Journal of Theoretical and Applied Information Technology
31st August 2015. Vol.78. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

AN EFFICIENT DETECTION SYSTEM FOR A DROWSY DRIVER

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ABSTRACT

This paper describes an efficient detection system to monitor driver vigilance. A regular webcam is used to point directly towards the driver's face and monitors the driver's eyes in order to detect drowsiness in about real-time. Image processing technology is involved to analyze images of the driver's face taken by a regular webcam. Alertness is detected based on the degree to which the driver's eyes are open or closed. Several efficient methods are employed to achieve the efficiency. Experiments are performed to reveal the performance of the proposed method in a simulating environment with subjects of different ages, genders, and under different lighting conditions.

Keywords: *Drowsy Driver Detection, Facial Expression Detection, Eyes Detection, Facial Expression Extraction, Facial Action Unit Detection.*

1. INTRODUCTION

The annual global road crash statistics reveals that nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day [1]. The prominent cause resulting from the drivers who do not take regular breaks when driving long distances runs a high risk of becoming drowsy. In this case, they often fail to recognize early enough according to the experts. Several studies prove that around one quarter of all serious motorway accidents is attributable to sleepy drivers in need of a rest, meaning that drowsiness causes more road accidents than drink-driving. Driving a motor vehicle while being impaired by a lack of sleep is called Drowsy driving. In this work, an efficient and automatic detection system for drowsy driver is proposed. Smart phones which are the most popular devices have been considered to run the proposed system.

The proposed system uses a regular webcam that points directly towards the driver's face and monitors the driver's eyes in order to detect drowsiness. In such a case when drowsiness is detected, a warning signal is generated to alert the driver. The proposed system illustrates how to detect the eyes, and how to verify if the eyes are open or closed. The warning signal should be generated no later than one second that depends on the speed of the machine in order to achieve the robustness.

The aim of this paper is to develop an efficient drowsiness detection system. Designing a system to accurately monitor the open or closed state of the driver's eyes in about real-time will be the main focus of this work.

This paper is organized as follows. Section 2 describes the related works. Section 3 introduces the proposed system design. Section 4 illustrates the experimental results and evaluation for the proposed method. Finally, Section 5 presents our conclusions and future works.

2. RELATED WORKS

Many accidents are occurred every day because of driver drowsiness. State-of-the-art technologies in computer vision using camera are employed to tackle the problem of drive fatigue and drowsiness which is considered one of the main factors causing vehicle accidents. Surveying the literature shows that non-invasive techniques are introduced to address the problem of the drowsiness of driver.

A hybrid drowsiness monitoring system was proposed in [2]. The proposed system is composed of wireless sensors such as pulse rate sensor and

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

eye blink sensor. The first sensor was used to monitor the pulse rate, while the second was used to calculate the rate of eye blinking. Bluetooth was used to receive the sensors signal, and an alert is given to the drowsy driver.

A real time driver fatigue system based on eye gaze detection was introduced in [3]. The system was essentially based on eye gaze technique and designed to capture images for the face of the driver. Several parameters were extracted from the face such as gaze direction, blink rate, blink speed, eyelid distance, and percentage of PERCLOS. The parameters are used to estimate the driver distraction and fatigue and as a result an alarm rings for fatigue driver.

In [4] two semi-automatic methods were introduced to detect driver drowsiness, both methods were mainly based on ocular artefacts in EEG signals. Linear regression was used in the first method, and fuzzy detection for the second one. Canonical Correlation Analysis was used to extract ocular artefacts from EEG signals, while components containing eye blink are automatically detected using wavelet transform.

Another drowsiness detection system was developed in [5], the proposed system composes of four steps which are respectively: face detection, eye detection, eye state analysis and drowsy decision. The technique used for drowsiness detection can be summarized in face detection to remove background first, then brightness and roundness of the eye and iris were used to detect the eyes and determine if the eye open or close.

An automatic detection of driver drowsiness from video was proposed in[6]. Machine learning on a separate database of spontaneous expressions was used to automate the process of classifying 30 facial actions from the Facial Action Coding system. The facial actions include blinking and yawn motions in addition to other facial expressions. The proposed system take into consideration the head roll to predict the drowsiness of driver.

Another automatic vision-base drowsy driver detection system was developed in[7]. The proposed system was mainly based on tracking and detecting the eye region. An image for the face was captured, then being sent to eye detection system where the Kalman filter was employed to track the eye region, this was followed by applying a modified existing system for drowsiness detection which was designed to detect the upper and lower eye lid to measure the eye blink and finally a decision was made of the driver drowsiness. As in the previous system this one was taking into account the head position where the head was completely dropped down, an alarm was given to the driver.

CarSafe application for alerting drowsy and distracted drivers using dual cameras on Android phones was introduced in [8]. Computer vision and machine learning algorithms were employed to alert the distracted or drowsy driver monitored by front camera at the same time rear camera was used to monitor the road conditions. Since the smart phones don't have the ability to process video streams generated from the front and rear camera at the same time, a context-aware algorithm was used to tackle this problem by switching between the two cameras while processing the data in real time. However switching between two cameras generates blind spots in the first or second camera, embedded sensors on the phone were used to solve the problem by producing soft hints to alert the driver of dangerous blind spot.

Another android application for fast driver's fatigue estimation and drowsiness detection was introduced in [9]. The work of the system can be described in the following steps: in the first step images for the driver face were captured by the system, and then the captured images were converted from coloured to gray scale images. In the second step the eye region was detected using Viola-Jones methods existed in OpenCV library. The final step included determining the eye status whether it is open or closed, this was achieved by counting the ratio of black pixels with white ones, if the ratio is less than 20% then the eye is closed and the system gives alarm to the driver.

Detecting driver drowsiness using feature-level fusion and user-specific classification was developed in [10]. The proposed method addressed the limitations of previous methods based on features extracted from a single eye which yields from visual obstacles and eye localization errors. The main steps of the proposed method were described as follows: first adaptive boosting (AdaBoost) method was employed to track and detect the face, then AdaBoost and blob detection were applied to detect eyes region. In second step four existed methods such as PCA, LDA, sparseness, and kurtosis were employed to extract features from eyes, this was followed by fusing features from both eyes. The third step included classifying the eye state using support vector machine to determine whether the eye is open or closed using fused features. The fourth step was

Journal of Theoretical and Applied Information Technology
31st August 2015. Vol.78. No.3

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

designed to verify previous step result by applying score level fusion which was achieved by sending the features extracted from each eyes to SVM which produces two decisions where seven fusion methods were used for comparison. A classification method was used to find a user-specific threshold for each driver by taking into account variation of shape and texture of eyes for each driver, decisions resulting from the third and fourth step was used to give the final decision of the eye state.

A component based face detection approach using colour features was introduced in [11]. The proposed system aimed to address the problem of the effective global facial appearance change using the component based method. The algorithm was designed as follows: first eyes were segmented into the right and left eye by applying the threshold based segmentation algorithm on eye database system, this was followed by separating the eyes. The second step included identifying the status of eye to find whether the eye is open or closed which was achieved using edge detection algorithm.

An approach for detection of drowsy driver through eye state analysis was proposed in [12]. The face of the driver was detected using colour space and then the face region was cropped from the background image. The next process was designed to estimate and crop the eyes region from the face region. In the next step, retrenching the face pixels from the eye region and canny operator for edge detection were used to identify the top and bottom coordinates of the eyes. In the last step the drowsiness of driver was determined by counting the number of white and black pixels and comparing the distance between these coordinates.

A system for detecting of eye blinking and yawning for monitoring driver's drowsiness in real time was proposed in [13]. In the system, the Haarcascade library available in OpenCV was used for the detection of facial features and mouth detection, the contour of lips was identified using the Contour Activation Algorithm.

3. THE PROPOSED WORK

The flow chart of the proposed system is shown in Figure 1. The efficient methods for face and eyes detection that available in the library of OpenCV are used to detect the eyes [14] as shown in Figure 2. The system initially needs to capture a sample image for the driver's eyes in order to be used later to apply the matching process. The efficiency is achieved by saving the prominent features of SURF (Speeded Up Robust Feature) taken from the sample image. SURF outperforms the related proposed schemas in terms of distinctiveness, robustness, and speed of detecting and matching features as presented in [15] The images need to be converted into a gray scale because SURF detector and descriptor do not use colour.

The proposed system can be divided into three steps. Firstly, points of interest are selected at distinctive locations in the image using a Fast Hessian detector [5]. Integral images for image convolutions are used to minimise the computational time. Secondly, the feature vector is generated by building a square region centred on the point of interest and then the direction of the Haar wavelet response within the square neighbourhood is used to create the feature vector (the longest vector is the dominant orientation). Finally, a matching pair is being detected, if the Euclidean distance between the features vectors is less than 0.7 times (best threshold value that was found based on the tested images) the distance of the second nearest neighbour.

A sample test to show the performance of SURF method is shown in Figure 3. The speed of matching is increased by only comparing features having the same type of contrast (sign of the Laplacian). Hence, if the matched is achieved and the number of matched points is greater than 3 then the system considers the eyes are open otherwise they are closed. Consequently, if the eyes are found closed for 3 consecutive frames; the system draws the conclusion that the driver is falling asleep and issues a warning signal. Figure 4 shows the performance of the proposed method on faces with and without glasses.

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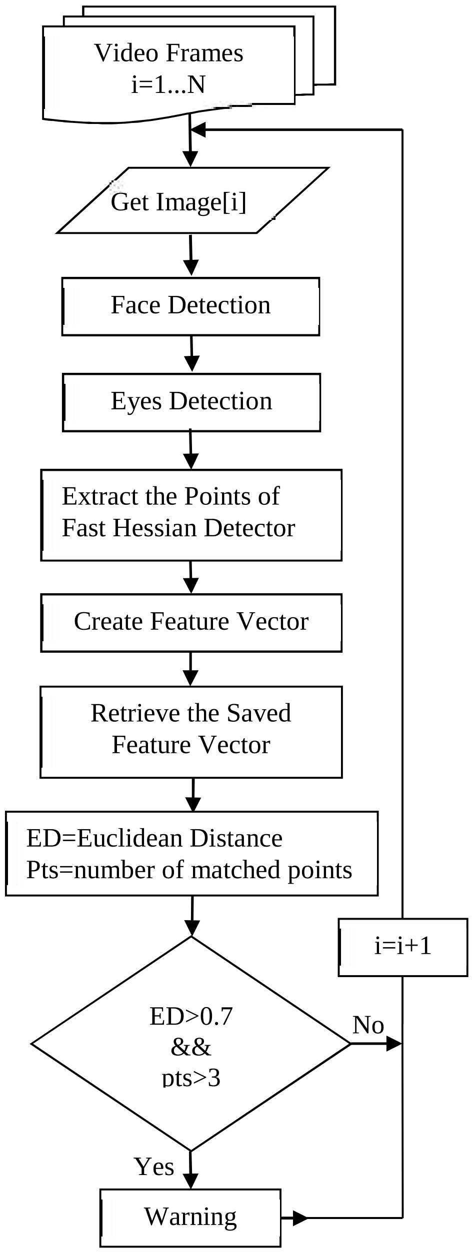

Figure 1: Flow Chart Of The Proposed Drowsy Driver Detection System.

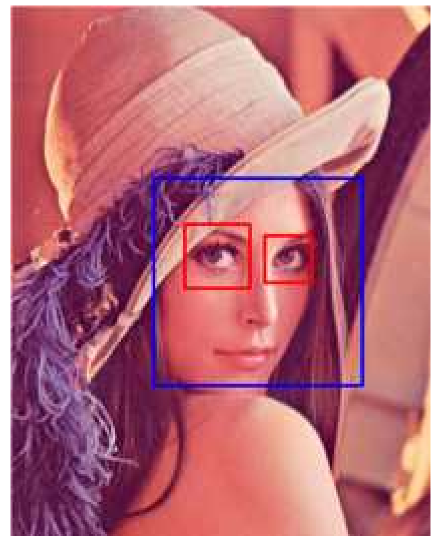

Figure 2: Face And Eyes Detection Using OPENCV Library.

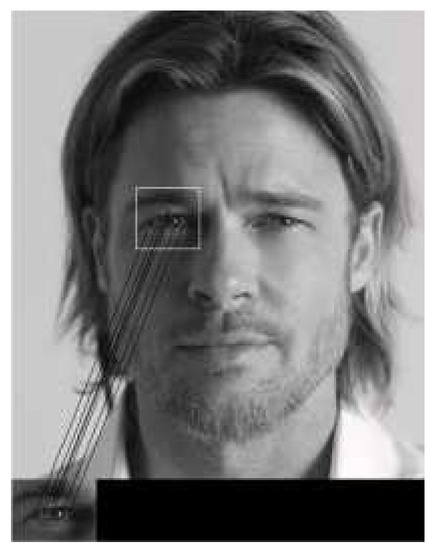

Figure 3: SURF Performance For Matching Regions Of Interest.

Figure 4: The Performance Of The Proposed Method On Faces With And Without Eyeglasses.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

4. EXPERIMENTAL RESULTS

A regular VGA HP webcam with 1.7 MP resolution was used to conduct the experiments. The webcam was placed in front of the driver, approximately 40 cm away from the face. The camera should be positioned such that the driver's face takes up the majority of the image. The resolution of taken images was in 480x640 pixels. For conditions at night time or when the ambient light is poor, a light source must be present to compensate. The system was tested on 10 persons, and about 200 frames were taken from the webcam under enough source of light. A recognition rate of 91% was achieved in average consuming time about 0.71 second per image. The limitation of this work could be by any reflective objects behind the driver that may cause a fail to detect the face. The more consistent the background is, the more robust the system becomes.

5. CONCLUSION AND FUTURE WORK

This paper illustrates the localization of driver's eyes that involves looking at the entire webcam. The position of the eyes is determined by a highly investigated efficient image processing algorithms. Once the position of the eyes is located, the system is designed to determine whether the eyes are open or closed by using SURF method, and then being able to detect drowsiness. High recognition was achieved on the tested images under enough source of light. The proposed system has a problem when the person is wearing eyeglasses with low transparency. Localizing the eyes is not the problem, but it comes when determining whether the eyes are open or closed. In the future work, thermal cameras can be used to overcome the problem of poor light source.

REFRENCES:

[1] Non-profit, non-governmental organization, "The Association for Safe International Road Travel (ASIRT)", http://asirt.org/, last accessed May, 2015.

[2] Veena.S.L, R.Subhashini. "Driver Alertness Based on Eye Blinking and Bio-signals", *International Journal of Advanced Research*, 2014, Volume 2, Issue 3, 666-670.

[3] Thummar S., Kalariya V., "A Real Time Driver Fatigue System Based On Eye Gaze Detection". *International Journal of Engineering Research and General Science*, Volume 3, Issue 1, January-February, 2015 ISSN 2091-2730.

[4] Goovaerts, G., Denissen, A., Milosevic, M., van Boxtel, G., & Van Huffel, S. (2014, March). "Advanced EEG processing for the detection of drowsiness in drivers". *In Proc. of the International Conference on bio-inspired systems and signal processing*, 2014, Angers, France (pp. 205-212).

[5] Seifoory, H., Taherkhani, D., Arzhang, B., Eftekhari, Z., & Memari, H. "An Accurate Morphological Drowsy Detection", 2011.

[6] Vural, E., Çetin, M., Erçil, A., Littlewort, G., Bartlett, M., & Movellan, J., "Automated drowsiness detection for improved driving safety", 2008.

[7] Phooi, K., Jen, W., Minn, L. "Automatic Vision-Based Drowsy Driver Detection System", 2003.

[8] You, C. W., Lane, N. D., Chen, F., Wang, R., Chen, Z., Bao, T. J., & Campbell, A. T., "Carsafe app: Alerting drowsy and distracted drivers using dual cameras on smart phones". *In Proceeding of the 11th annual international conference on Mobile systems, applications, and services*, June 2013, (pp. 13-26). ACM.

[9] Budiharto.W, Putra.W, Putra.Y ." Design and Analysis of Fast Driver's Fatigue Estimation and Drowsiness Detection System using Android", *Journal of software*, VOL. 8, NO. 12, (2013, December).

[10] Jaeik Jo. a, Sung Joo Lee. a, Kang Ryoung Park. b., "Detecting driver drowsiness using feature-level fusion and user-specific classification". *Expert Systems with Applications*, 2014, 4(1), PP. 1139–1152,

[11] Jaya Bharathi, C. "Detection of Drowsiness in Human Eye using SVM", *International Journal of Innovative Research in Computer and Communication Engineering*, (February, 2014), Vol. 2, Issue 2.

[12] Kusuma Kumari B.M., "Detection of Drowsy Driver's through Eye State analysis", *International Journal of Science and Research (IJSR), ISSN (Online)*: 2319-7064, Impact Factor 3.358, (2012).

[13] Kumar.N, Barwar. N."Detection of Eye Blinking and Yawning for Monitoring Driver's Drowsiness in Real Time". *International Journal of Application or Innovation in Engineering & Management (IJAIEM).* (2014, November), Volume 3, Issue 11, ISSN 2319 – 4847.

[14] Open Source Computer Vision Library (Open CV), http://opencv.org, Last accessed (May, 2015).

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

[15] Bay, Herbert, Tinne Tuytelaars, and Luc Van Gool. "Surf: Speeded up robust features", *Computer vision–ECCV 2006. Springer Berlin Heidelberg*, 2006, Pages 404-417.

[16] C. Rieth, "SURF-ing a Model of Spatiotemporal Saliency," *A report submitted by department of psychology*, University of California, San Diego, (2006).