3rd International Conference on Automation, Control, Engineering and Computer Science (ACECS'16)
Proceedings of Engineering & Technology (PET)
pp. 779-783

Monitoring of Driver's Drowsiness based on Eyes State Analysis

Soumaya Hichri,[1] Houda Nakkach,[1] Faouzi Benzarti,[1] and Hamid Amiri[1]
[1]LR-11-ES17 Signal, Images et Technologies de l'Information (LR-SITI-ENIT)
Université de Tunis El Manar, Ecole Nationale d'Ingénieur de Tunis
1002, Tunis Le Belvédère, Tunisie
Soumaya.hichri73@gmail.com
h_nakkach@yahoo.fr
benzartif@yahoo.fr
hamid.amiri@enit.rnu.tn

***Abstract*— In this paper, we presents a non-intrusive method based on eyes state analysis in real time. Our proposed algorithm captures continuously the image of the driver by low cost camera fixed on dashboard. In the first step, The Viola-Jones algorithm is used for the detection of face region of the first frame. Then for tracking images, we used CamShift method. Subsequently, we focus our interest on the presence/absence detection of iris by using the Circular Hough Transform (CHT). Some experimental results are promising and show the performance of our method.**

***Keywords*— CamShift; CHT; Computer Vision; Driver Fatigue; Eye Tracking; Face and Iris Localization; Feature Extraction**

I. Introduction

The traffic accidents has become a serious problem for society. In the last decade, this problem know a significant increase due essentially to a diminished driver's vigilance level. The statistics show that 20% of accidents in road caused by the diminished vigilance level of drivers [1]. The driver behaviour monitoring became seriously required to solve this problem with applying a system of alerting driver.

Driver's drowsiness generally identified by vehicles responses, sensing physiological characteristics, or monitoring driver's behavior. The best accurate detection techniques based on driver's physiological parameters like brain waves, heart rate, pulse rate and respiration. However, these techniques are intrusive as electrode attachment to the driver' body is required, this usually causing annoyance and impractical [2]. Hence, this paper focus on non-intrusive methods of drowsiness detection based on measuring driver's state.

Automatic driver state detection carried out from the facial features like eyes, head, mouth and face.

The eye state gives more accuracy to verify the level of drowsiness characterized by short period, which the driver closes the eyes and sleep [3]. Many works uses the Percent of Eyelid Closure (PERCLOS) as an indicator of drowsiness [1]. Others researchers uses the presence of the iris to determine if the driver awake [4].

This paper is organized as flows: in Section II, the proposed method is presented. Section III, the experimental results showed. Finally, in section IV presents the conclusion and future studies.

II. The Proposed Method

Fig. 1 shows the steps of our proposal approach for Driver's Drowsiness Detection.

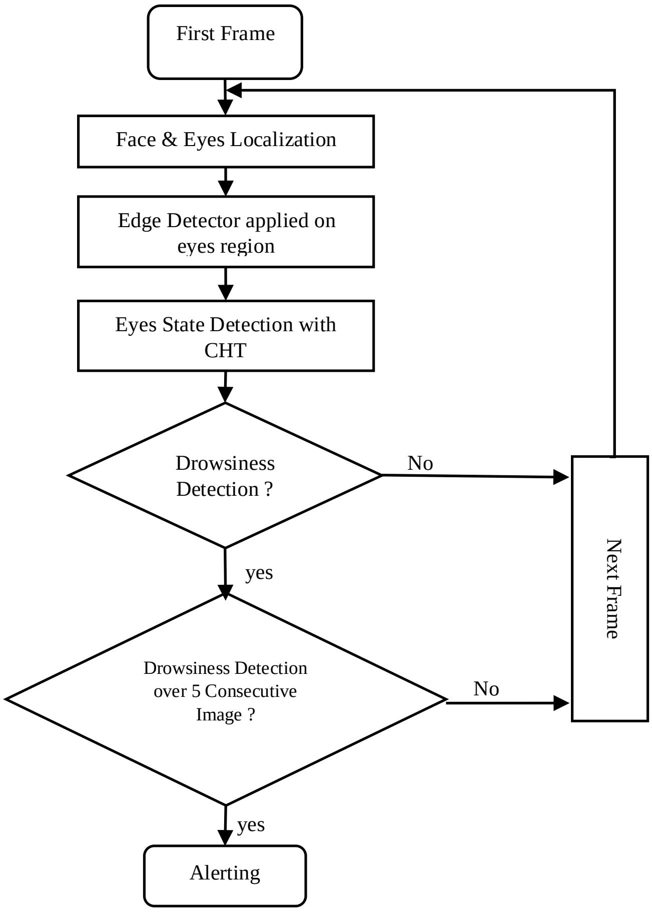


Fig. 1 The flow chart of the proposed Driver drowsiness Detection System

ISSN: 2356-5608

A. Face detection & eye location:

Face detection from the first captured image is a necessary step for further processing. Generally, before driving the vehicle, the driver supposed in frontal position of the camera, in this case we have used the existing method of Viola and jones for solving detection task [5]. The basic idea of the algorithm proposed by Viola and jones using a sub-window that can rescaled to scan image to filter face and reject background based on a set of values of Haar-Like features. The procedure of face detection shown in Fig.2.

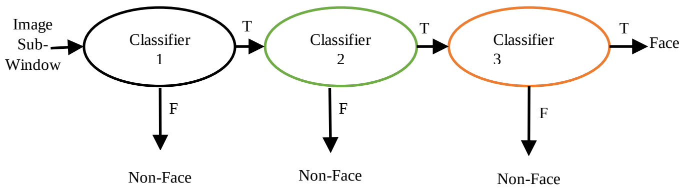


Fig. 2 Procedure of Face Detection

After face detection, the eyes region are located using geometric properties to reduce the search area. Assumed that position of eyes located on the block of the upper three fifths of driver face region [6] as shown in Fig.3.

Fig. 3 Eyes Region detection

B. Face Tracking with CamShift algorithm:

This algorithm provides the ability to track the face based on skin color, uses one-dimensional histogram as a captured object model. The histogram shows that the hue (H) chain in the HSV color space. The search of the object carried by finding the maximum probability distribution obtained from a procedure called back projection histogram. To reduce the amount of calculation, color probability distribution not scanned over the entire image. Instead, it is limited to calculate the distribution in a small image area surrounding the current search window as shown in Fig.4. We recall the CamShift algorithm steps below:

1) Define the calculation area of the probability distribution equal to the entire frame.

2) Select the original location of the two-dimensional search window Mean Shift

3) Calculate the color probability distribution in 2D region centred on the location of the search window in a slightly larger area than the size of the Mean Shift window.

4) Conduct research on the probability of maximum density using Mean Shift convergence setting to set the number of iterations. Store the zero moment (area or height) and middle.

5) In the next video frame, place the fixed central position in search window in step (4) and set the window size in accordance to the last minute. Go to step (3).

Fig.4 Face Region with CamShift

C. Circular Hough Transform CHT

The Hough Transform described as a transformation of a point in Cartesian space to the parameter space defined according to the shape of the object of interest. In the case of circular forms, the circle equation presented in (1) considered for the transformation:

$$r^2 = (x - a)^2 + (y - b)^2 \tag{1}$$

Where r represents the radius, a and b refer respectively to the abscissa and the ordinate of the circle center. As it can be seen the circle got three parameters, r, a and b. Where a and b are the center of the circle in the x and y direction respectively and where r is the radius. The parametric representation of the circle is

$$\begin{aligned} x &= a + r\cos(\theta) \\ y &= b + r\sin(\theta) \end{aligned} \tag{2}$$

The locus of (a, b) points in the parameter space fall on a circle of radius r centered at (x, y). The true center point be common to all parameter circles, and funded with a Hough accumulation array. The process of finding circles in an image consists of using a modified Hough Transform called Circular Hough Transform: The first step is to find all edges in the image by any edge detection technique. At each edge point, we draw a circle having center in this point with the desired radius. This circle drawn in the parameter space, such that our x-axis is a value and the y-axis is b value while the z-axis is the radii. To simplify the circle parametric representation, the radius fixed. At the coordinates that belong to the perimeter of the drawn circle, we increment the value in our accumulator matrix, which essentially has the same size as the parameter space. In this way, we sweep over every edge point in the input image drawing circles with the desired radii and incrementing the values in our accumulator.

When every edge point and every desired radius is used, the accumulator will contain numbers corresponding to the number of circles passing through the individual coordinates. Thus, the highest numbers correspond to the center of the circles in the image. Fig. 5 illustrates the CHT from the Cartesian space to the parameter space.

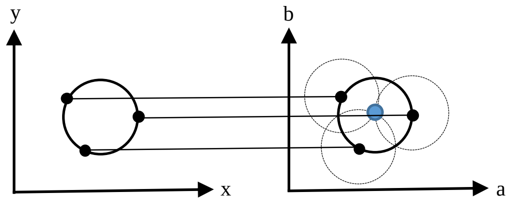


Fig. 5 Each point in geometric space (left) generates a circle in parameter space (right). The circles in parameter space intersect at the (a, b) that is the center in geometric space.

D. Driver's Drowsiness Analysis:

After converting the eye region into gray scale image, we use an enhanced canny edge detector with regularised parameters and morphologic operators, in Fig.6. Before applying the CHT to check presence/absence of the iris, we used the technique of horizontal projection. The horizontal projection used to locate the eyes for more precision and to avoid detecting false detection.

The method of CHT, as defined in Section III-C, extracts the circles if founded from edge images. When an iris identified from frontal and profile faces prove eyes opened as shown in Fig.7.

The drowsiness detection represents the decisional step of our method, once the tracking of the driver's face achieved and the eye region successfully identified, we continuously monitoring the eyes state of the driver during driving. The time of the driver's eyes are closed is an important indicator which is directly linked to the safety of the occupants of vehicles. The counter of the number of frames where eyes closed are incremented. When a counter of number frames exceeded threshold (Eye Closure), the system immediately generate an alarm to awake the drowsy driver before making a danger

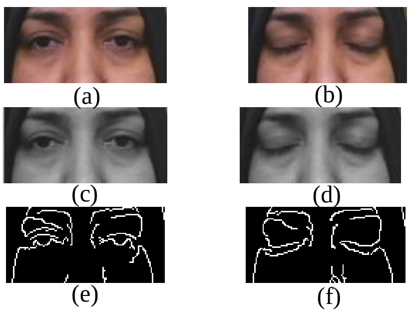


Fig.6 Eyes Edge Detection,(a) original opened eyes ,(b) original closed eyes, (c) grayscale of opened eyes, (d) grayscale of closed eyes, (e) edge of opened eyes, (f) edge of closed eyes

Fig.7 Iris detection in different profile face

III. EXPERIMENTAL RESULTS

In this section, we presents the experimental results. The proposed driver's drowsiness detection system used a Dell PC with one camera to capture driver's images. We tested the system under the environment of core i7 with 2 GB RAM. The format of input video is 352x288 true colour. The system less than 30 milliseconds for initial face location and eye detection. Once the eye region identified, face tracking could achieve more than 30 frames per second. We mentioned that in our method, the driver considered drowsy when his/her closes eyes over five consecutive frames.

To evaluate our method performance we uses statistical measures TP, FP, TN, FN, Total number of samples (T), correct classification rate (CCR) is computed in equation (1) and kappa *K* nonrandom agreement degree.

$$CCR = \frac{(TN+TP)}{T} \tag{1}$$

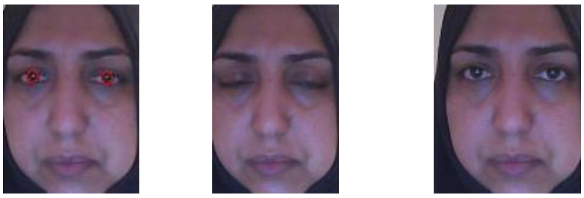
In Table1, show the interpretation between k and the observations of the same categorical variable. Where:
True positive (TP): opened eye and the method detected open.
False negative (FN): opened eye but the method detected close.
False positive (FP): closed eye but the method detected open.
True negative (TN): closed eye and the method detected close.

Fig.8 and fig.9 shows examples of iris detection of TP, FP, TN and FN for test sequences in different lighting. From these results, we can see that our proposed system provides good and real-time estimation of the driver's drowsiness detection.

According to Table 2, the *CCR* (resp. *K*) is 0.99 (resp. 0.98) in the ambient daylight and is 0.88 (resp. *0.68*) under lights at night. We notice that during the lighting at night, the statistics deteriorated compared with the results obtained under ambient daylight.

TABLE I
KAPPA STATISTIC INTERPRETATION

Kappa statistic	Interpretation
k > 0.81	Almost perfect agreement
0.61<k<0.80	Strong agreement
0.21<k<0.60	Moderate agreement
0 <k<0.20	Poor agreement
k<0	Disagreement



TP FP FN

Fig.8 Results of night lighting

TP TP FP FN

Fig.9 Results of day lighting

TABLE II
STATISTICAL MEASURES OF DRIVER'S DROWSINESS DETECTION

Video Sequence	**TP**	**TN**	**FP**	**FN**	**T**	**CCR**	**Kappa**
1(night lighting)	75	13	12	0	100	0.88	0.68
2(day lighting)	70	29	1	0	100	0.99	0.98

IV. CONCLUSION

This paper presented a real-time driver drowsiness detection system for driving safety based on eye state. Our method uses three steps: the detection of the first face of driver by using Viola and Jones method where demonstrated a robustness to find frontal face, eye region localization using geometric properties of face. The second, using CamShift algorithm to track face in real time where showing the ability to good tracking in different profile of face. The latest, presence/absence of iris verified to identify drowsy/awake driver where applying CHT on our detector of edge to find iris. Our method provides a robustness in detection of driver's drowsiness with 95% accuracy rate. For further work, we focus on gaze tracking, yawning and head orientation.

REFERENCES

[1] *L. Bergasa, J. Nuevo, M. Sotelo, and M. Vazquez, "Real-time system for monitoring driver vigilance," IEEE Transactions on Intelligent Transportation Systems, vol. 7, no. 1, pp. 63–77, 2006.*

[2] *W. Shen, H.Sun, E.Cheng, Q.Zhu, Q.Li, "Effective Driver Fatigue Monitoring through Pupil Detection and Yawing Analysis in Low Light Level Environments,"International Journal of Digital Content Technology and its Applications (JDCTA), Vol. 6, no. 17, September 2012.*

[3] *A.Amine, N.Alioua, F. Zann, Y.Ruichek and N.Hmina,"Monitoring Drivers Drowsiness using a Wide Angle Lens", IEEE Annual Conference on Intelligent Transportation Systems,october 2013.*

[4] *Tripathi, D.P., Rath, N.P. "A novel approach to solve drowsy driver problem by using eye-localization technique using CHT". International Journal of Recent Trends in Engineering ,2009.*

[5] *P.Viola, M.Jones," Rapid object detection using a boosted cascade of simple features", International Conference on Computer Vision and Pattern Recognition ,2001.*

[6] *Z.Zhang, J.Zhang, "Driver Fatigue Detection Based Intelligent Vehicle Control", International Conference on Pattern Recognition, 2006*