Periodicals of Engineering and Natural Sciences ISSN 2303-4521
Vol.6, No.2, December 2018, pp. 210~223
Available online at: http://pen.ius.edu.ba

Drivers Drowsiness Measurement and the Indication of Eye Movements through Algorithmatic Approach to Avoid Accidents

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Article Info

Article history:

Received Jun 2nd, 2018
Revised Sep 12th, 2018
Accepted Sep 26th, 2018

Keyword:

First keyword
Second keyword
Third keyword
Fourth keyword
Fifth keyword

ABSTRACT

Numerous accidents are caused by sleepy drivers. To prevent such mishaps, the sluggishness acknowledgment framework is built based on the acknowledgment of eye states. The primary thought behind this exploration is to build up a drivers Safety framework by demonstrating the auspicious cautioning. This framework will screen the driver's eyes utilizing camera and by building up a calculation we can recognize indications of driver fatigue sufficiently early to avoid accident. We propose an algorithm for knowing the drivers drowsiness by checking the width and height of the eye. It helps to indicate the driver's drowsiness by giving an alarm. A new formula has been used to check the measurements of eye and face detection. Added that the number of eye blinking count can be measured to check the driver's drowsiness. Moreover the warning will be deactivatedmanually rather than automatically. So for this purpose adeactivation switch will be used to deactivate warning.

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1. Introduction

Driving with laziness or drowsiness is one of the fundamental causes of car crashes. There are numerous advances for drowsiness detection. They can be separated into three types: Biological indicators, vehicle behavior, and face analysis [1]. The main types estimates biological indicators, for example, cerebrum waves, pulse and heartbeat rate. These procedures have the best location exactness however they require physical contact with the driver. They are intrusive. Consequently, they are not down to earth. The second type estimates vehicle behavior, for example, speed, parallel position and turning edge.

These systems might be actualized non-rudely, however they have a few constraints, for example, the vehicle behavior, driver experience and driving conditions. Moreover, it requires exceptional hardware and can be costly. The third type is face analysis. In spite of the fact that it very well may be less exact than natural markers, this compose is non-meddling and effortlessly actualized. It tends to be utilized autonomous of driver experience and vehicle compose. Further, it is both more pragmatic and precise than vehicle conduct investigation. It is restricted by lighting conditions and the driver's separation from the camera.

Distinctive highlights of the face can describe a man's level of alertness while driving, including eyelid development, pupil development, head movement, and outward appearance [1]. Eye state gives huge information and if such visual conduct can be estimated, at that point it is doable to anticipate a driver's condition of sleepiness, watchfulness or mindfulness. Numerous frameworks have been proposed to distinguish laziness dependent on eye state investigation [1]-[5]. Subsequent to distinguishing face region, we identify eye area. Eye finding is an imperative advance for eye state examination. Numerous chips away at eye identification utilized IR illuminators which can be unsafe for retina [1]-[4] or required preparing information and utilized circle Hough change [5]. Hsu et al. [6] decided eye district by building Eye Map. This strategy has great execution for eye area discovery in various light conditions and has bring down computational intricacy than the Hough change.

In this paper, we utilize Eye Map to recognize eye area. After eye discovery, we perform eye state examination – assurance of whether the eye is open or shut. There are a few techniques which decided open or shut eye dependent on separation between two eyelids [2]-[4]. Orazio et al. [5] utilized preparing information for shut eye recognition. Our proposed strategy depends on brilliance and numeral highlights of the eye picture. The technique can decide open, halfway open and shut eye states with a high precision without utilizing any preparation informational collections. We contrast the strategy and the three past strategies for [2]-[4].

2. Related works

At long last, we choose about sluggishness and give a warning messages for the lazy state. Eye squinting is one of the essential physiological estimates that have been concentrated to recognize languor. PERCLOS (Percentage of eye conclusion after some time) is the most prevalent strategy for estimating eye squinting in light of the fact that high PERCLOS scores are emphatically identified with sleepiness [1]. Accordingly, we utilize PERCLOS parameter for laziness or drowsiness decisions. Segregation of face from picture foundation is required for precise eye recognition. We use a past work [6] to identify confront district. Hsu et al. [6] proposed a face recognition calculation for shading pictures within the sight of changing lighting conditions and in addition complex foundations. Even though our proposed technique focuses on eye detection and drowsiness of the driver, Face recognition and the detection plays a vital role in finding the proposed work.

At the point when the eye is open or shut, the change projection bend is distinctive vertical way of the eye region. Then again, in open eyes, if the understudy is secured by the upper eyelid, the individual can't see anything. In this manner, examination of the eye state is done in two stages. In the primary stage, the closed eye is controlled by methods for the difference projection bends vertical way. In the second stage, the open eye is separated from the semi-open eye (which has no visual capacity) by looking at the separation between two eyelids and the iris range. The two periods of the eye state investigation can be clarified as pursues.

Eye developments can be estimated utilizing EOG (Electro-Oculo-Graphy). EOG is a system for estimating the corneoretinal standing potential that exists between the front and the back of the human eye. In any case, much the same as EEG, EOG has a shortcoming in the illogical situation of the gadget and the quantity of cathodes that must be put on the driver [6]. Eyelid conclusion can be checked with the camera correctly and rapidly. Nonetheless, the utilization of the camera has a constraint of brightening, as the ordinary cameras don't function admirably around evening time when checking is more imperative. Different worries for camera-based frameworks are the surprising expense and the loss of picture when the drivers look in their mirrors outside the perspective of cameras. Likewise, the majority of the camera-based framework require PCs, picture preparing calculations and highlight extraction procedures to extricate lazy indications [7].

Rather than the camera, the eyelid conclusion can be caught utilizing a versatile and minimal effort gadget dependent on IR sensors mounted on an eyeglass, that guiding an IR pillar to the human eye [8]. Be that as it may, solid IR shaft in high temperature could be unsafe to eyes [9]. As an elective sluggishness recognition gadget, this paper proposes the utilization of a minimal effort EMG (Electro-Myo-Graphy) to screen the eyelid muscles, and measure the length of the eyelid conclusion, at that point sound a notice when the span surpass the utmost.

As detailed by Wylie et al, controlling wheel changeability is identified with the measure of languor in drivers (fluctuation more noteworthy as driver turn out to be more lazy) in the wake of being balanced for street subordinate effects.The procedure which is utilized here depends on the way that human body conducts ebb and flow. Subsequently by utilizing a directing wire on non leading controlling wheel of Vehicle (as appeared in Fig .3) and by utilizing an Analog To Digital Convertor (ADC) and associated through a Transistor which go about as a switch and when the driver hold the guiding firmly more momentum courses through base of Transistor as parallel protections made by our fingers include in parallel and accordingly net obstruction declines and base ebb and flow increments. Subsequently this variety is changed over by ADC into some limit and at whatever point yield is not as much as edge it shows Driver Drowsiness or Fatigue state.

3. Flowchart

Sleepy drivers are a noteworthy contributing variable to auto collisions. It has been demonstrated in numerous investigations, that there is a connection between drivers who are languid with car crashes. Keeping the driver from languor will have the capacity to lessen the event of mishaps. [7,8]. Languid driving is a noteworthy contributing element to an auto collision. This has been demonstrated by the numerous examinations that found an association between driver sleepiness and car crashes. Keeping the driver from laziness will have the capacity to diminish mischances. Physiological measures have every now and again been utilized for languor location as they can give an immediate and target measure. Conceivable measures are EEG (Electro-Encephalo-Graphy), eye developments, eye flicker and eyelid conclusion [9].

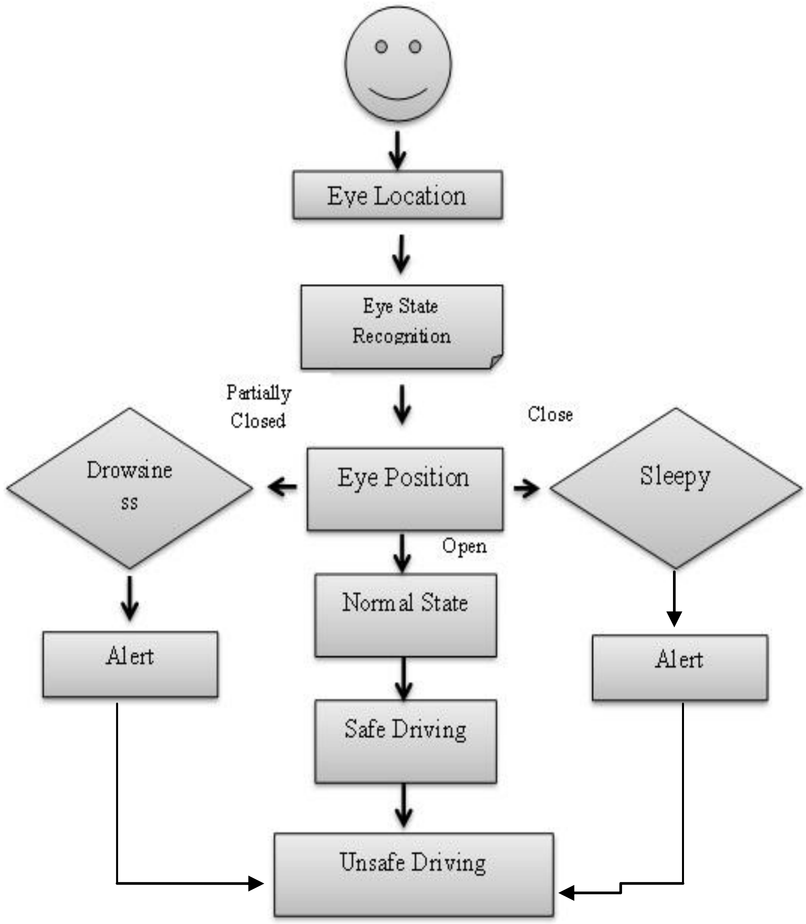


Fig 1: Flowchart of eye state recognition

EEG is an electrophysiological observing strategy to record electrical movement of the cerebrum. EEG has appeared to be a solid marker of sluggishness. The measure of movement in various recurrence groups can be estimated to recognize the phase of sluggishness. The disservice of utilizing EEG are hard to quantify in field settings because of flag ancient rarity, are not promptly amiable to ongoing sign preparing and are not exceedingly prescient of impeded conduct because of laziness [10].

Further, rather than utilizing EEG, mechanical advancement has empowered more nitty gritty estimation of eyelid developments continuously. Introductory reports recommend that the speed and abundancy of eyelid developments give helpful pointers of sleepiness and that the utilization of various eyelid conclusion measurements may enhance the rediction of tiredness [11].

Driver checking frameworks has been examined generally lately, to identify driver laziness and to send to the driver reasonable cautions to maintain a strategic distance from conceivable issues. There are a few methods to driver laziness and weariness identification. Head position location is a technique to distinguish changes in head position tilt [12], or, in other words late to caution the driver since it is the last advance of nodding off.

The other path is to recognize anomalous driver conduct in which the framework initially takes in driver's social qualities and thinks about his typical and ebb and flow response times to give an alarm if there should arise an occurrence of laziness discovery which is driver subordinate and the framework should be prepared [13, 14]. Additionally voice discovery techniques can be utilized to distinguish a conceivable exhausted voice in the auto, however these strategies are confounded [15]. Also driver's biometrics can be identified and followed utilizing diverse sensors in the auto and weakness can be recognized dependent on his position and imperative signs [16], however these strategies are to some degree meddling and can irritate the driver.

4. Proposed work

We propose an algoritmatic approach to find out the drivers drowsiness. The maximum blinking count of the eye can be a best intimation to find the drowsiness of the driver. Then proposed technique and the formula helps to identify the width & height of the eye position. The width of the face also calculated to know the exact projection of the head movements. We simulated the driver's drowsiness by showing the status with the help of the diagram. While at the time of drowsy driving automatically the alarm will indicate the driver and to the control room.

Eye detection and the level of drowsiness will be find out in numerous ways. The face recognition, blinking count of the eyelid, color change of the eye, position of the eye, open eye / closed eye differences, iris positioning and so on. Usually blinking maximum times of eyelid is normal for many persons. So we couldn't judge the maximum blinking of eyelid leads to drowsiness. For that we went through an experiment by checking the drivers' drowsiness by the eyelid count. The maximum count within a minute had been under test for a driver. As a result the drowsy driver has the maximum count of blinking of eyelid.

When the driver under such condition he tries to awake himself by opening his eye in various position. While he tries to open the eye intentionally the count of the eyelid varies according to the situation. In another case the sleepy driver has automatically have the maximum blinking count unknowingly. In both conditions the warning messages or alarm will indicate the driver or the central pool.

The driver's seat in which subjects were comfortably seated simulated the swaying motion of driving on the road. The recorded data were analyzed off-line in MATLAB (Math works). Using custom-made scripts, from each frame of the videotaped eye images, eye position was measured as the center of the pupil. Eye position was measured from the center of the pupil for each frame of the videotaped eye images using custom scripts. Errors in the measurement of eye position due to blinks and saccades were eliminated automatically [17]. The eliminated periods of data were interpolated using a linear function. The measured eye positions [mm] were converted to angular eye position θ [deg] by the following equation:

$$\theta = 2\sin^{-1}\frac{d}{2r}$$

Where$d$denotes the difference in eye positions [mm] between previous and current frames, and r denotes the radius of the average adult eye ball i.e., 11mm. Angular eye velocities $e\ (t)$ [deg/s] were calculated by a low-pass differentiation filter. Head movements were calculated as follows:

$$e_{rot}\,(t) = e_{rot\ j}\,(t) + e_{rot\ k}(t)$$

$e_{rot\ k}(t)$is the sign-reversed head pitch rotational velocity measured by the gyroscope attached to the goggles,

$$e_{rot\ j}\,(t) = \frac{d}{dt}\,2\sin^{-1}\frac{y\,(t)}{2L}$$

Where$y\ (t)$ is vertical head displacement estimated as the 2^{nd} integration of the vertical head acceleration, and L denotes the distance between the eye and the fixation point on the DS screen.

Some others may have encountered heavy drowsiness yet did not close their eyes by any stretch of the imagination. In this way, for a few cases, shutting the eyes isn't straightforwardly identified with drowsiness. It is important to watch the propensity before wearing this instrument. Nonetheless, when all is said in done, if a man initially closes and flickers, then suddenly over time becomes frequently closed and blinked, then this can be a sign that the person is sleepy. In this way, a difference in example from shutting the eyes all of a sudden and frequently can be an indication that there is languor or drowsiness.

The shortcoming of this model is that the observing can't keep running progressively, on the grounds that there is dependably a period slack when on the web, that is when information is sent to the web each moment, the presentation in Google Spreadsheet will dependably show a period interim of over 1 minute.

Drowsiness level can be calculated based on how many seconds the eyelid is closed, which is accumulated in 1 minute. If the accumulated value in 1 minute is less than 5, then the drowsiness level is low, whereas if more than 10, the drowsiness level is high, and buzzer will sound. This level of drowsiness will be sent to the internet every minute with the help of ESP8266, which is displayed in Google Spreadsheet.

Table 2: Blinking count for Open, semi-open & Drowsy state

Eye Position	**Maximum Count**	**Minimum Count**	**Status**
Open	10	7	Normal State
Semi Open	18	8	Drowsy
Closed	0	0	Sleepy

Algorithm :Analyzing the Width and Height of Eye and face, for detecting Driver's drowsiness

Finding drivers drowsiness by detecting Eye position

Input :(x_e, y_e) *are the coordinates of the top left corner of eye*
x_k *is the x coordinates of the mouth region*
w_g *is the width of the face region*
y_g *is the y coordinates of the face region*
i_j *height of the face* ; h_e *determines the height of the eye*

Output : Width and Height of the Eye// **Easily find the**
Initially eye position is in three stages according to our research

Case 1:
If the eye position is open then
{
$(x_e, y_e) = (x_k - 0.16\, w_g\ , y_g + 0.16 i_j + 20)$//***Open***
then
{
Normal mode // Driver in normal state
}
}
Case 2:
{
If the eye position is closed then
$(x_e, y_e) = (x_k - 0.14\, w_g\ , y_g + 0.13 i_j + 20)$ // ***Closed***
then
{
Closed mode*// **Driver in Sleepy mode***
}
}
Case 3:
{
If the eye position is Semi Open then
{
$(x_e, y_e) = (x_k - 0.15\, w_g\ , y_g + 0.16 i_j + 20$// ***Semi Open***
then
{
Drowsy mode*// **Driver in drowsy mode***
}
}
The width and height of the eye can be defined as
$W_e = 1.8\ X\ 0.15\ X\ w_g$ //**Width of Eye**
$h_e = 0.16\ i_j$ respectively // **Height of the eye**
End

The height and the width of the face and eye can be defined by the above algorithm. The values mentioned as a height and width is an approximate value. For the most cases the value resides below the prescribed above values. There will be a slight variation in the width and height. It won'tgive a major difference. The three different stages of the eye position.

Mechanism of the proposed work

In this mechanism flows the driver driving a car followed by checking the face detection. There are plenty of car cameras in usage. In our research we use a " Cara negra 60 mm universal de 2.5" camera . The camera detects the eye lids count as well as the condition of the eye (mentioned in the proposed technique) . The proximity camera helps to convert the signal into a messages. It may be a audio or text. If we want text image the detailed will be connected to GPS through net. After checking the eye lids condition the sensor gives a warning message eith an alarm. So driver can alert himself in the first stage.

5. Experiments and results

The various projection of the eye can be described in the below diagram. The normal mode, Drowsy mode and the sleepy mode can be detected and indicated by the help of sensors & cameras attached in front of the driver. At the time of drowsiness and the change of eye position automatically the alarm indication will be done. It helps to wake up the driver and to indicate the emergency of the driving to the control room. The measurement of the eye can be calculated with the help of above proposed algorithm. The width and height of the eye & face can be measured through the above said formula to avoid the emergency. Thus the driver drowsiness can be find out easily.

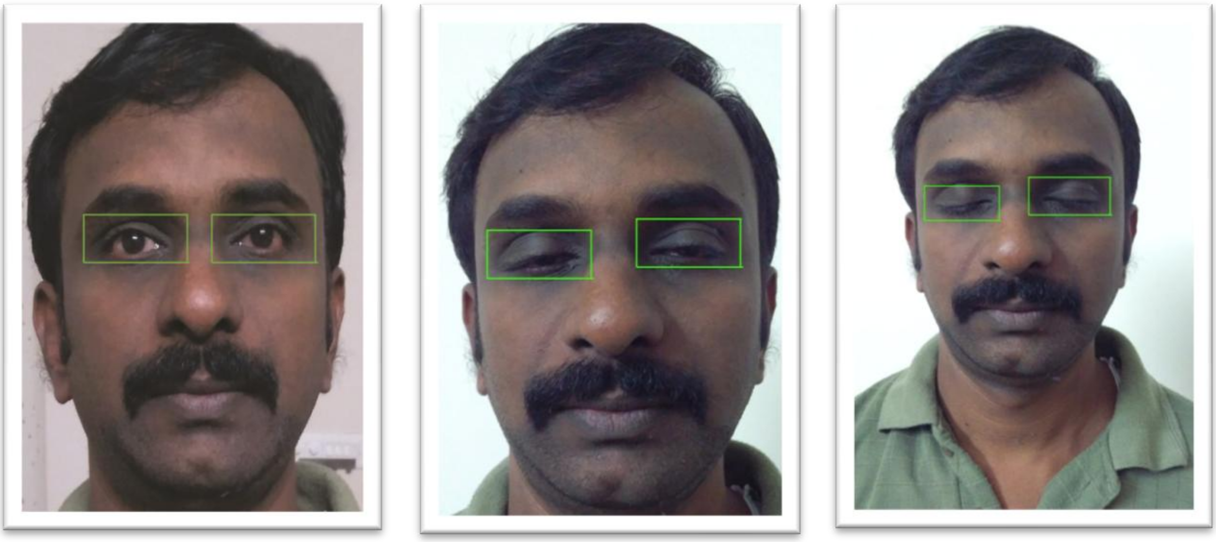


Fig 3:Various projection of Eye (a) Normal mode (b) Drowsy mode (c) Sleepy mode

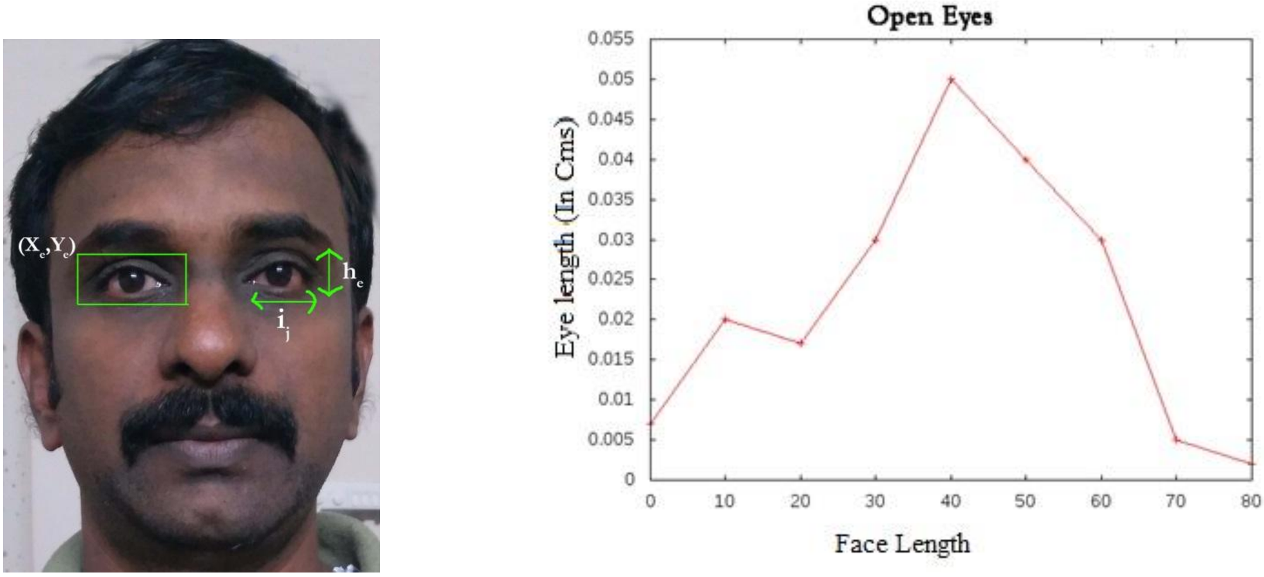


Fig 4:Open eyes or Normal mode and its measured graph

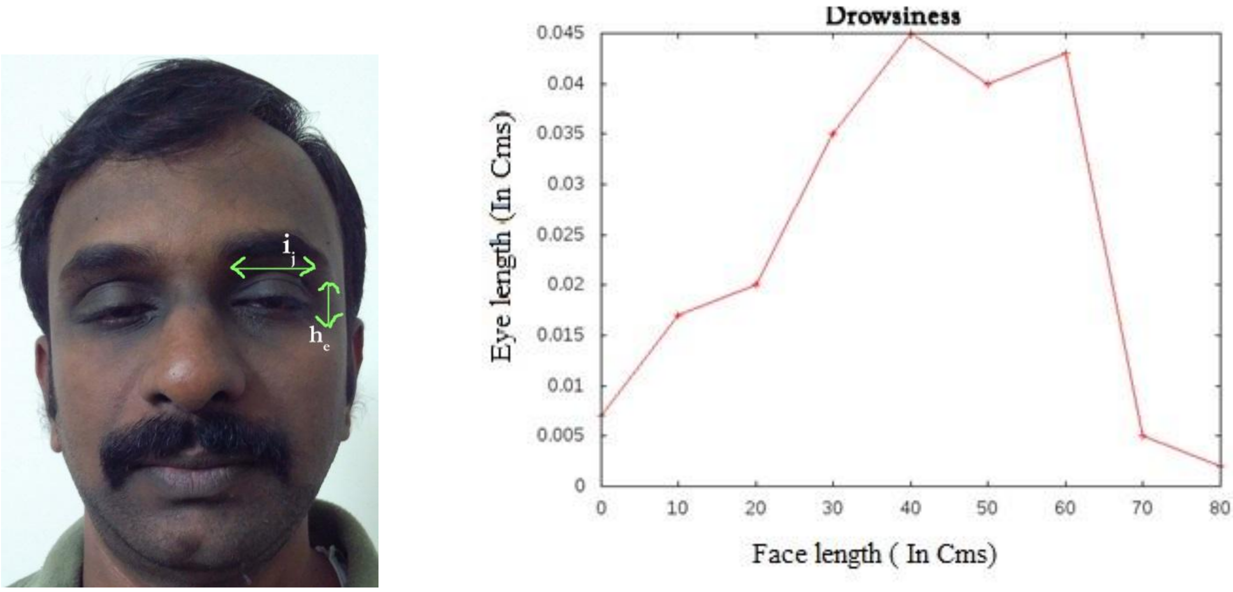
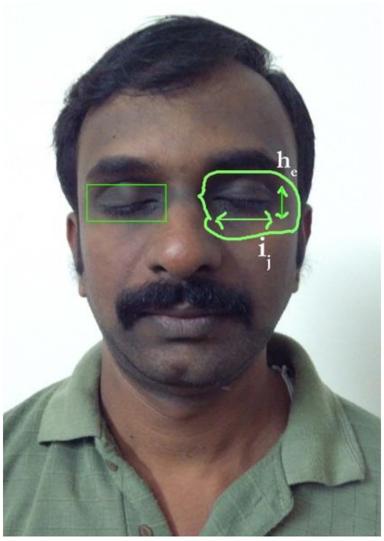


Fig 5:Drowsy eyes or semi-opened and its measured graph



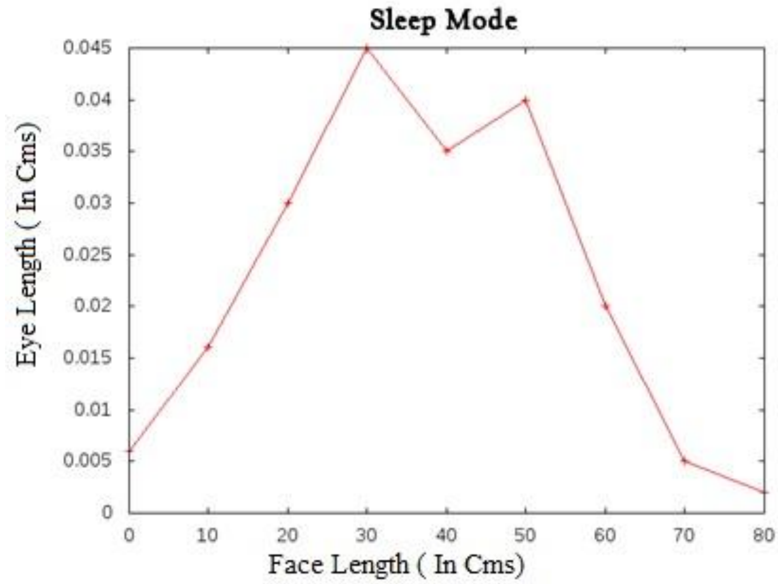


Fig 6:Closed Eyes or Sleepy mode and its measured graph

Fig 5: Various head movements and eye position while driving

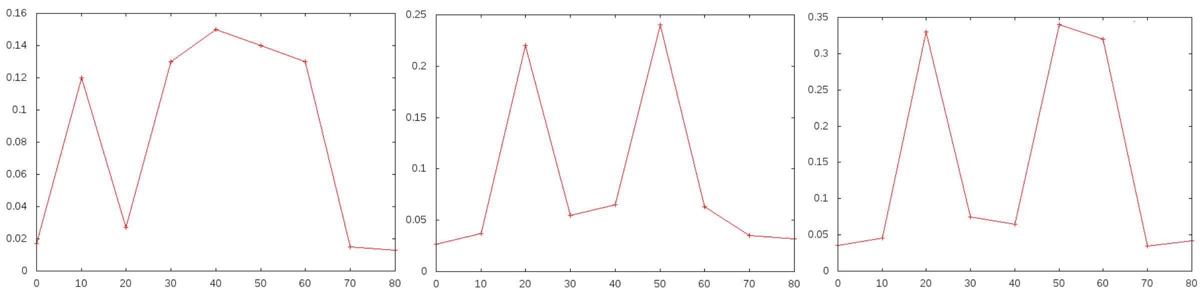


Fig 6: Various Levels of Drowsiness Head movement's simulation (X axis denotes Eye Length in Cms and Y Axis denotes Face Length in Cms)

6. Simulations and analysis

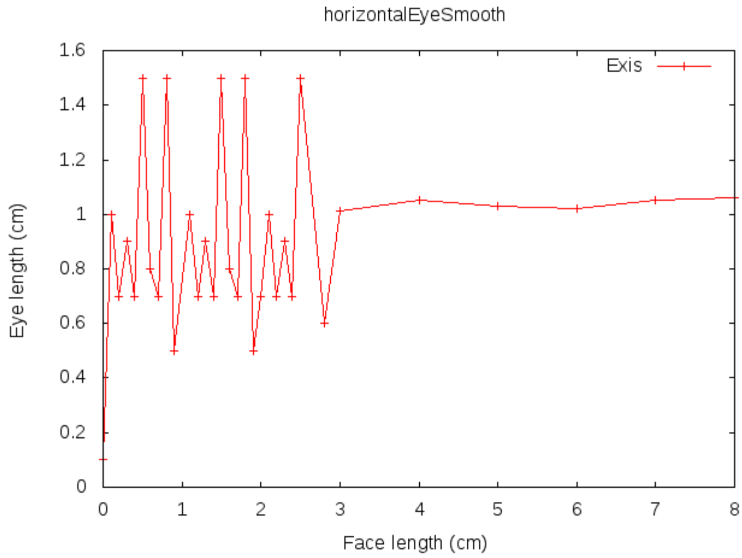


Fig 7: Driver's status in Normal mode

Figure 7 explains about the drivers status. X axis focus the face length of the person and the Y axis focuses the length of the eye. The figure explains the clear view of the normal state because in normal stage the eye lid will open and the measurement will be above 1.2 cm or 1.3 cm. It indicates the driver is in normal stage and his eye will be open . In the above diagram the eyelid opens upto1.6 cm of length.

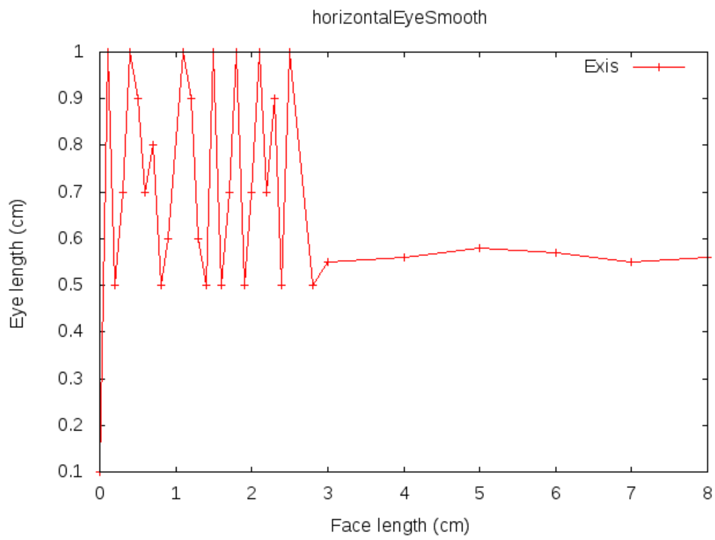


Fig 8: Driver's status in drowsy mode

In figure 8 it clearly defines the semi sleepy driver i.e., drowsy drivers. The eye length varies from the normal condition of the eye. The eye lid will open below 1.2 cm and the minimum of 1 cm , then the driver is in drowsy mood. It may cause accidents and unnecessary problem. We couldn't judge all the drivers in such condition. The possibility of drowsiness level may lead from the above measurements. The above graph clearly defines the drowsiness of the driver. The sharp upper curve represents the normal mode and the variation of the graph (minimum value curve) represents the drowsiness state

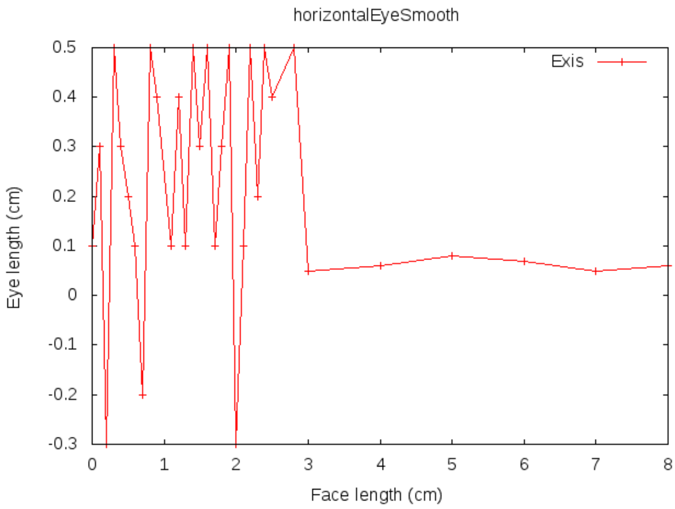


Fig 9: Driver's status in sleepy mode

Figure 9 defines the driver's sleepy status. The eye lid is below 0.5 cm to the negative values then the driver is in sleepy mode. When the eye length of the driver is from 0.5 to the minimum then the driver is not in a normal condition. He is in sleepy mode, so it is very dangerous to drive in his way. Our proposed technique proposes the variation of the drivers condition by projecting their eye length and the eye blinking count.

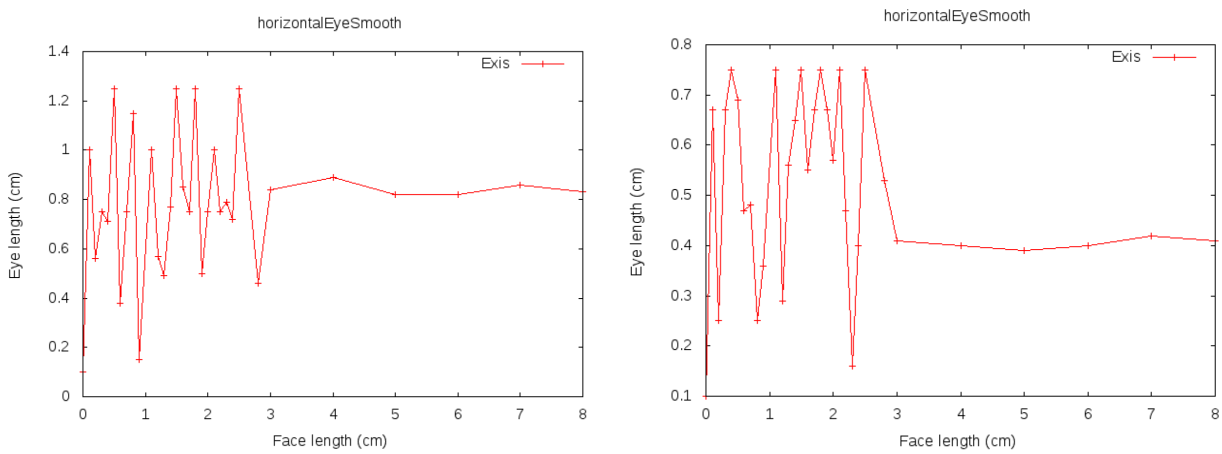


Fig 10 (a) Driver's status in between Normal & Drowsy mode (b) Driver's status in between Drowsy & Sleepy mode

The above figure 10 (a) the graph variations lies between the normal mode to the drowsy condition. The eye length value lies between 1.3 to 1 cm . The figure 10 (b) the graph variations lies between 0.7 cm to 0.5 cm that indicates the condition is between drowsy to sleepy condition. Both the condition is not safe to drive the vehicle.

7. Conclusion

This system will detect eye movement to detect the fatigue state of driver and gives warning in half second. The Warning arrangements help to avoid major accidents. The algorithmatic, formula's and the table helps to get a clear picture about driver's condition. Automatically the indication will alarm at the time of drivers sluggy mode. Our proposed algorithm helps to get a clear image about the safety and security of the driver.Bymonitoring the eyes using camera and using this new algorithm we can detect symptoms of driver fatigue earlyenough to avoid an accident.

References

[1] Q. Ji, Z. Zhu, and P. Lan, "Real-time nonintrusive monitoring and prediction of driver fatigue," IEEE Trans. VehicularTechnology. vol. 53, no. 4, Jul. 2004, pp. 1052–1068.

[2] H. Ueno, M. Kaneda, and M. Tsukino, "Development ofdrowsiness detection system," Proc. IEEE Int. Conf. VehicleNavigation and Information Systems, Yokohama, Japan, Jun.1994, pp. 15-20.

[3] T. Hayami, K. Matsunaga, K. Shidoji, and Y.Matsuki,"Detecting drowsiness while driving by measuring eyemovement – a pilot study," Proc. 5th IEEE Int. Conf.Intelligent Transportation System, Singapore, Sep. 2002, pp.156-161.

[4] M. Suzuki, N. Yamamoto, O. Yamamoto, T. Nakano, and S.Yamamoto, "Measurement of driver's consciousness by imageprocessing - a method for presuming driver's drowsiness byeye-blinks coping with individual differences -," Proc. IEEEInt. Conf. Systems, Man, and Cybernetics, Taipei, Taiwan,Oct. 2006, pp. 2891-2896.

[5] T. Orazio, M. Leo, C. Guaragnella, and A. Distante, "A visualapproach for driver inattention detection," PatternRecognition, vol. 40, Jan. 2007, pp. 2341–2355.

[6] R.L. Hsu, M. Abdel-Mottaleb, and A.K. Jain, "Face detection in color images," IEEE Trans. Pattern Analysis and Machine Intelligence. vol. 24, no. 5, May. 2002, pp. 696-706.

[7] R. Zuraida, H. Iridiastadi, and I. Z. Sutalaksan, "Indonesian driver's characteristics associated with road accidents", International Journal ofTechnology (2017) 2: 311-319, ISSN 2086-9614.

[8] M. A. Puspasari, E. Muslim, B. N. Moch, and A. Aristides, "Fatigue Measurement in Car Driving activity using Physiological, Cognitive,and Subjective Approaches", International Journal of Technology (2015) 6: 971-975, ISSN 2086-9614.

[9] U. Svensson, "Blink behaviour based drowsiness detection – method development and validation", Master's thesis project in Applied Physicsand Electrical Engineering, 2004, Swedish National Road and Transport Research Institute, ISSN 1102-626X.

[10] Wilkinson VE; Jackson ML; Westlake J; Stevens B; Barnes M; Swann P; Rajaratnam SMW; Howard ME.The accuracy of eyelid movementparameters for drowsiness detection. J Clin Sleep Med 2013;9(12):1315- 1324.

[11] Z. Mardi, S.N. Ashtiani, and M. Mikaili, "EEG-based Drowsiness Detection for Safe Driving Using Chaotic Features and Statistical Tests", J Med Signals Sens. 2011 May;1(2):130-7.

[12] M. Celenk, H. Eren, and M. Poyraz, "Prediction of driver headmovement via Bayesian Learning and ARMA modeling," *In Proc. OfIEEE Intelligent Vehicles Symposium* , pp.542-547, 2009.

[13] K. Murata, E. Fujita, S. Kojima, S. Maeda, Y. Ogura, T. Kamei, T.Tsuji, S. Kaneko, M. Yoshizumi, and N. Suzuki, "NoninvasiveBiological Sensor System for Detection of Drunk Driving," IEEE Trans.on Information Technology in Biomedicine, vol.15, no.1, pp.19-25,2011.

[14] T.H. Chang; .C.S. Hsu, "Irregular Vehicle Behavior Warning Modules,"*In Proc. of IEEE Intelligent Vehicles Symposium*, pp.1150-1155, 2007.

[15] L.S. Dhupati, S. Kar, A. Rajaguru, and A. Routray, "A novel drowsinessdetection scheme based on speech analysis with validation usingsimultaneous EEG recordings," *In Proc. of IEEE Int'l Conf. onAutomation Science and Engineering (CASE),* pp.917-921, 2010.

[16] C.T. Lin, N.R. Pal, C.Y. Chuang, T.P. Jung, L.W. Ko, and S.F. Liang,"An EEG-based subject- and session-independent drowsiness detection,"In Proc. of IEEE Int'l Joint Conf. on Neural Networks, IJCNN, pp.3448-3454, 2008.

[17] J. Kasper, A. Diefenhardt, A. Mackert, U. Thoden, "The Vestibulo-Ocular response during transient arousal shifts in man," Acta.Otolaryngol, 112(1), pp. 1-6, 1992