Simple Feature"[11]. The method efficiently detects faces from an image with good accuracy rate.

- The first is the introduction of a new image representation called the "Integral Image" which allows the features used by our detector to be computed very quickly.
- The second is a learning algorithm, based on AdaBoost, which selects a small number of critical visual features from a larger set and yields extremely efficient classifiers.
- The third contribution is a method for combining increasingly more complex classifiers in a "cascade" which allows background regions of the image to be quickly discarded while spending more computation on promising object-like regions. The cascade can be viewed as an object specific focus-of-attention mechanism which unlike previous approaches provides statistical guarantees that discarded regions are unlikely to contain the object of interest[11].

The algorithm has four stages:

1. Haar Feature Selection
2. Creating an Integral Image
3. Adaboost Training
4. Cascading Classifiers

c. Region of Interst

Region of Interest (ROI) is detected from complete image. The ROI area first obtain by using Haar Cascade Classifier which include height, width. This region shown by fig.3.5.

Fig. 2 The region of Interest of an image

d. Eye Detection

After obtaining face of the driver, eyes part of image is separated by Paul Viola and Michael Jones algorithm for face detection[11]. This method marks both eyes with rectangle colored boxes. To equalize various face sizes, images are resized in same dimensions. The area of the eye is further cropped.

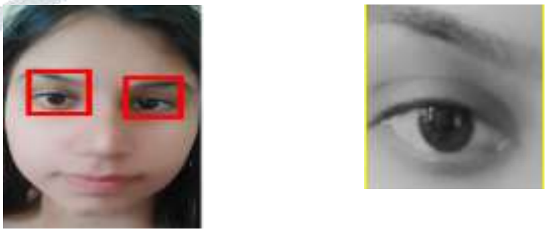

Fig. 3 Eyes Detection with rectangle mark and Cropped eye

e. Drowsiness detection

It is observed that when eyes are opened then having some white portion on image which area have some high intensity value, if eyes are closed then having same equal dark area which have some low intensity value comparatively white portion. The mean value of open eye block will be certainly higher than close eye block. After obtaining eye block the mean value of that block is checked, if it is greater than a particular value than eye is open otherwise detected eye is closed. The proposed system collected more than 100 samples to test the system, it is observed high accuracy in minimum process time.

IV EXPERIMENTAL RESULTS AND OUTPUTS

The propose system collected more 100 samples and checked its efficiency on all levels. The results are calculated at own collected data and ready available data on web.

a. Acquisition of Image

Image of face is captured by web camera. This camera is able to capture all facial activities of the driver.

b. Grayscale Conversion

The image which is captured by camera is converted in grayscale format. Now each pixel of image is available as array in form of intensity values.

c. Region of Interest

After getting complete image of driver, the face is detected as region of interest. The Haar Cascade Classifier is used to detect face and eye of whole image. Thus, the object detection framework employs a variant of the learning algorithm AdaBoost to both select the best features and to train classifiers that use them. This algorithm constructs a “strong” classifier as a linear combination of weighted simple “weak” classifiers.

$$h(x) = \text{sgn}\left(\sum_{j=1}^{M} a_j h_j h(x)\right)$$

Each weak classifier is a threshold function based on the feature f_j

$$h_j(x) = \begin{cases} -s_j & \text{if } f_j < \theta_j \\ s_j & \text{otherwise} \end{cases}$$

The threshold value θ_j and the polarity s_j belong to 1 are determined in the training as well as the coefficient aj

Cropping of Eye Area of facial Image

After finding eye area of an image, there is task to crop both eye part from the face. This task is done by using imcrop() function in matlab and when we see intensity value of this area, it looks like fig. 4. It is observed that intensity value of each pixel in eye block image in center part of open eye condition (which has white part) having some high intensity value and other part of eye block having some low intensity value (as shown in Fig. 4) .

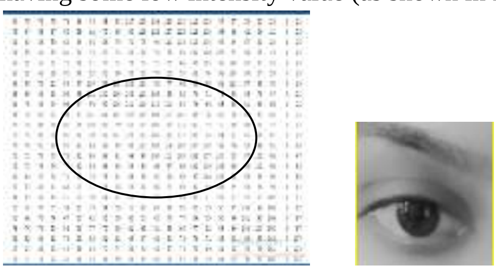

Fig.4 Intensity value of each pixel in open eye block

d. Experimental results of Accuracy , Process Time and Mean Intensity Value

The proposed system collected more than 200 samples and 100 sample were used to find the experimental results.

Mean Intensity Value of Samples

The proposed system was examined on 105 samples The mean Intensity value of cropped eye block calculated in both states.

$$\text{Mean Intensity Value} = \frac{\sum \text{Intensity Value of Each Pixel}}{\sum \text{No. of Pixel}}$$

$$\text{Mean Intensity Value} = \sum_{i=0,j=0}^{m,n} P_{ij} \Big/ N$$

Graphical Representation

The graphs can be drawn between mean intensity value of close eye condition and open eye condition from different views.

Front View and close Eye View

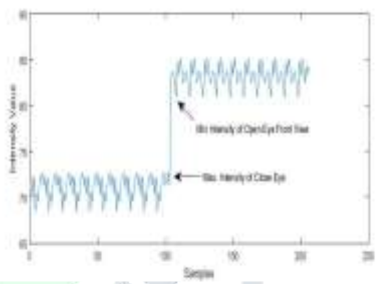

Fig.5 Graphical representation of Close Eye and Front View Open Eye

The above graph show that maximum mean intensity value of close eye condition is below 72 and minimum mean intensity value of open eye front view is 81. It is observed that there is big gap between close eye and open eye front view. This gap decide open and close eye condition.

Left Eye view and Close Eye

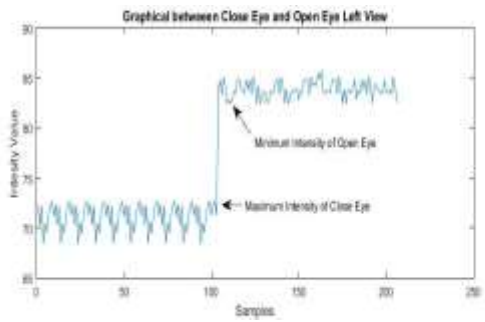

Fig.5 Graphical representation of Close Eye and Left View Open Eye

The above graph show that maximum mean intensity value of close eye condition is below 72 and minimum mean intensity value of open eye left view is 81. It is observed that there is big gap between close eye and open eye front view. This gap decide open and close eye condition.

Right Eye and Close Eye

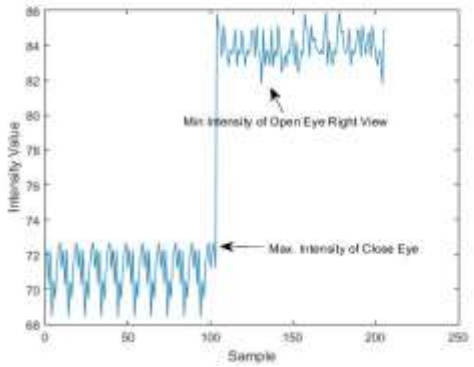

Fig.6 Graphical representation of Close Eye and Right View Open Eye

The above graph show that maximum mean intensity value of close eye condition is below 72 and minimum mean intensity value of open eye right view is 81. It is observed that there is big gap between close eye and open eye front view. This gap decide open and close eye condition.

Accuracy of Each Sample

It is observed that accuracy of each sample on each attempt is about true.

$$\text{Accuracy\%} = \frac{\text{Total Number True chance}}{\text{Total Number of Chance}} \times 100$$

Accuracy %= 98/100 x 100 = 98.00

Hence performance of system is quite satisfactory. The experiments were performed for both spectacles or without spectacles.

e. Summary of Results

It is observed that proposed system is designed on working of only one parameter and provide more than 98% percentage accuracy. The time taken to process each sample was less than single minute. The mean intensity value in close eye condition is less than 75 and in minimum intensity value in open eye condition is 81. This cut off can be used to detect the drowsiness of eye. The findings of proposed work is good and satisfactory.

f. Comparative Analysis

The proposed algorithm is tested on INVEDRIFAC data set.[12] The videos and images of this concern are downloaded from site. The proposed algorithm has been tested on more than 100 image from different views for each sample. The performance of the same on this data is with acceptable accuracy. Also, images have different light conditions, different face angles which indicate that the algorithm can perform well in adverse conditions.

It is observed that proposed system tested on more than 100 images and it is found that system give negligible error/ false value .

Table 1 shows the comparative analysis of proposed work with other methods

	Image acquisition device	Type	Accuracy
Ashish Kumar,Rusha [patra[1]	Webcam	Non intrusive	96%
Oraan Khunpisuth, Narit Hnoohom[3]	Raspberry Pi Camera	Non intrusive	99%
Yogesh Chellappa, Narendra Nath Joshi[4]	Camera	Combination of both intrusive and non-intrusive	85%
Arun D Panicker, Madhu S Nair[10]	Camera	Non-intrusive	93%
Proposed research work	Mobile Camera	Non-intrusive	98 %

Table 1 also shows that propos work is having good and satisfactory result on synthetics data.

g. Demonstration of Proposed Work

More than 100 samples are collected and randomly 5 samples taken for experiment, the images of 5 samples are as under.

Front View		
		
Fig.1 show gray scale image capture through android mobile phone.	Fig 2 Shows that EYE Tracing on Face by using Facial Recognition Function . Both	Fig.5 shows a message box which tells us eye is open or close after checking intensity..

	Eyes are appearing in Yellow boxes.	
		
Fig 3 Shows that EYE Tracing on Face by using Facial Recognition Function in Both Eyes are appearing in Red boxes.	Fig.4 Shows Left is cropped after selection of both eyes..	

View from left side		
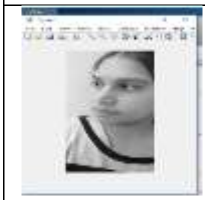		
Fig 7. Show that left side view with traced eyes..	The screen snapshot in Fig8shows that face is positioned from left side and left eye is focused.	The screen snapshot shows in Fig 9that face is positioned from left side and left eye is cropped.
6.6.3 View From Front side with spectacles		
		
As shown in figure experiment is also tried with eye side spectacles front side of the camera. Above screen shot from front side.	The screen snapshot shows in Fig 11that face is positioned from left side and left eye is focused.	Fig12 Shows that EYE Tracing on Face by using Facial Recognition Function . Left Eye is appearing in Red box.
		
As shown in screen snapshot in Fig 13 ,when the face is positioned from front side with spectacles and left eye is cropped.	As shown in screen snapshot in Fig 14 ,when the face is positioned from front side with spectacles and showing eye is open.	

Hence proposed system is based on non-intrusive method based on visual behaviour by using digital image processing technique. Here, visual behaviour feature of eye is captured by camera. The results are taken on own created data is good and satisfactory. It is also tested that proposed system works accurately with generated synthetic data which were used by other systems. It is found that accuracy of proposed system was better than other systems.

CONCLUSION AND FUTURE DIRECTIONS

Conclusion

A low cost driver drowsiness monitoring system has been proposed based on visual behaviour. Here, visual behaviour feature like eye block mean value computed from image, captured by Mobile Phone. The facial features and eye is detected by Paul Viola and Michael Jones algorithm. Such eye feature cropped and mean value of this eye block is computed. The dark portion of this block having low intensity value and white part of the block having high intensity value. The mean intensity value decide that eye is open or close. The accuracy of proposed system is good and satisfactory. When proposed system is tested on synthetic data (which is used by other systems) and made comparison with other methods, it is found that proposed system performance is good and satisfactory.

Future Scope

The future works may focus on the utilization of outer factors such as vehicle states, sleeping hours, weather conditions, mechanical data, etc, for fatigue measurement. Driver drowsiness pose a major threat to highway safety, and the problem is particularly severe for commercial motor vehicle operators. Twenty-four hour operations, high annual mileage, exposure to challenging environmental conditions, and demanding work schedules all contribute to this serious safety issue. Monitoring the driver's state of drowsiness and vigilance and providing feedback on their condition so that they can take appropriate action is one crucial step in a series of preventive measures necessary to address this problem. Currently there is not adjustment in zoom or direction of the camera during operation. Future work may be to automatically zoom in on the eyes once they are localized.

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