



## **Improved Driver Drowsiness Monitoring System using Real-time Eye Blinking Method**

**Aree A. Mohammed<sup>1</sup>, Mohammed Q. Kheder<sup>1</sup> and Azhee W. Muhammed<sup>3</sup>**

<sup>1</sup>*Faculty of Science and Science Educations, Computer Department, University of Sulaimani, Kurdistan Region, Iraq.*

*e-mail: aree.ali@univsul.edu.iq*

*e-mail: mohammed.kheder@univsul.edu.iq*

<sup>3</sup>*School of Basic Education, Computer Department, University of Sulaimani, Kurdistan Region, Iraq.*

*e-mail: azhee.muhamed@univsul.edu.iq*

---

### **Article info**

Original: 19 Mar 2015

Revised: 18 May 2015

Accepted: 31 May 2015

Published online:

20 Dec. 2015

#### **Key Words:**

*drowsiness detection*

*eye blinking*

*eye tracking*

*detection accuracy*

### **Abstract**

Drivers with a diminished vigilance level suffer from a marked decline in their perception; recognition and vehicle control abilities and therefore pose a serious danger to their own lives and the lives of the other people. According to the National Highway Traffic Safety Administration (NHTSA), about 100,000 crashes are the direct result of driver drowsiness each year. This is the reason why more and more researches are made to build automatic detectors of this dangerous state. In this paper, an efficient drowsiness detection system based on eye state (close and open) is developed. The camera should be fixed in front of the drivers to capture real time frames. After that, the results from the camera (new frames) are subject to the some vision-based algorithm to detect the eyes. Finally, the eye blink detection is applied to determine the state of eyes. There are two states: open state and close state. Based on eye state the warning alarm or telephone calling should be done to the drivers for preventing undesired accident. The proposed system will be tested with different light conditions, namely, day and night vision to show the performance in term of efficiency and accuracy. The results explain that the proposed system which is based on Android platform has a high accuracy rate (%97.2) for drowsiness detection especially during the night vision.

### **Introduction**

Drivers fatigue is a significant factor in a large number of vehicle accidents. A technology that is used to prevent or detect drowsiness has been applied to the wheel is a major challenge in the field of accident avoidance systems. Due to the hazard that drowsiness presents on the road, methods should be expanded for counteracting its affects [1]. Svensson states that drowsiness could be detected both in brain and eye activities. Brain activity refers to the ability to process the information, but eye activity refers to the perception ability [2]. This study focuses on the visual signs of drowsiness, such as blinks. According to [3], an eye electrical muscles activity based on Electrooculogram (EOG) measurement has used to estimate drowsiness. Moreover, an efficient eye blinks detection method for disabling person based on Android Mobile Phone is developed and applied in a real time application with very high detection rate [4].

Abhi and et al, describe a real time online prototype driver-fatigue monitor. This approach uses remotely located charge-coupled device cameras equipped with active infrared illuminators to obtain video images of the driver. Under different illumination conditions it was found that the system is reasonably robust, reliable and accurate in fatigue characterization [5].

A nonintrusive prototype computer vision system for real-time monitoring of a driver's vigilance is developed. In the initial, the necessary hardware and imaging algorithms are developed simultaneously extract multiple visual cues which typically characterize a person's level of fatigue. After that, a probabilistic framework is built to model fatigue [6]. According to Mandeep and Gagandeep [7], an automatic drowsy driver monitoring and accident prevention system that is based on monitoring the changes in the eye blinks duration. Experimental results in the eye-blink database showed that the proposed system detects eye blinks with 99.4% accuracy with a 1% false positive rate.

Chuang-Wen and et al, discuss that a new driver safety application for Android Phones which detect and alert drivers to dangerous driving conditions and behavior [8]. It uses computer vision and machine learning algorithms on the phone to detect and monitor whether the driver is tired or distracted using the front-facing camera, whereas at the same time tracking road conditions using the rear-facing camera. The results from the CarSafe deployment are promising. CarSafe is able to infer a common set of dangerous driving behaviors and road conditions with an overall precision and recall of 83% and 75%, respectively.

To detect and track the eyes from the camera, different methods in different conditions are used based on computer vision algorithms like (Image Binarization, Histogram Equalization and Median Filtering) [9]. For a night vision application, Hrishikesh et al, argued that the algorithms which have been used to detect drowsiness. The decision whether the driver is dozing or not is taken depending on whether the eyes are open for a specific number of frames. If the eyes are found to be closed for a certain number of consecutive frames then the driver is alerted or called with an alarm [10].

The rest of the paper is organized as follow. In section II, the proposed drowsiness methods are presented. Section III studies the test results of a real time application for two scenarios: day and night vision. Conclusions and future remarks are described in section IV.

## **Proposed Drowsiness System**

Improved eye blinking method for real time drowsiness detection is implemented through developing different steps as indicated in Fig. 1.

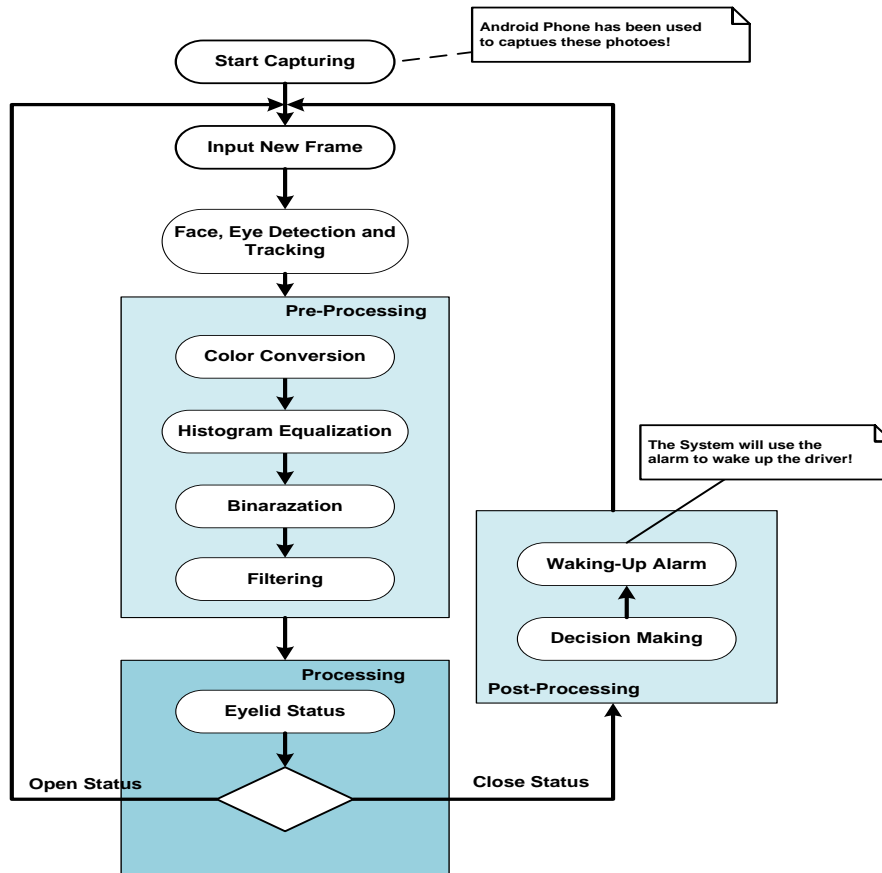


Fig.1: Block diagram of drowsiness system. → completely changed

#### A. Real Time Face and Eye Detection

The first step is to capture frames from a fixed Android mobile phone located in front of the driver from a given distance. Then, they processed under an algorithm of color conversion which converts frame's color form RGB to Gray model. This step is because of the intensity channel is more sensitive to the human vision system than colors.

The Haar classifier is used for face detection. Haar classifier rapidly detects any object, based on detected feature not pixels, like facial feature [11]. As the result, the face is detected and marked with color rectangle and will be used later to approximate an axis of the eyes for eye detection step. For eye detection, another classifier which is based on AdaBoost algorithm is applied to detect both right and left eyes. Fig. 2 shows an example of real time eye detection.

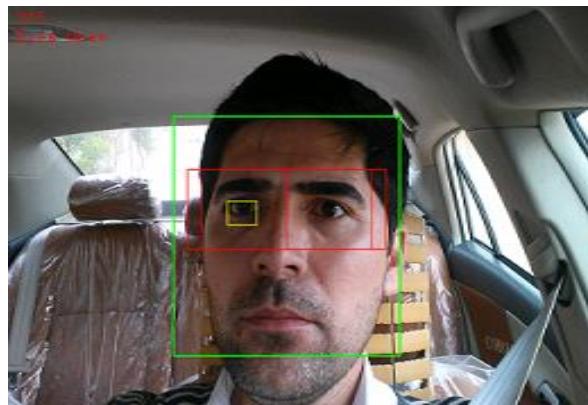


Fig.2: Real time capture image

*B. Eye Tracking Method*

The eye tracking by moving the corneal-reflection and pupil-center features. By identifying the center of the pupil and the location of the corneal reflection, the vector between them is measured. This can make the face and the eye's pupil moved together in the same direction synchronously and with the same direction.

*C. Eye Blink Detection Algorithm*

The identification of blinking and the duration are built exclusively in light of perception of the relationship scores created by the tracking at the previous step utilizing the online format of the user's eye. As the eye closes when it is blinking, its similarity to the open eye template decreases.

Likewise, it regains its similarity to the template as the blink ends and the user's eye becomes fully open again. This decrease and increase in similarity corresponds directly to the correlation scores returned by the template matching procedure. This score is useful in deriving a threshold to be used for classifying the user's eyes as being open or closed at each frame. Fig. 3 depicts the eye blink states (close or open). The threshold technique is used to binarize eye image for two different intensities as follows:

$$dst(x, y) = \begin{cases} 0 & \text{if } src(x, y) > T \\ src(x, y) & \text{otherwise} \end{cases} \dots\dots\dots(1)$$

Where  $dst(x, y)$  represents the binary image according to the threshold value T.

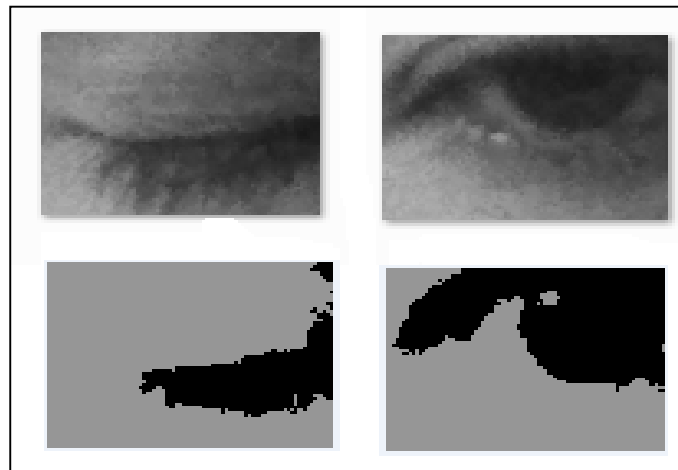


Fig.3: Eye blink states (close and open)

*D. Detection Rate Accuracy*

In almost all eye detection techniques, two parameters could affect the accuracy of detection rate which are (light and distance from the user). In our system, the distance between a driver and a camera can be adjusted after some trial and error test. However the light condition is dramatically affecting the detection rate for both day and night drivers. The following equation has been used to determine the accuracy of detection.

$$\frac{TP}{TP + FN} * 100\% \dots\dots\dots(2)$$

Where TP is the number of frames that are correctly detected eye blinks (true positive); FN is the number of frames that show eye blinks but the program is not detected (false negative);

*E. System Flow Chart*

Fig. 4 shows the flowchart of the proposed eye blink detection for both day and night drivers.

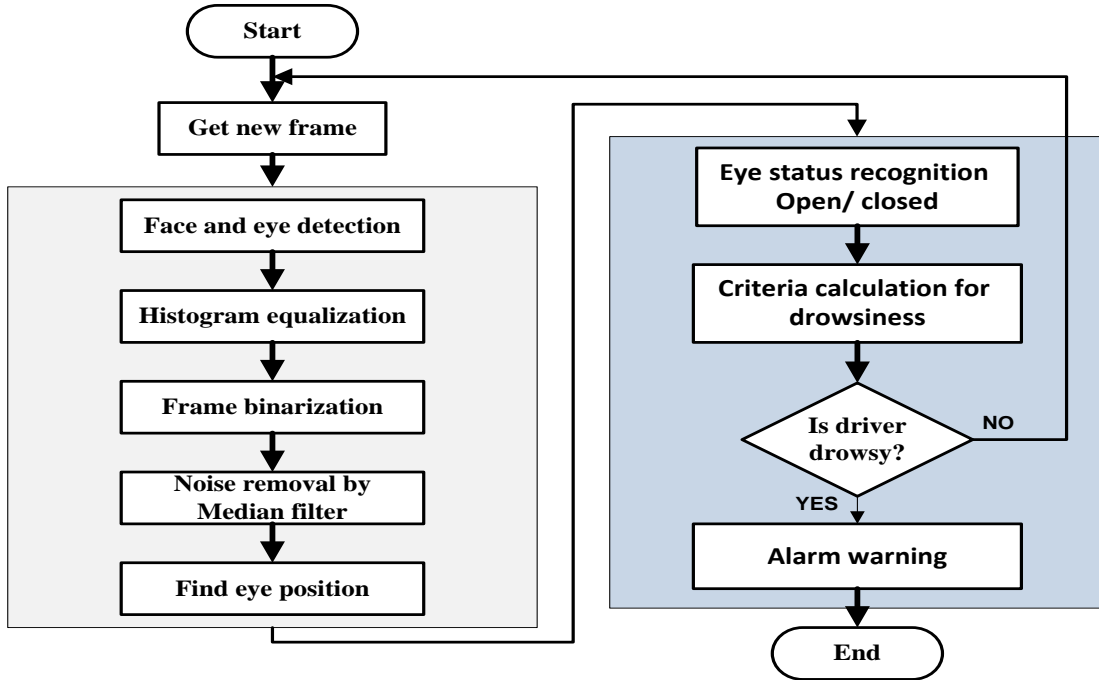


Fig.4 Drowsiness system flowchart

**Test Results Scenarios**

The proposed real time drowsiness application is mainly tested for driven in both day and night time. Normally all eye blink detection is affected by two parameters (distance and light condition). In this work, the distance between the driver and the mobile phone screen is taken as a fixed value with 30 cm because of non-availability of place. For other distance below and above the fixed value, the performance of the system is decreased in term of accuracy detection.

*A. Day Test Scenario*

Normal light condition is used for testing the application during driven in the daytime. 1000 frames are taken to determine the accuracy detection through calculating the true positive eyes which represent the detected eyes as a close state and false negative eyes as non-detected eyes.

Table I shows the result of accuracy detection when the histogram equalization and the median filtering are not applied.

Table I: Accuracy detection versus number of frames.  
(without histogram equalization and filtering)

No. of frames	TP	FN	Accuracy%
100	23	16	58.9
200	112	27	80.5
300	171	32	84.2
400	234	42	84.7
500	254	51	83.2
600	257	66	79.5
700	375	85	81.5
800	370	122	75.2
900	374	129	74.9
1000	383	198	65.9

Table II shows the result of accuracy detection when the histogram equalization is not applied while the median filter is applied. Results show that the detection accuracy is improved especially for the number of frames (300 - 600).

Table II: Accuracy detection versus number of frames.  
(without equalization and with filtering)

No. of frames	TP	FN	Accuracy %
100	54	9	85.7
200	66	9	88
300	172	10	94.5
400	232	11	95.4
500	306	12	96.2
600	300	15	95.2
700	439	17	96.2
800	353	30	92.1
900	423	37	91.9
1000	616	59	91.2

Table III presents the result of accuracy detection when the histogram equalization is applied while the median filter is not applied. Results show that the detection accuracy is dramatically decreased. This fact proves that the histogram equalization algorithm does not affect the performance of the system application.

Table.III: Accuracy detection versus number of frames.  
(with equalization and without filtering)

No. of frames	TP	FN	Accuracy %
100	35	14	71.4
200	92	18	83.4
300	85	26	76.5
400	196	35	84.8
500	291	45	86.6
600	273	62	81.5
700	438	66	86.9
800	358	89	80.1
900	445	102	81.3
1000	358	131	73.2

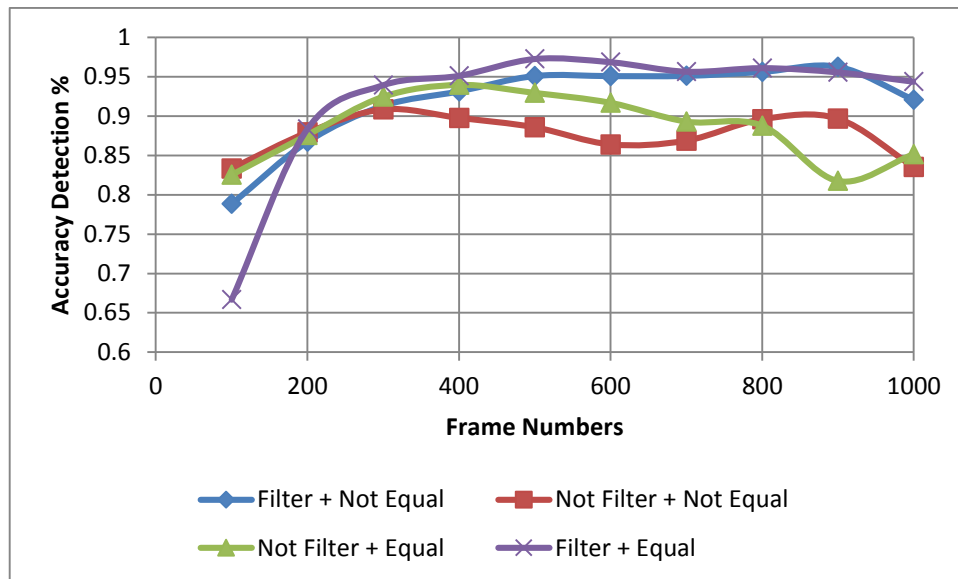
Finally, Table IV presents the result of accuracy detection when the histogram equalization and the median filter are both applied. Results show that the detection accuracy is high when both equalization and median filter are applied.

Table.IV: Accuracy detection versus number of frames.  
(with equalization and filtering)

No. of frames	TP	FN	Accuracy %
100	41	10	80.3
200	120	10	92.3
300	209	10	95.4
400	267	11	96.1
500	282	12	95.9
600	252	17	93.6
700	470	19	96.1
800	406	28	93.5
900	452	32	93.3
1000	484	46	91.3

### B. Night Test Scenario

The same tests are conducted during the night for monitoring the drowsiness of the driver. An artificial light source is simulated through a small lamp hanging beside the mobile phone. Fig. 5 shows the accuracy detection versus number of frames for different cases as mentioned in the above tables.



**Fig.5 Accuracy detection test for driven in night time**

Experimental results show that in the night test, the accuracy of drowsiness detection is attained to the maximum value (97.2 %) when both histogram equalization and median filter are applied.

## Conclusion

The monitoring of the driver drowsiness is becoming a very important topic in the field of computer vision to avoid the traffic accidents. In this work, an improved drowsiness detection system is developed based on android mobile phones. The application is first tested in a day time for different cases. Detection rate for 1000 frames is determined. Then, another test is conducted during the night to show the performance of the proposed system application in term of accuracy detection.

Test results show that an improvement of accuracy is achieved during the night test when some image processing algorithms are applied. When the number of frames is 500, the detection accuracy is 97.2%. Other eye blink detection algorithms can be used for improving both (accuracy and efficiency) of the detection rate.

## References

- [1] Srijayathi K., and Vedachary M., "Implementation of the Driver Drowsiness Detection System", IJSETR. 2(9), pp. 1751-1754, (2013).
- [2] Dr. Suryaprasad J, Sandesh D, Saraswathi V, Swathi D, Manjunath S, "Real Time Drosy Driver Detection using HaarCascade Samples", Computer Science and IT Proceeding Conference, Vol. 13, pp. 45-54, (2013).
- [3] Caffier P., Erdmann U., and Ullsperger P., "Experimental evaluation of eyeblink parameters as a drowsiness measure", European Journal of Applied Physiology, 89, pp. 319–325, (2003).
- [4] Aree A., Shereen A., "Efficient Eye Blink Detection Method for Disabled-Helping Domain", IJACSA, 5(5), pp. 202-206, (2014).
- [5] Abhi R., Seema V., and Chenta B., "Accident Prevention Using Eye Blinking and Head Movement", IJCA, 1(4), pp. 18-22, (2012).
- [6] Qiang J., Zhiwei Z., and Peilin L., "Real-Time Nonintrusive Monitoring and Prediction of Driver Fatigue", IEEE Transaction on Vehicular Technology, 53(4), pp. 1052-1068, (2004).

- [7] Mandeep S., Gagandeep K., "Drowsy Detection On Eye Blink Duration Using Algorithm", IJETAE, 2(4), pp. 363-365, (2012).
- [8] Chuang-Wen Y., et al, "CarSafe App: Alerting Drowsy and Distracted Drivers using Dual Cameras on Smartphones", MobiSys. ACM Conference, pp. 461-462, (2013).
- [9] Robert L., "OpenCV 2 Computer Vision Application Programming Cookbook", Packt Publisher, ISBN 978-1-849513-24-1, UK, (2011).
- [10] Hrishikesh B., "Drowsy Detection and Alarming System", Proceedings of the World Congress on Engineering and Computer Science, USA, pp. 267-270, (2007).
- [11] Loris N., et al, "Effective and precise face detection based on color and depth data", Journal of Applied Computing and Informatics, December 9-14, Vol. 10, Issues 1-2, pp. 1-13, (2014).

\

