International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

Driver's Face Monitoring System for Detecting Hypo-Vigilance: A Review

Priyanka N. Lahange
B.E VIII semester, Department of IT, Nagpur university, Maharashtra (INDIA)
Priyankalahange06@gmail.com

Krutika S. Admane
B.E VIII semester, Department of IT, Nagpur university, Maharashtra (INDIA)
Admanekrutika13@gmail.com

Mrunali Gedam
B.E, M.Tech.(CSE), Asst. Professor, Department of IT, Nagpur university, Maharashtra (INDIA)
Mrunaligedam40@gmail.com

Abstract —
Now a days, there are large number of accidents caused due to drivers fatigue and distraction. Every year, many car accidents occur around the world which causes casualties and injuries. For accident detection or drivers fatigue and distraction detection we can use Drivers face monitoring system. This system captures the image of the driver and focuses on the face region and extract the symptoms of fatigue and distraction. These symptoms are usually percentage of eyelid closure, blink speed, gaze direction, eyelid distance, yawning and movement of head. Drivers face monitoring system alerts the driver based on the extracted symptoms and alarm would be set on so that the driver is alerted and pays attention to the driving task.

Face and eyes of the driver are first localized and then marked in every frame obtained from the video source. Using real time video source the eyes are tracked using correlation function with an automatically generated online template. Sleeping and drowsiness while driving are now one of the reasons for fatal crashes while driving which causes accident. In this paper, we have discussed various drowsiness detection techniques. This uses various images of driver to detect drowsiness states using his/her facial expression and eyes states.

Keywords —
Drivers fatigue and distraction, Drivers face monitoring system, drowsiness detection and facial expression, eyes states

Introduction

The traffic accidents will be largely reduced if we get any solutions so that the driver can be stay awake. Improvement in public safety and reduction in accidents are of the important goals of the Intelligent Transportation System (ITS). An important factor for causing accidents is drivers fatigue and distraction. Many educational programs are conducted to alert the driver and should not drive when he/she is not able to concentrate on his driving task. Through researches we have get to know that after every 1 hour of driving the driver is fatigue. In this paper, we describe a non-intrusive vision-based system for the detection of driver fatigue. The system uses a colour video camera that points directly rewards the driver's face and monitors the driver's eyes in order to detect micro-sleeps (short periods of sleep). The system deals with skin-color information in order to search for the face in the input space. After segmenting the pixels with skin like colour, we perform blob processing in order to determine the exact position of the face. We reduce the search space by analysing the horizontal gradient map of the face, taking into account the knowledge that eye regions in the face present a great change in the horizontal intensity gradient. In order to find and track the location of the pupil, we use grey scale model matching. We also use the same pattern recognition technique to determine whether the eye is open or closed. If the eyes remain closed for an abnormal period of time (5-6 sec), the system draws the conclusion that the person is falling asleep and issues a warning signal.

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

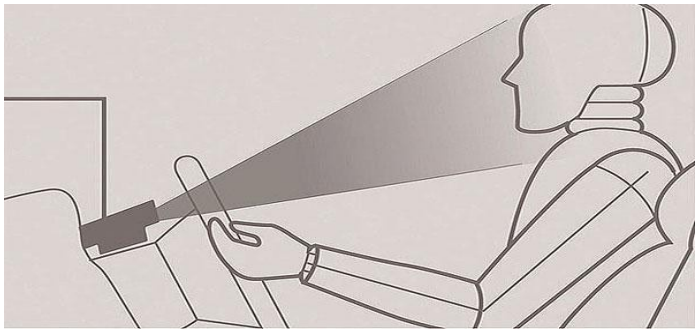

Fig. 1: Overview of driver face monitoring system.

Recently many safety systems are followed to avoid transportation accidents. These systems focuses on the detection of drowsiness among fatigue-related impairments in driving based on eye-tracking – an active safety system. In this system live video capturing is done. Through this capturing video face is tracked and then the eye is tracked from the face. As the images are captured, if there is any change between the images then the fatigue is detected and the alarm is set on. With the help of medical science, we have discussed the driver's drowsiness detection techniques. The medical help may include techniques based on EEG (Electroencephalograph), ECG (Electrocardiograph), and EMG (Electromyography). The major challenges in drivers face monitoring system is the measurement of fatigue and the measurement of concentration.

Fig. 2: EEG based technique.

The first challenge is to measure fatigue. Despite the progress of science in physiology and psychology, there is still no precise definition for fatigue. And due to this lack of definition of fatigue, there is no particular criterion for measuring it. Yet there is a relation between fatigue and body temperature, eye movement, breathing rate, heart rate and brain activity, etc. One of the first and most important signs of fatigue appears in the eyes of the person driving the vehicle. The second challenge is to measure of driver's distraction on the road. Driver's distraction can be estimated by detecting driver's head and gaze direction. The main problem is that if driver is looking forward towards the road doesn't mean that he/she is paying full attention on his/her driving task. Beside these mentioned challenges of the driver face monitoring system, developing a real-time system on conventional hardware platforms, reducing error of the system in detection of face and its components, reducing error of face tracking and increasing system accuracy in detection of fatigue and distraction are considered as other problems of such system. To acquire the vehicle parameter along with the head movement monitor, the driver alertness system is used which has multiple sensors. To judge the status of the driver and to attend any emergency the GPS module with a crash sensor is used. The GPS module along with the crash sensor is incorporated to monitor the speed and location of the vehicle and sends and alert

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

message to the EMRI (Emergency service) during any crash or mishap.

I. VARIOUS HYPO-VIGILANCE DETECTION TECHNIQUES

In Drivers face monitoring technique, we can use various techniques for detection of hypo-vigilance. Hypo-vigilance is another term means lack of consciousness and may include drowsiness, distraction or both. The various techniques are studied by observing symptoms related with different regions of face which includes eyes, mouth, head etc. Some of them are studied here:

A. *EEG/ECG Based Technique:*

The Electroencephalogram (EEG) is the physiological signal which is used to detect drowsiness. According to the researches, EEG signal has various frequency bands, including the delta band (0.5–4 Hz), which corresponds to sleep activity, the theta band (4–8 Hz), which is related to drowsiness, the alpha band (8–13 Hz), which represents relaxation and creativity, and the beta band (13–25 Hz), which corresponds to alertness . A decrease in the alpha frequency band and an increase in the theta frequency band indicate drowsiness. In the EEG (electroencephalogram) based technique, it is compulsory to wear the helmet while driving. The helmet is having various electron sensors which are placed at correct place and it gets data from the brain. The EEG signals of driver were captured by using the instrument NT-9200 in the driver's stimulation system. The NT-9200 has two states one is sober and other is drowsy. The heart rate (HR) also varies significantly between the different stages of drowsiness, such as alertness and fatigue. Therefore, heart rate, which can be easily determined by the ECG (electrocardiogram) signal, can also be used to detect drowsiness.

B. *Artificial Neural Network Based Technique:*

In this technique they use neuron to detect driver's drowsiness. Only one neuron will not give accurate result as compared with using more than one neuron. Some researchers are carrying out investigations in the field of optimization of driver drowsiness detection using Artificial Neural Network. People in fatigue exhibit certain visual behaviors that are easily observable from changes in facial features such as the eyes, head, and face. Visual behaviors that typically reflect a person's level of fatigue include eyelid movement, gaze, head movement, and facial expression. To make use of these visual cues, they made artificial neural network to detect drowsiness.

C. *Techniques Based on Eye Region:*

1) Template matching technique:

In this technique, it is focused on the eye region of the drivers face. This method is easy and simple to implement. This is focused on the eye region of the face and it has both open and close eyes template of the driver. This template is so trained that it can get the open and close template of the driver i.e. it uses the states of eye. If the eyes are close for some particular time then the system will generate an alarm.

2) Eye blinking Based Technique:

To detect the driver's drowsiness, eye blinking rate and eye closure duration is measured. As the driver is felt sleepy then the gaze between the eyelids are different from normal situation and there is a change in his/her eye blinking rate. So due to this it is easy to detect drowsiness. In variation with time, the position of irises and eye state are monitored to measure the eye blinking frequency and eye close duration. Fatigue and distraction can be measured by slow eye blink speed. Eye blink speed is the time between opening and closing eyelids during one blink. If speed of blinking is larger than a threshold (about 0.5 to 0.8 seconds) driver drowsiness is detected. Eye blink rate is the number of blinking in a certain period of time. This symptom can be used to detect hypo-vigilance. Eye blink rate varies from person to person. If eye blink rate is much less than the normal state, it shows distraction and if it is much higher than the normal state, it shows driver drowsiness or fatigue.

3) Eye closure Based Technique:

Through eye closure we can also detect the symptom of drowsiness. It gives us the

International Journal of Research
International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 4, April 2015
Available at http://internationaljournalofresearch.org

necessary information about the symptoms that can lead to accident. For detection of driver drowsiness eye closure has two different forms (1) continuous eye closure and (2) percentage of the eye closure in a particular given time. In continuous eye closure method, if the eye of the person is closed for a particular given time then it detects the symptoms of drowsiness. Driver drowsiness will be detected only when his/her eyes are closed completely for a certain period of time. At this time there are more chances of severe accident and hence this method is not efficient and not very reliable. Percentage of eye closure (PERCLOS) is another method which is based on the eye closure. Based on lighting and imaging in the IR spectrum, we can detect the eye location. From eye location and pupil we can consider the property of reflected IR beam. Closed or open eye state can be detected using the same way. Then PERCLOS can be calculated and was used for driver drowsiness detection.

D. *Techniques Based on Mouth Region:*

One of the fatigue symptoms is yawning. Mouth is widely open in yawning as compared to normal speaking. By using mouth tracking, one can detect yawn. One can detect yawning by measuring open rate of mouth and the number of changes in mouth area by focusing on lips movement. When the mouth is widely open then the system is alerted. When yawn is detected by system then it alarms the driver. Driver talking with other while driving can be considered as a symptom of distraction. In some researches, open mouth was detected by measuring the ratio of width to height of mouth. If ratio is low then the mouth is closed, and it is higher when mouth is open. The main drawback of this method is that the system recognizes driver is drowsy when mouth is open for whatever reason (*e.g.*, talking).

Fig. 3: yawning detection.

E. *Techniques Based on Head Region:*

1) Head Orientation/ Nodding Detection Technique:

Head orientation is also one of the symptoms of distraction. During the driving task, the driver has to pay full attention to his/her driving task. If he/she doesn't pay attention to the driving task then an accident can occur. If the driver is not concentration on the task then his/her head moves continuously then an alarm would be generated which alerts the driver. Another symptom related to drowsiness is head nodding. During drowsiness, head is gradually bent.

Also driver's fixed head over a long period of time is also a symptom of driver distraction. When driver focuses on something except driving task in his/her mind, his/her head will be fixed. By this distraction can be detected and driver can be warned accordingly. Nose tip location with respect to head and eyes is an appropriate criterion for determination of the direction of the head. This is way to track the direction of the head of the driver to find his/her distraction from the road.

2) Gaze Direction Detection Technique:

Gaze direction is an effective symptom to determine driver distraction. Using this symptom, it is possible to determine lack of driver attention to road. Moreover, driver decision to overtake or lane changing can also be predicted using this symptom. Based on previous researches, it is shown that driver changes his/her looking permanently from the current lane to the destination lane and vice versa during overtaking. According to studies, gaze direction was estimated based on center of pupil and the reflected light from

cornea. The light reflected from cornea is called glint which is weaker than the reflected light from pupil and its diameter is smaller. The reflected light from pupil is only appear in the even frames, while the reflected light from the cornea is appear in all frames. Direction of the line which connects center of pupil to center of glint determines the gaze

II. CONCLUSIONS

Evaluation of driver state estimation is a difficult task because there is not any criterion for measurement of fatigue and distraction. Due to lack of scientific definition for fatigue and there is not any quantitative approach to measure it. Only by using these techniques and recognizing symptoms related to face, eye, mouth and head regions can be extracted and fatigue and distraction can be detected. Driver wearing glasses make this complicated to detect eyes and in turn fatigue cannot be detected, but researches are going on to eliminate this drawback. Various studies show that face tracking increases computational complexity than that of eye tracking. In future driver face monitoring systems can detect unusual and abnormal state of driver such as heart attack or epilepsy and send S.O.S message to police. Many researches shows that current driver face monitoring systems work well in laboratory conditions, but they usually fail in night light and sudden light changes. So with the use of correct algorithm and technique this can be reduced.

REFERENCES

[1] Marco Javier Flores, Jose Maria Armingol, and Arturo de la Escalera(2010), "Driver Drowsiness Warning System Using Visual Information for Both Diurnal and Nocturnal Illumination Conditions," EURASIP Journal on "Advances in Signal Processing", Vol 2010 (2010), Article ID 438205.

[2] Hawlader Abdullah Al-Mamun, Nadim Jahangir, Md. Shahedul Islam and Md. Ashraful Islam(2009), —Eye Detection in Facial Image by Genetic Algorithm Driven Deformable Template Matching,‖ IJCSNS International Journal of Computer Science and Network Security, Vol 9, Issue 8, August 2009, Page(s): 287-294.

[3] Wen-Bing Horng, Chih-Yuan Chen, Yi Chang, Chuu-Hai Fan, (2004), —Driver Fatigue Detection Based on Eye Tracking and Dynamic Template Matching,‖ IEEE Proceedings of International Conference on —Networking, Sensing & Control‖, Taipei, Taiwan.

[4] Wenhui Dong, Xiuojuan Wu, (2005), "Driver Fatigue Detection Based on the Distance of Eyelid," IEEE Int. Workshop on "VLSI Design & Video Tech.", Issue May 28-30,2005, Page(s):365-368.

[5] Ling Gan, Bing Cui and Weixing Wang, (2006), "Driver Fatigue Detection Based on Eye Tracking," IEEE Proceedings of the 6th World Congress on Intelligent Control and Automation, June 21-23,2006, pp.5341-5344.

[6] Tianyi Hong, Huabiao Qin and Qianshu Sun, (2007), "An Improved Real Time Eye State Identification System in Driver Drowsiness Detection," IEEE International Conference on "Control and Automation", May 30-June 1, 2007, page(s): 1449-1453

[7] Jie Tang, Zuhua Fang, Shifeng Hu, Ying Sun, (2010), "Driver Fatigue Detection Algorithm Based on Eye Features," IEEE proceedings of 2010 Seventh International Conference on "Fuzzy Systems and Knowledge Discovery" (FSKD 2010).

[8] Yung-Lung Kuo, Jiann-Shu Lee, Sho-TsungKao(2009), "Eye Tracking in Visible Environment", 2009 Fifth International Conference on

[9] "Intelligent Information Hiding and Multimedia Signal Processing", pp.114-864.

[10] Jianxiong Tang, Jianxin Zhang,(1988), "Eye Tracking Based on Grey Prediction,"

2009 First International Workshop on Education Technology and Computer Science.

[11] N.G. Narole, and G.H. Raisoni., —IJCSNS A Neuro-genetic System Design for Monitoring Driver's Fatigue.vol. 9. No. 3, March 2009.

[12] QiangJi, Zhiwei Zhu and PeilinLan —IEEE transactions on Vehicular Technology Real Time Non-intrusive Monitoring and Prediction of Driver Fatigue, vol. 53, no. 4, July 2004.

[13] Cho, K. J., Roy, B., Mascaro, S. and Asada, H. H., "A Vast DOF Robotic Car Seat Using SMA Actuatorswith a Matrix Drive System," Proc. IEEE Robotics and Automation, New Orleans, LA, U.S.A., Vol. 4, pp.3647 3652 (2004).

[14] Chieh, T. C., Mustafa, M. M., Hussain, A., Zahedi, E. and Majlis, B. Y., "Driver Fatigue Detection UsingSteering Grip Force," Proc. IEEE Student Conference on Research and Development, Putrajaya, Malaysia,pp. 45 48 (2003).

[15] Davies, E. R., Machine Vision: Theory, Algorithms, Practicalities, Third Edition, Elsevier, Oxford, UK (2005).

[16] K.P. Yao, W.H. Lin, C.Y. Fang, J.M. Wang,S.L. Chang, and S.W. Chen, "Real-Time Vision-Based Driver Drowsiness/Fatigue DetectionSystem," Proc. IEEE 71st VehicularTechnology Conference, Taipei, Taiwan, 2010, pp. 1-5.

[17] Dr. Xiong (Bill) Yu, P.E.,"Non-Contact Driver Drowsiness DetectionSystem",(safety IDEA),2012

[18] STRID Sub-Group on Fatigue, Canadian operational definition of driverfatigue, Ottawa, ON, Canada, May 2006.

[19] L. Bergasa, J. Nuevo, M. Sotelo, R. Barea, and E. Lopez, "Real-timesystem for monitoring driver vigilance," IEEE Trans. Intell. Transp.Syst., vol. 7, no. 1, pp. 63–77, Mar. 2006.

[20] Y. Liang, M. L. Reyes, and J. D. Lee, "Real-time detection of drivercognitive distraction using support vector machines," IEEE Trans. Intell.Transp. Syst., vol. 8, no. 2, pp. 340–350, Jun. 2007.

[21] Ralph OyiniMbouna, Seong G. Kong, Senior Member,IEEE,(2013),Visual Analysis of Eye State and Head Pose for DriverAlertnes Monitoring, (IEEE),pp.1462-1469,vol.14,USA

[22] S. Vitabile, A. De Paola, F. Sorbello, J Ambient Intell HumanComput, "A real-time non-intrusive FPGA-based Drowsinesssystem" Springer, pp.251-262, University of Palermo, Italy 2011

[23] ArunSahayadhas,KennethSundaraj,"Detecting Driver DrowsinessBased on Sensors A Review",pp.16937-16953, ISSN 1424-8220,Malaysia 2012 http://djhurij4nde4r.cloudfront.net/images/images/000/005/917/fullsize/eskandarian.png?1386903510

[24] Anirbandasgupta,anjithgeorge,"A Vision Based System ForMonitoring The Loss Of Attention in Automotive Drivers",(IEEETransaction),vol.14,no.4 2013

[25] AntoinePicot,SylvieCharbonnier,"On-Line Detection of DrowsinessUsing Brain and Visual Information",IEEE Transaction on systems,man and cybernetics part a: systems and humans, VOL. 42, NO.3,2012..

[26] Boon-Giin Lee and Wan-Young Chung, "Driver AlertnessMonitoring Using Fusion of Facial Features and Bio-Signals",(IEEE) Sensors journal, vol. 12, no. 7,2012

[27] Ralph OyiniMbouna, Seong G. Kong, Senior Member, "VisualAnalysis of Eye State and Head Pose for Driver

AlertnessMonitoring",IEEE transactions on intelligent transportationsystems, VOL. 14, NO. 3 2013

[28] Rami N. Khushaba, SarathKodagoda, Sara Lal, and GaminiDissanayake,"Driver Drowsiness Classification Using FuzzyWavelet-Packet-Based Feature-Extraction Algorithm", (IEEE)Transactions vol. 58, no. 1, 2011.

[29] Raoul Lopes , D.J Sanghvi, AdityaShah,"Drowsiness Detectionbased on Eye Movement, Yawn Detection and Head Rotation", Vol.2, No.6,2012.

[30] R.C. Coetzer and G.P. Hancke, "Eye Detectionfor a Real-Time Vehicle Driver Fatigue MonitoringSystem," Proc. 2011 IEEE IntelligentVehicles Symposium, Baden-Baden, Germany,2011, pp. 66-71.