A Review On Vision-Based Real-Time Driver Fatigue Detection System For Efficient Vehicle Control

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ABSTRACT

The driver fatigue plays big role in road accidents. So to avoid the number of road accidents we proposed the driver fatigue detection system. Accidents can be prevented by monitoring driver face. Face monitoring system continuously capture the images of driver face. Driver face gives the information about distraction from head, mouth, eyes using face monitoring system. Eye blinking, head movement, yawning are main characteristics of fatigueness. Using these characteristics of face, given system detect whether driver is in fatigue state or not. If driver is in fatigue state then alarm will be raised and driver will be alerted. In this paper, the basic structure of the face monitoring for driver fatigue detection to be discussed. After that formal review of fatigue detection system is presented.

Index Terms: Face monitoring system, Face detection, Eye detection, Eye tracking, Fatigue detection

I. INTRODUCTION

The important factor of the human safety, while driving the vehicle is to avoid the number of accidents caused due to the fatigueness of the driver. Driver fatigue reduces the concentration and intention towards the driving of the vehicle and driver does not able to do the driving and to control the vehicle.

Some researches shows that for a long time driving, driver does not able to do the more driving of the vehicle and after that driver goes into the fatigue state. If the driver is addicted of alcohol, cigarettes, or any drugs[14] then also he/her do not able to do the driving the vehicle and he/her losses the concentration from driving the car. According to researches, they told that some percentage of accidents causes due to the fatigueness of the driver.

There are two types of safety system to overcome crashes and accidents of the vehicles [18]. They are active safety system and passive safety systems. Passive safety system includes air bags, seat belts and crashworthy body structure of the vehicles. But these passive safety systems only reduce the damage after an accident. So the passive safety system are not suitable for prevention of the accidents because these safety system comes into the picture when accidents occurs. So the active safety system is used to avoid the accidents. Active safety system continuously monitors the state of the driver and these systems give the alert to the driver when the driver is in the fatigue state. So these active safety systems are used to avoid the accidents.

So current studies shows that these accidents or crashes can be reduced by using face monitoring and fatigue detection system. So the face monitoring and fatigue detection comes into the picture. The face detection system continuously monitors the face of the driver and the state of the eyes whether the eyes are closed or open or blinking. If the eyes become closed for some seconds then the fatigue detection system activates the alarm system and alarm will be raised till the driver wake up and come out of the fatigue state. In Figure 1, we have given general flow of driver fatigue detection system.
Driver fatigue detection also checks whether the driver is tired or lost attention while driving the car from the facial expression. So the important problem is to avoid the fatigueness while driving to reduce the number of accidents.

II. FACE MONITORING SYSTEM AND FACE DETECTION

Face monitoring system gives result about driver’s physical and mental condition after processing is done on face images. Many systems implemented for fatigue detection system starts with face monitoring because fatigue can be detected with less complexity using driver's facial expression. For face monitoring, Hardware as well as Software Platform can be used. Among them, Software platform is used in many existing systems.

Face detection is first step towards real time driver fatigue detection. Most of fatigue detection system depends on eye tracking which is easily carried out by face detection. Therefore face detection plays important role in driver fatigue detection. In [11], various problem related to face detection are mentioned, they are

1) Position
2) Orientation
3) Lighting
4) Presence of glasses, makeup, beards, mustache.

There are various methods for face detection which gives a result up to 70-80% [14] or more in standard conditions but they are failed in night lighting condition. Below are the various popular methods for face detection:

A. Skin colour model

Skin colour model is feature-based face detection model which depends on skin colour. Skin colour is used to get know face region and non face region from various characteristics of skin colour [9,18,4]. Also Skin color models depend on the skin color of the people, lighting conditions and video cameras. For skin color modeling, in [18] RGB, [9,5] YCbCr and [4] HIS color space is used. This method is useful only when image in simple background otherwise it gives more errors when background contain lots of things.
B. Learning-based method

Learning based methods give fast speed for face detection rather than feature-based methods. Learning based methods give you less errors in face detection but it have more computation complexity. Viola et al is the algorithm used for object detection which uses simple Haar-like features for evaluation of images. Haar-like features are catch-up from images and these features are selected using AdaBoost algorithm. Using AdaBoost algorithm, Haar-like features are processed for further face detection. This algorithms gives fast and robust result.

III. EYE DETECTION

After face detection, generally in all driver fatigue detection system eye detection carried out. Eyes gives a lot information about drivers physical condition i.e. driver is in fatigue or not. For detection of clues related to eyes generally eye detection is important stage. Here are some popular methods of eye detection:

A. Binarization

Binarization is the process of detection exact location of the eyes. It is very complicated process because error rate of this process is very high. Through the binarization, it represents an image only in two different pixel values. It is basically performed by differentiating a gray scale image into two groups of pixels. These pixels are calculated by using certain threshold value. Those pixel having same or greater value than threshold value is set to particular gray value and those pixel having less value than threshold value set to another gray value. Quality of the binary image is dependent on how the threshold value is set for binarization and how the pixels are differentiated into two groups of pixels. The threshold values are manually chosen for binarization because there is no any one particular algorithm for set the exact threshold value.

B. Projection

Projection is a method of eye tracking. It is used to checking eye position in vertical and horizontal face image. Projection is also used to determine initial location of eyes. Projection is not applied directly on image, but projection of the edge detected image is used. It is based on face color variation method. The projection method gives direction to calculate horizontal and vertical pixel. This method used for eye detection process. This method exactly detects the eyes position in a normal condition. Sometimes projection not suitable for black people. The binarization result of the eye area is performed the horizontal projection. Horizontal projection is used to locate the vertical position of the face image.

C. Dynamic Template Matching

Dynamic template matching technique is important in eye tracking. It tracks the eyes of the human face from an image. The pixel value of eye region is basically less than the other region of the eyes. The average gray value is calculated along with the x-axis and after that approximate eye region is to be calculated. So from the same characteristics of the eyes, the eye templates are obtained. After the eye template, using the gray scale correlation on the eye region, the position of the eyes is to be calculated. So the first template obtained is used for the pattern matching technique. The first template is used to match the previous template of human face.

IV. DETECTION OF CLUES RELATED TO EYE REGION

After detection of eyes, every fatigue detection system checks whether it gets any clue for fatigueness or not. This clues gives information about driver’s physical state. Each fatigue detection system checks one clue only. Depends upon clue, if symptoms are detected then further processing is done by system. There are some clues which described below:
A. Distance between the Eyelids

This is the symptoms of the driver fatigue. The eyelid distance is used for driver fatigue detection. When the driver goes in to sleeping state the distance between the eyelids goes decreased. The horizontal projection method is used for the distance calculation of the eye region.

B. Eye blink speed

The slow eye blink speed is one of the symptoms of the driver fatigue. The time between opening and closing of the eyelids at one blink event called as eye blink speed. This symptom is used to detect the fatiguness of the driver. If the blinking speed of the eyes is more than threshold speed, driver fatigue is detected.

C. Gaze direction

This is another symptom used to calculate the driver distraction. So from that symptom, the lack of the driver's attention to the road is to be determined. This symptom is also used to take the decision of overtake the vehicle or lane changing of the road can be predicted.

V. FATIGUE DETECTION USING EYE FEATURES

After detection of clues using eye features, generally this is clues are further used for fatigue detection. The clues leads to mainly two conditions such as fatigueness or non-fatigueness. There are some popular methods used for fatigue detection system as follows:

A. Blink detection algorithm

Blink detection algorithm[18] uses the blinking features of eyes to detect fatigue of driver. After detection of eyes, system continuously checks the variation of eyes such as eyes are open or closed.

Eyes variation can be detected by entire video sequence. First eye templates are converted into grayscale to differentiate the eyeball pixel. When template converted into grayscale, original eyeball becomes more brighter. Saturation value of this eyeball gives the result that given pixel is eyeball pixel or not. This gives result that if eyes are open or closed. This eyeball pixel are used to detect eye blinking. [18] Blink detection algorithm checks the 8 frames in row. If darkness of template image is more than 12 pixel than original image then fatigue is detected and driver alerted.

B. Support Vector Machine fatigue state classification

First of all, clues from eye state i.e. eye open or close is extracted. Change level of eyes are measured in PERCLOS which gives level of driver attention. This eye features are send to the SVM. In SVM, [2] there are mainly two class labels such as +1 and -1. Normal state of driver is indicated by +1 and fatigue state is indicated by -1 label. The video sequence used for this SVM is generally captured in constant illumination and variable illumination. SVM classifiers uses parameter which are trained by [2] 10-fold cross validation.

C. Bayesian Networks

Bayesian Network is used to represent probabilistic knowledge. Bayesian Network contains arcs and nodes which forms directed acyclic graph. Depending upon past and current information, Bayesian Network can predict future information. So using Bayesian Network, fatigue can be detected using past information such as drivers health, mental condition, environments and many causes of fatigue.[19] Bayesian Networks is complex to form. It has large number of computation complexity. Processing speed of BN is high. [14]
D. Dempster-Shafer theory

In Bayesian Network, it is impossible to detect classes in real time. At this high complexity instead of using Bayesian Network in [14] Dempster-Shafer Theory is used for detection of driver’s condition by monitoring its eyes, face and system takes decision which gives result that driver is in fatigue state or not.

Dempster-Shafer Theory built by using both fuzzy logic and probabilistic reasoning. Dempster-Shafer Theory gives flexible and robust result which leads to accurate fatigue detection system.[14] Computational complexity of Dempster-Shafer model is much higher than BN.

VI. CONCLUSION

Many technologies available to determine the driver fatigue are reviewed. According to researches and statistics, 20% to 30% of crashes and accidents due to the driver fatigue and distraction are observed. So design and development of driver fatigue detection system seems to be very important. The reviewed system performs processing of the face region, eye region, some symptoms like yawning, head orientation facial expression, eye closure, percentage of eyelid closure over time, blink rate of the eyes and gaze direction to detect driver fatigue and distraction. Here we have tried to look forward for acquiring the new technologies and determining the best approach to avoid the number of accidents due to the driver fatigue.

VII. REFERENCES


