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# Driver Fatigue Detection System

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***Abstract:***
*Road users have long been known to fall asleep whilst driving. Driving long hours can induce fatigue causing lack of concentration and occasionally road accidents. There has been done much work on driver fatigue detection system. This paper provides information about recent studies and work that have been done and the techniques and methods used till now. Driver fatigue detection system mainly measures various factors like facial features, characteristics (edges and color), eyes status, mouth status (yawning), physiological signals, e.g. ECG and EEG, head positions and nod and driving behaviors, such as accelerate, brake, shift and steer. These approaches are presented and discussed in detail. Some typical driver monitoring systems are also introduced in this paper. Finally, conclusions are presented.*

***Key words:*** *Bio signals, Driving Fatigue, eye detection, face detection, Hough transform, physiological signal*

## 1. Introduction

The National Highway Traffic Safety Administration (NHTSA) compiles numerous statistics on driving fatigue accidents. Their records indicate that there are more than 55,000 driving fatigue accidents in the America each year [1]. Even worse, surveys conducted by the National Sleep Foundation show that 60 percent of admit to driving drowsy. Statistics show that both cars and trucks are involved in their share of driving fatigue accidents, but semi-truck drivers seem to be particularly at risk.
A number of factors can contribute to a driver becoming excessively fatigued. Lack of quality sleep is the primary cause of driver fatigue, especially when a driver fails to obtain sufficient sleep over a number of days or weeks, working long hours, driving long hours, not taking required rest breaks when driving, night driving. The sad fact is that most of these driving fatigue, injuries and deaths could have been prevented if the driver had followed a few safety tips at the first signs of fatigue.
The rest of this paper is organized as follows: Section 2 provides a detailed survey of different fatigue detection methods. In Section 3, details of some typical driver monitoring systems are provided and discussed. Finally, conclusions are presented in Section 4.

## 2. Fatigue Detection Technique

### *2.1. Feature Based Methods*

It explores the characteristics (such as edges, color distributions, etc…) of the object of interest in an image, to identify some distinctive features around that object. Mostly, face detection methods applied to monitoring fatigue driving status include mainly both Haar-like feature based method [2][3] and skin color feature based method [4][5]. But these are sensitive to changes of facial expression and face dimension. Although the latter is sensitive to lighting changes. The face image of the driver is likely to be affected by the external environments because of complicated and various road conditions [6].

### *2.2. Eye Status and Eye Position*

Since human eyes express the most direct reaction when dozing, is usually used as the basis for driver drowsiness detection by researchers and the position of other facial features can be estimated using the eye position. Systems measure different eye reaction such as the frequency of blink, the average degree of opening eyes, the eye stagnation time and the longest time of closing eyes[7].

*2.3. Mouth State*

Some researchers have used mouth state as a visual cue instead of eyes for detecting fatigue since yawning is also a symptom of fatigue. Fatigue can be detected based on changes in the mouth geometric features. Fatigue can also be analyzed from multiple visual cues like eyes as well as mouth. [8]

*2.4. PERCLOS*

PERCLOS is the abbreviation for Percentage of Eyelid Closure over the Pupil over Time, which is ratio of eyes close time per time. The ratio in PERCLOS method can represent fatigue, and is the most potential, the best method to detect driving fatigue. There are three evaluation indicators in PERCLOS, that is P70, P80, EM. P80 (Eyes closed at least 80% of the time is the percentage of a specific time) is used as the evaluation criteria [9].

*2.5. Physiological Signal*

Physiological signals such as electrocardiogram (ECG) [10], electroencephalogram (EEG). Fatigue can cause EEG changes. The EEG is not on the performance of the same when the cerebral cortex is in excitement or inhibition. According to the EEG's frequency distribution and waveforms, assumes the function status of the brain activity, so as to speculate whether the driver is fatigued. Electroencephalogram (EEG) method of mental fatigue, which is an important basis in the assessment of changes in the central nervous systems, has been widely researched. However the EEG is vulnerable to interference from external factors and there are so many differences in individual physiological response [11][12].

*2.6. Driving Behaviour*

Driving behavior such as accelerate, brake, shift and steer. Because the signals of driver's behaviors are easy to acquire and detecting these signals do not need to touch the driver, besides, analyze these signals is very fast, it meet the requirements of the system.

**3. The Proposed SYSTEM**

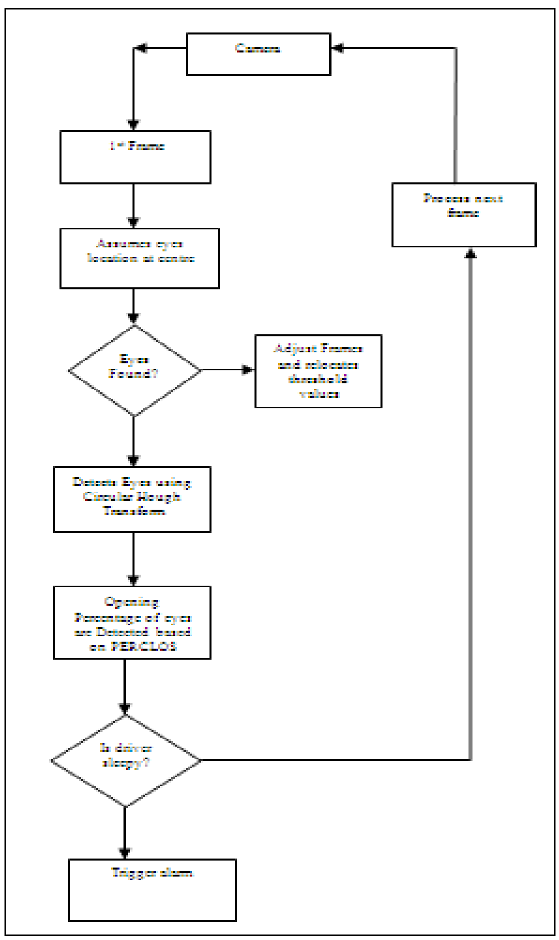


*Figure 1: Design Flow of Fatigue Detection System*

*3.1. The System Mainly Categorized Into Following*

- Image capturing
- Eye detection
- Eye state estimation
- Driver drowsiness detection

*3.2. Image Capturing*

Image is captured using integrated camera. Ideal view of camera should be:

- User should focus into the camera such that the face of user should be in the centre of the camera's frame.
- There should be proper illumination in the room. After capturing image it gets saved into database.

*3.3. Eye Detection*

There are two techniques involved in this part. Firstly the image is processed and converted into a greyscale image and Circular Hough Transform is applied for detection curves in the image. The next algorithm is applied to identify eyes among the detected curves. So this algorithm basically takes data returned from Circular Hough Transform.

It was devised to reduce the level of error in the returned data that the geometric properties of the face and eyes be used to differentiate points the Hough transform sees as circular objects.

Initially the points are screened based on colour information, setting a threshold to ignore points that have a greyscale value towards the white end of the spectrum removes any shadows on the face or light source reflections from the returned data.

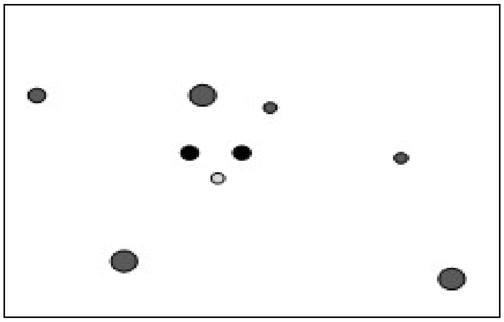

*Figure 2*

Pairing data points of the same radius allows for the identification of probable matching pairs of eyes. Healthy pupils should be of the same size and react together to any changes in light so it is reasonable to assume they should be the same size. At this stage a point may have multiple pairings with other points.

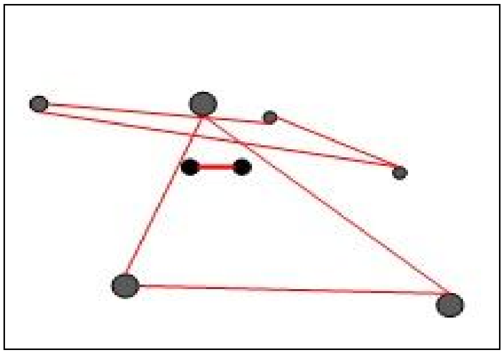

*Figure 3*

The angle condition to be applied, this involves removing pairings from the selection that fail to have a relatively small angle with the horizontal. This reflects the normal orientation of the driver's eyes during normal driving conditions. A tolerance is given to allow for leaning

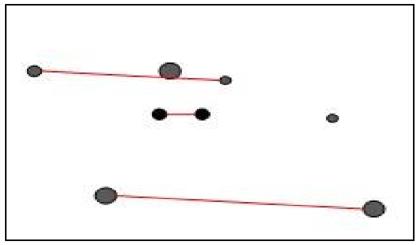

*Figure 4*

Now the distance condition is applied to the pairings, this is used as the distance between the eyes is fixed and can be said to lie within a maximum and minimum distance range for the majority of people, i.e. most people's eyes are greater than 2cm apart but less than 20cm. This is a broad range, but eliminates any outlying points.

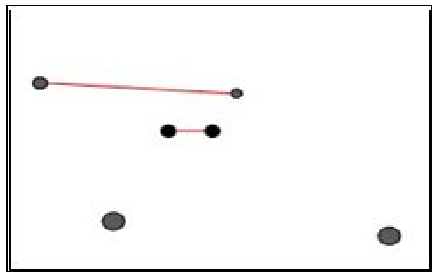

*Figure 5*

A final check on the colour data is made, pairs should have similar colour information. The selection of the best matching pair to the defined colours of the pupil is made at this point.

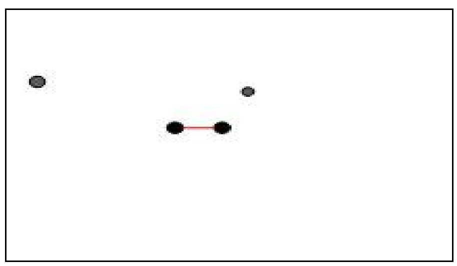

*Figure 6*

*3.4. Eye State Estimation*

In this step the status of the eye is detected using PERCLOS principle. PERCLOS used to judge whether drive is driving fatigue. PERCLOS is the abbreviation for Percentage of Eyelid Closure over the Pupil over Time, which is ratio of eyes close time per time. The ratio in PERCLOS method can represent fatigue, and is the most potential, the best method to detect driving fatigue [3]. There are three evaluation indicators in PERCLOS that is P70, P80, and EM. P80 (Eyes closed at least 80% of the time is the percentage of a specific time) is used as the evaluation criteria. Figure 7 shows PERCLOS measuring theory. That is t1~t4 is measured. And calculated as shown in formula 1.

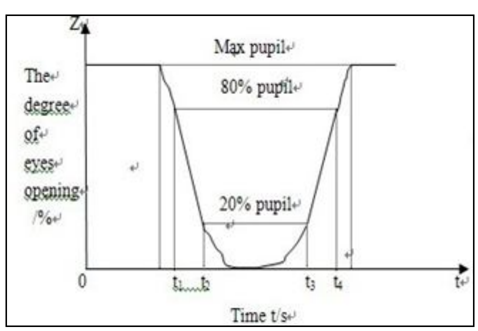


*Figure 7: PERCLOS measuring theory*

Where, f Percentage of eye close time, that is PERCLOS, t1 spend time from open the maximum to close 80% of pupil opening, t2 spend time from open the maximum to close 20% of pupil opening, t3 spend time from open the maximum to open 20% of pupil opening, t4 spend time from open the maximum to open 80% of pupil opening. This measurement method is as follows. First face image of the driver is extracted by camera, then eye image is obtained by image processing, and then open or close of eye is determine after image analysis and recognition, finally more than 20% of pupil open is defined as eye open, otherwise as eye close. Opening size of pupil is measured through calculation of the eye area that is defined as pixels number of eye region (horizontal edge pixels×vertical edge pixels). If PERCLOS is more than 40%, that is closure time of eye is more than 3s, then it shows that driver is fatigue.

### *3.5. Drowsiness Detection*
After estimating the eyes whether open or closed next step is to detect the drowsiness. If the eyes are close for certain numbers of frames then system issues a warning signal and drowsiness is detected.

## 4. Conclusion
This paper proposes a system for fatigue detection of driver by proposing some suitable techniques for Image Processing in the inputs taken by the system. This paper enhances the techniques like Circular Hough Transform, PERCLOS and detection of eyes using Image Processing. First, the system captures drivers image using camera with ideal position. Secondly, it detects eyes using Circular Hough Transform for curves detections and amongst various curves it finally detects accurate eyes. Then eyes status is estimated using PERCLOS (Percentage of eyes closure) measuring theory. Based on the output of PERCLOS theory, it will conclude whether the driver is fatigued or not and accordingly triggers the alarm.

## 5. Future Work
The future work can be appropriately quoted after the actual implementation of the proposed system

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