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Monitoring Driver Distraction in Real Time using Computer Vision System

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Abstract- Driver tiredness is one of the most important causes of road accidents. This article presents a real-time non disturbance drowsiness monitoring scheme which exploits the driver's facial appearance to identify and aware tired drivers. This presented work worn the Viola-Jones Algorithm to identify the driver's facial appearance. Continuously Adaptive Mean Shift algorithm has been used for continuous face tracing of driver. With this uncomplicated and not expensive execution, the whole scheme achieved an accuracy of 99.5%, outperforming other developed schemes adopting expensive hardware to arrive at the similar objective.

Keywords– Image processing; Face recognition and tracing; Fatigue level; Ada-boost learning classifier; Circular Hough Transform; Continuous Mean shift algorithm; Viola Jones algorithm for Face recognition.

I. INTRODUCTION

Progress in a Driver Monitoring System is a process where a system can monitor continuously a face of driver in a vehicle also detects face and non-face which includes the parameter face recognition, eye recognition, face direction, eye flashing, etc. Aim of the developed scheme is to actively monitor the driver drowsiness level for identifying drowsiness situation to avoid fatigue in real time driving situations. The Research shows that generally after 2to 3 hrs. Of continuous driving, driver is tired and steering performance becomes slow. It is observed that Drowsiness level is more in afternoon after eating lunch and high in midnight. Further, consuming alcohol and addiction of drug can lead to loss of consciousness.

Mainly three types of disruptions are measured i.e. Visual, Cognitive and Manual. Visual disturbance means eyes off the path, cognitive means brain off the path and manual means hands off the steering wheel, Also region of interest can be analysed for stress finding [1], the changes in eye movement association structure can specify disturbance [3].Firstly given a number of possible eye images, eye detection is in concentrate the category of these sub-images as either eyes or non-eyes [7], The purpose of choosing the project is to develop a real time mechanism to detect the fatigue state of driver to avoid heavy accidents which are taking place these days also this is a low-cost vision based scheme to correctly identify Eyes Off the Road [8].

Rest of the paper is organized as follows: Section I contain the Introduction of project, Section II contain Literature Review, Section III contain the Literature Summary, Section IV explains the Methodology with flow chart, Section V describes results and discussion, Section VI describes conclusion of work with future directions.

II. LITERATURE REVIEW

A. Detection of Physiological Stress using Hyper-spectral Image Techniques:

Tong Chen, Peter Yuen, Mark Richardson, Guangyuan Liu, and Zhishun She [1], here author describe Human strain shows an imbalanced state of a person. Author considered three different parts of the face i.e. eyebrows, lips, and mouth to detect human stress and achieved an accurate positive rate of 92% also observed that StO2 is important not only around the eye opening region but also around the forehead when individuals respond absolutely to a psychological stressor. This inspection increases the amount of Region of interest that can be analyzed for stress recognition.

B. Wireless and Wearable EEG System for Evaluating Driver Vigilance:

Chin-Teng Lin, Fellow, Chun-Hsiang Chuang, Student Member, Chih-Sheng Huang, Student Member, Shu-Fang Tsai, Shao-Wei Lu, Yen-Hsuan Chen, and Li-Wei Ko [2], Author present a novel dry sensor which is created on moveable electronic system which displays motorist' so observance in actual time in direction to link the difference of driving performance with changes in intelligence actions. The proposed scheme includes the use of a wireless and wearable device to record indicators from hairy sections of the driver. As well, the proposed system can process recordings and translate them into the alertness stage.

C. Changes in the Correlation between Eye and Steering Movements Indicate Driver Distraction:

In [3], this paper presents a technology that can discover and moderate disturbance by alerting distracted drivers based either eye events or driver presentation measures, numerous algorithms to detect disturbance have been developed, combining both eye glance and vehicle data could enhance distraction detection. The goal of this paper is to approximate whether changes in the eye movement association structure can specify disturbance. Three distractions are considered visual, cognitive, and cognitive/visual responsibilities. For sense situation the parallel situation is stately and direction approach show that eye actions associated with road skimming crop a low eye–routing association. Though, even this weak association is complex to trouble.

D. A Yawning Measurement Method Using Embedded Smart Cameras:

In [4], author shown the growth of an assistive scheme that monitors a driver's level of drowsiness based on a method to measure yawning. The system uses a Viola-Jones algorithm for detection of face and mouth, as well as for yawning detection uses the back projection theory, for measuring both the rate and the amount of changes in the mouth. This scheme is built on the top of an actual smart camera embedded platform, called APEXTM from Cogni-Vue Corp., which is easy and practical for installation inside a car. The scheme is optimized in a way that meets the real time requirements of the monitoring task while relying on the limited processing power of the embedded platform.

E.A Review on Driver Face Monitoring Systems for Fatigue and Distraction Detection:

Mohamad- HoseynSigari, Muhammad-Reza Pour shahabi, Mohsen Soryani, and Mahmood Fathy [5], here author highlight on detecting variation in human face expressions near eye and other face regions. Enhancement of public safety and the decrease of accidents is one of the essential goals of the intelligent transportation schemes. It gives more importance to top half area of face thus giving hypo vigilance symptoms from face and eye, respectively. Any angular change for head position gives indication of distraction in system. It may use factors regarding eye like as how much % of eye closure, eyelid changes and eye closure. Eye closure and eyelid distance changes may indicate how much distraction for driver and warns prior to total distraction but eye closure detection symbolizes complete distraction. There are three main contributions in the introduced method: (1) Angular change in head position (2) Eye region monitoring (3) Analyzing extracted signals.

F. Real-Time Gaze Estimator Based on Driver's Head Orientation for Forward Collision Warning System:

Sung Joo Lee, Jaeik Jo, Ho Gi Jung, Member, Kang Ryoung Park, and Jaihie Kim [6], author gifts a vision-based real-time based gaze zone yaw and pitch., the planned system works under both day and night environment and is robust to facial image deviation caused by eyeglasses since it only requires simple facial features and does not require exact features like eyes, lip corners, and facial contours.2nd, an ellipsoidal face model is planned instead of a cylindrical face model to accurately verify a driver's yaw. 3rd, author propose new features where the normalized mean and the standard deviation of the horizontal edge projection histogram too reliably and quickly guess a driver's pitch. 4th, the planned technique obtain an exact eye zone by using a support vector machine.

G. Eye Detection for a Real-Time Vehicle Driver FatigueMonitoringSystem:

In [7], the goal of this author is to investigate the driver tiredness which is based on camera monitoring system and centered around the tracing of driver's eyes, since the eyes offer the mainly information with regards to drowsiness. Firstly given a number of possible eye images, eye detection is in concentrate the category of these sub-images as either eyes or non-eyes. The categorization techniques that have been measured are artificial neural networks, support vector machines and adaptive boosting. For a real world driver fatigue monitoring system, Results have shown that Ada-Boost algorithm will be the most suitable eye classification technique.

H. Driver Gaze tracking and Eyes off the Road Detection System:

In [8], this paper propose an low-cost vision based scheme to correctly identify Eyes Off the Road. The scheme has three main components: 1-robust facial feature tracing; 2- head pose and gaze evaluation; and 3- (3-D) geometric reasoning to identify eyes off the road. Since for taking up the video, a video stream of a camera installed on the steering wheel column, this scheme trace facial texture from the driver's face. By using the tracked landmarks and a 3-D face model, the structure computes head pose and gaze direction. The head pose evaluation algorithm is robust to non-rigid face deformations due to changes in expressions. Lastly, using a

3-D geometric investigation, the structure reliably detects eyes off road

I. Using Support Vector Machines Driver Fatigue Monitoring System:

In [9], Author presents a real-time non-intrusive exhaustion monitoring scheme which explains the driver's facial expression to detect and alert fatigued drivers. Here Viola-Jones algorithm used to detect the driver's facial features. To derive the state of each feature on a frame by frame basis the correlation coefficient template matching method is then applied. Finally a Support Vector Machine is integrated within the structure to classify the facial look as either fatigued or if not. Using this simple and low-priced implementation, the overall structure achieved an accuracy of 95.2%, outperforming other developing schemes requiring an expensive hardware to reach the similar objective. Support Vector Machines are very frequently used for the organization of data in a wide variation of mechanism knowledge requests. A set of training examples are given, the mission of the vector machine is to produce a classical that allows it to categorize undetected examples into the suitable targets. The support vector machine then linearly classifies the transformed data points in the new feature space, even though the input space may not be linearly divisible. The mapping function is identified as the kernel task. During the training and testing phases both Linear and Radial Basis Function kernel models were considered and used.

J. Learning Sampling Distributions for Efficient Object Detection:

In [10], in computer vision system object detection is an important task. In order to have a fast and accurate object detection multistage particle windows algorithm has been used in the scheme. From a proposal distribution sampling of particle windows done in first stage) it avoids scanning the image. Here author try to solve the difficulties. A significant detail is that it used a large probability for randomly generated particle windows, which does not to contain the object because the object is relative to the huge number of candidate frames. Thus design a proposal distribution which efficiently rejects the huge number of non-object windows. Thus, proposes the concepts of rejection, receiving, and uncertainty windows and regions. Now, the ideas are used to form and appraise a uniform distribution and a spoilt Gaussian distribution. The particle design is acceptance form. Hence by using the algorithm got the experimental results on human and face detection prove the efficiency and the success.

K. Adaptive EEG-Based Alertness Estimation System by Using ICA-Based Fuzzy Neural Network:

In [11], here Author describe drivers' tiredness has been occupied as a fundamental issue in various accidents. The growth of human perceptive level of monitoring scheme for the driver to prevent accidents behind the steering wheel has become a main focus in the field of safety driving. The difficulties in mounting such a scheme are lack of significant guide for noticing sleepiness and the intervention of the difficult sound in a truthful and active driving situation. An adaptive alertness approximation process based on electroencephalogram, power spectrum analysis, fuzzy neural network and independent component analysis, models is planned in this paper for always monitoring driver's drowsiness level with parallel changes in the alertness level.

A novel based adaptive article selection device is established for mechanically choosing effective occurrence bands of works for recognizing a non-linear alertness monitoring scheme based on the association examination amongst the time-band power spectra of mechanism and the driving errors defined as the nonconformity between the center of the vehicle and the traveling path in the virtual-reality driving situation. The device also delivers operative and efficient structures that can be fed into -mixture-model based self-developing to ultimately evaluation driver's drowsiness level expressed by around and forecasting the driving fault.

L. Wrinkle Detection Using Hessian Line Tracking:

In [12], this paper shows wrinkles show an essential role in the face based examination. This applications has used in features such as facial touch up, facial appearance appreciation and face age approximation. Thus techniques for a wrinkle examination have been reconnoiter din the literature, poor discovery borders the correctness and consistency of wrinkle division. In this paper, author proposes Hessian line tracking to overcome the discovery difficult. Line tracking is collected for line tracing though it also increases the accuracy of wrinkle localization when related with existing systems. In the experimental stage three coders were educated to interpret wrinkles yourself. To measure the manual explanation, both inter reliability and intra reliability was measured, by accuracy of 94% or above. The experimental results display that the planned technique is proficient of tracing unseen pixels; thus, it increases connectivity of recognition between wrinkles, allowing some fine wrinkles to be noticed. Thus planned line tracing produces better results, by an accuracy of 84%. This paper validates that the line tracing is an unusually robust indicator of forehead wrinkles in 2-D pictures.

III. LITERATURE SUMMARY

This section gives the summary of the sources, and gives the details about the work of various authors performed in their research. It might give a new interpretation of old material or combine new with old interpretations.

Table.1. Literature Summary

Author	Year of Publication	Algorithm Used	Advantage	Accuracy
Tong Chen, Peter Yuen, Mark Richardson, Guangyuan Liu, and Zhishun She [1]	IEEE transactions- (October December - 2014)	Tissue oxygen saturation (StO2) generating algorithm	Successor in detection of human stress level	76% to 88 %
Chin-Teng Lin, Fellow, Chun-Hsiang Chuang, Student Member, Chih-Sheng Huang, Student Member, Shu-Fang Tsai, Shao-Wei Lu, Yen-Hsuan Chen, and Li-Wei Ko[2]	IEEE transactions- April 2014	Support vector regression(SVR) algorithm	Obtained Minimized (RMSE) Root mean square error	80%
Lora Yekhshatyan and John D. Lee [3]	IEEE transactions- March 2013	Numerous Algorithm used Ex: Driver distraction detection algorithm	Eye glance is detected.	The accuracy depends on the No. of samples i.e. signal length and sampling rate.
Shabnam Abtahi, Shervin Shirmohamma-di, Behnoosh Hariri, Daniel Laroche, and Luc Martel [4]	IEEE transactions	Viola Jones algorithm for Yawning detection	Yawning mouth can be detected easily	Face detection -85% Mouth detection-57% Yawning detection-20%
Mohamad-HoseynSigari , Muhammad-Reza Pour shahabi, Mohsen Soryani , and Mahmood Fathy [5]	International Journal of Advanced Science and Technology 2014	Image processing & decision making algorithm is used	Face detection results found correctly	Approaches based on Steering Motion -Good Approaches based on Driver Face Monitoring - Moderate
Sung Joo Lee, Jaeik Jo, Ho Gi Jung, Member, Kang Ryoung Park, and Jaihie Kim [6]	IEEE transactions- March 2011	Ada-boost algorithm was performed	Obtained exact results for gaze zones & gaze directions	accuracy can degrade when the face detection module cannot give a consistent result
R.C. Coetzer and G.P. Hancke [7]	IEEE Intelligent Vehicles Symposium-June 2011	Ada-boost & SVM algorithm were performed	Best suited for eye classification in a real-world application	1. Using ANN : Eyes Non-eyes :91:8% , 93:1% 2. Using SVM : Eyes Non-eyes : 96:3% 95:9% 3. Using Ada-boost: Eyes Non-eyes: 97:5%, 96:8%
Francisco Vicente, Zehua Huang, XuehanXiong, Fernando De la Torre, Wende Zhang, and Dan Levi [8]	IEEE transactions- December 2014	Head Pose estimation algorithm	Accurate estimation of gaze has been obtained	Accuracy above 90%
Matthew Sacco, Reuben A. Farrugia [9]	5th International Symposium, Italy, 2-4 May 2012	Ada-boost algorithm was performed	Correctly detected motion of face, eye & mouth	Recognition rate of 95.2%
Yanwei Pang, Senior Member, Jiale Cao, and Xuelong Li, Fellow [10]	IEEE Transactions on Cybernetic, 2168-2267 2016 IEEE.	Multistage particle windows (MPW) algorithm	Obtained efficient results for human face detection	Obtains better detection accuracy than MPW when they use the same number of PW (Particle windows).
Chin-Teng Lin, Fellow, IEEE, Li-Wei Ko, I-Fang Chung, Teng-Yi Huang, Yu-Chieh Chen, Tzyy-Ping Jung, and Sheng-Fu Liang [11],	IEEE Transactions on Circuits & Systems: VOL. 53, NO. 11, November 2006	Adaptive learning algorithm	Feature selection mechanism achieved efficiently by using fuzzy neural network & independent component analysis	Accuracy obtained about 91.3%
Choon-Ching, Moihoon yap, Icholascosten and Baihua li [12]	IEEE Transactions- Received May 20, 2015, accepted June 30, 2015, date of publication July 13, 2015, date of current version July 28, 2015.	Hessian Line Tracking algorithm	Successor in achieving wrinkle detection	Accuracy obtained about 84%

IV. METHODOLOGY

IV.I. Complete Flow of the Scheme

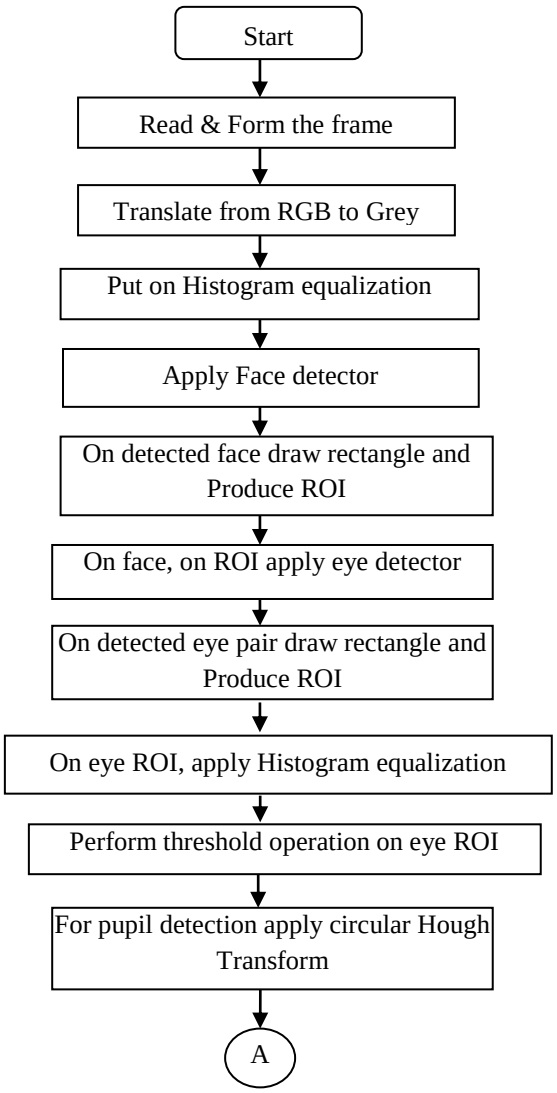

Figure 1. Process Flow Chart for Face and Eye Detection part-I

On acquired frame of image, Face detection algorithm has been applied. By accessing the camera, image is acquired. Once the face gets detected in the acquired image frame, region of interest of face is collected since image frame.

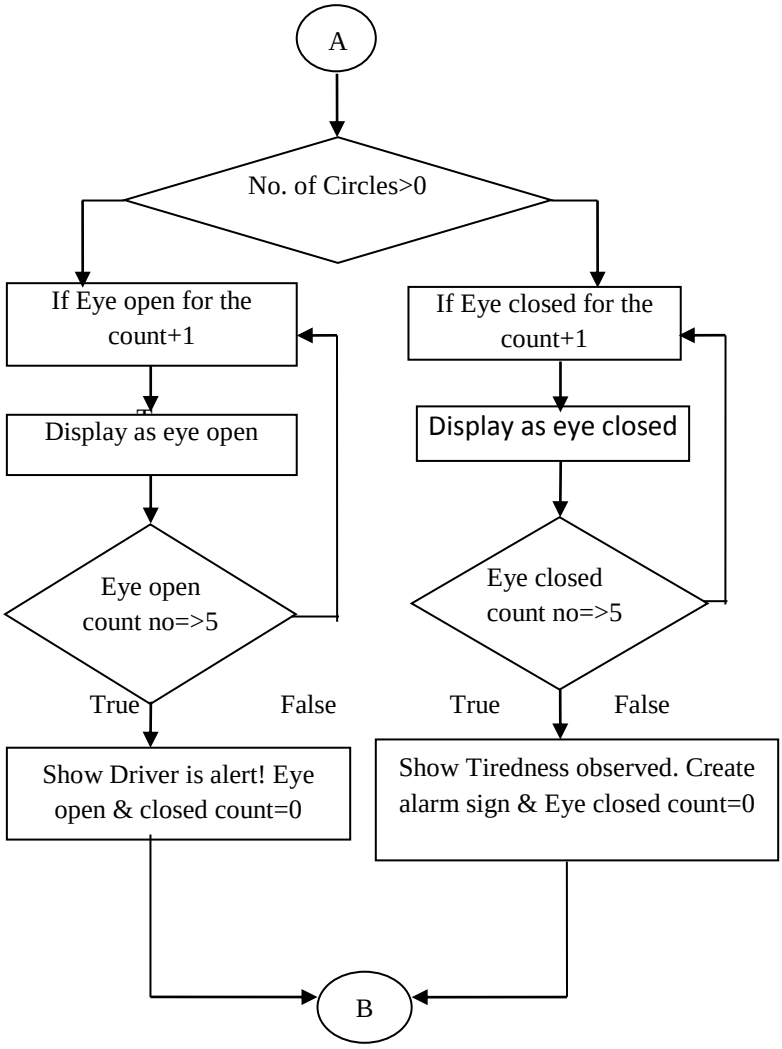

Figure 2.Process Flow Chart for Face and Eye Detection part-II

After finding of face region of interest, image frame can be changed from RGB scale to Grey scale is done. For additional processing eye region is discovered and collected. Region of interest for eye is further processed by various image processing functions like histogram equalization, edge detection, thresholding, filtering, etc.

IV.II. System Expectations

1- If eye position is open then scheme should correctly detect the circles formed on pupils of eyes.

2. If eye position is closed then scheme should not detect the circles.

3. Detection of False rate of pupil detection should be lowest.

4. Along with spectacles the presenting scheme should detect eyes, attentiveness and drowsiness situation.

5. Without considering the gender of person and age, the Structure should detect drowsiness.

6. Structure should give reaction after five consecutive frame detection.

IV.III. Hardware Design

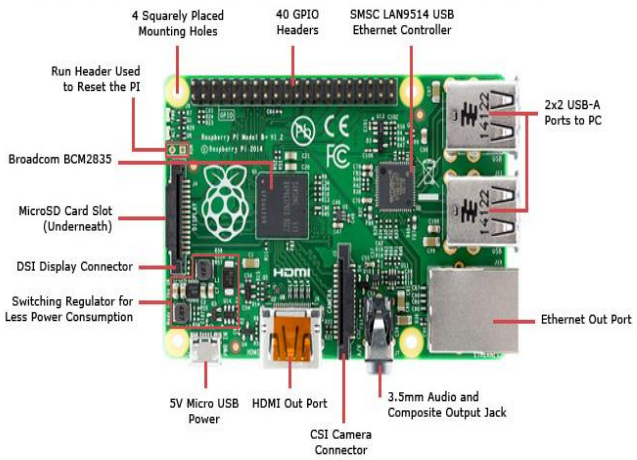

Figure 3.Raspberry Pi B+ Pin out Details

Rasp-Pi & Computer Peripherals Interfacing Description

1. One port of rasp-Pi connects to PC mouse pin.
2. Second port of rap-pi connects to PC Keyboard pin.
3. Third port of Rasp-Pi connects to Camera.
4. Power Pin of Rasp-Pi connected to External Power.
5. HDMI port of Rasp-Pi connects to RS-232port of PC.

IV.IV. Specifications of Raspberry-Pi B+ Model:

Table 2. Hardware Description

FEATURES	MODEL B+
BRCM2835 SoC	Yes
Standard SoC Speed	700Mhz
RAM	512MB
Storage	Micro SD
HDMI output port	Yes
Composite video output	On 3.5mm jack
Number of USB2.0 ports	4
Expansion header	40
Number of available GPIO	26
3.5mm audio jack	Audio/Video
Number of camera interface ports (CSI-2)	1
Number of LCD display interface ports (DSI)	1
Power (bare, approx., 5v)	650mA, 3W
Size	85 x 56 x 17mm

IV.V. Software Tools Used

Microsoft Visual Studio 2008 used as Software.

Why only Visual studio used?

This is also referred by the name integrated development environment, for real time applications it gives very fast and feasible results as compare to other software tools, Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store etc. As its supports 36 different programming languages though permits the code editor and debugger to provision, almost any programming language, providing a language-specific provision occurs. Built-in languages include C,C++ and C++/CLI , VB.NET (via Visual Basic .NET), C# (via Visual C#), and Type Script. Also Supports for other languages such as Python, Ruby, XML/XSLT, HTML/XHTML, JavaScript and CSS. J ava (and J#) was maintained in the past. Total software scheme is developed in Microsoft visual studio by taking support of open source computer vision library.

V. RESULTS AND DISCUSSION

V.I. FACE DETECTION RESULTS:

V.I.I Open Eye Condition

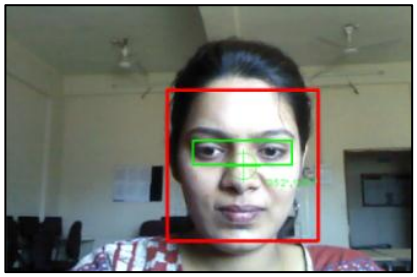

Figure 4.Open Eye Situation

Once face recognition is completed eyes are identified. For further processing region of interest of eyes has been chosen. To make their edges more clearly smoothing is applied on eye region of interest. For filtering purpose masking is applied on image. Lastly, circular Hough transform has been applied for pupil detection. For continuous five frames if one

or two circles (Pupils of eyes) have been recognized then the eye open condition will appear. Hence it displays result as 'driver is alert'.

V.I.II. Closed Eye Situation

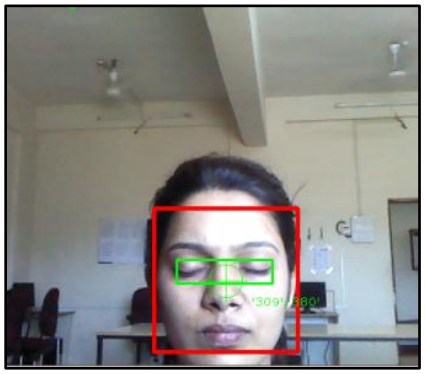

Figure 5.Closed Eye Situation

All the stages have been followed like open eye situation for closed eye condition. &amount of circles detected (Pupils of eyes) will be zero as eyes are closed. Therefore pupil recognition incident is false, therefore eyes are confirmed as closed. For continuous five frames eyes situation has been tested and then result of tiredness recognition is created by alarm sound, presented on screen as tiredness is identified.

V.II. FACE TRACING RESULTS:

Here both tracing and detection modules of face performed at a same time The only change in these two elements is that it takes coloured frame to process (in face tracing) and in face recognition section it takes converted grey frame of original image frame. As soon as face & eyes gets identified tracing element will continuously detect the middle of face for finding of correct on road position of face and eyes of driver and attention. Therefore results are achieved for three various cases as tracing face with driver alert situation; tracing of face with tiredness situation and tracing of face with out of box situation for no accurate central position of drivers in the direction of the camera and on road. The results for these 3 cases are established as below.

V.II.I. Tracking Face with Driver Alert Condition

To detect driver alert condition for five consecutive frames amount of eyes identified have to be at least one, At this point low concentration count have to be zero or less than four. For out of frame result Alarm will be generated if it is equal to or greater than four then. For five frames position of face & eye has been tested based on centre of pupil of eye, low concentration count level must be zero for Driver with alert position.

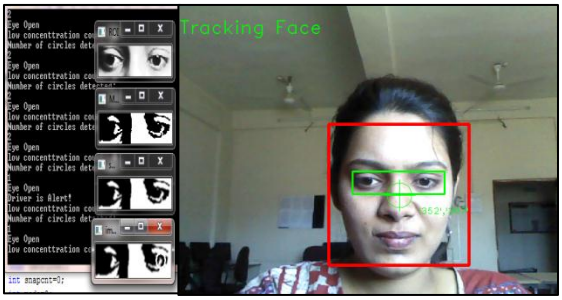

Figure 6.Tracing Face with Driver Alert Situation

V.II.II. Tracing face with drowsiness situation

Here also same procedure is followed as in case of driver with alert condition; for every five consecutive frames number of eyes should be detected to identify the fatigue condition of driver. For continuous five frames amount of circles detected are zero(found on pupils of eyes), position of face centroid is at centre and low concentration count is zero or less than four then tracing face with driver tiredness situation will take place and alarm is created.

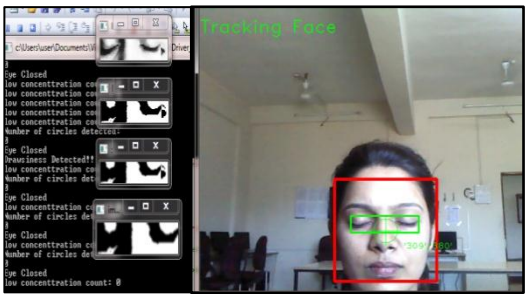

Figure 7.Tracing Face with Drowsiness Situation

V.II.III. Tracing faces with out of box condition

Now alarm will generate after the count of four if low concentration count is increasing continuously. Alarm generation will be continuous till it gets to zero. The low concentration count becomes zero when driver face centroid position is become at centre again. Tracing face with normal detection condition will take place once more.

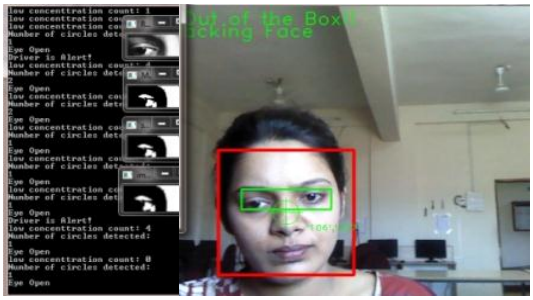

Figure 8.Tracing Face with Out of Box Situation

Table.3: Results

Sr.No.	Age Range	Face Recognition	Face Tracing	Alert Situation	Sleepy Situation
1	18-30	100%	100%	99%	100%
2	30-40	100%	100%	99.9%	99.9%
3	40-45	100%	100%	99%	97%
4	45-50	100%	100%	98%	98%
5	50-55	100%	100%	98%	98%
6	55-60	100%	100%	98%	97%

VI. CONCLUSION AND FUTURE SCOPE

A real-time execution of a driver tiredness monitoring scheme was obtainable in this paper. A number of techniques were used in the development process, median filtering for image pre-processing together with histogram equalization. The Viola-Jones object recognition framework was then used to identify the face, eyes and mouth in consecutive frames, along with continuous adaptive mean shift algorithm used for face tracing purpose. All the feature extraction has been achieved by using Viola Jones algorithm, here on image, integral method is applied first then Ada-boost learning method is applied and by applying cascade classifiers accuracy of face detection is improved. In general, as established in the previous section, the computer visualization approach adopted was very successful in identifying the visual appearance of the driver, achieving an average recognition rate of 99.5%. The results further make obvious the possibility of deploying non-intrusive tiredness monitoring schemes for commercial applications.

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