A Real Time Driver Fatigue System Based On Eye Gaze Detection

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Abstract— Now a days, Many accident occur due to Driver Fatigue and Distraction. The main problem due to which accident occur is drivers drowsiness. The main approach for driver fatigue or accident prevention is driver face monitoring. It first capture images from driver face and also it extract parameter of fatigue and distract from eye. This parameter are percentage of PERCLOS, eyelid distance, eye blink rate, blink speed, gaze direction. Base on this parameter the system estimate drivers alertness and rings the alarm if needed. It mainly focus on the Eye Gaze technique. This method is not only responsive to road enviornment and driver's action but also it is designed to correlate the drivers Blink behaviour base upon the driver's drowsiness. The driver fatigue system monitors the driver and accordingly detect and act on drivers inattentiveness. The system also detects if the eye is not found and will work accordingly. Hence all techniques tries to minimize the number of accident cause by drivers fatigues.

Keywords— Driver Fatigue, Distraction, Drowsiness Detection, Driver Face Monitoring ,PERCLOS, gaze direction, Eye Gaze Technique.

INTRODUCTION

The daily occurrence of traffic accidents has become a horrific price of modern life. Complacency about the dangers of driving contribute to the death of more than one million people worldwide in traffic accidents each year[1]. Fifty million more are seriously injured. In the organization for economic co-operation and development (OECD) member countries, road accidents are the primary cause of death for males under the age of 25 [2]. Driving and being drowsy is sometimes compared with driving under the influence of alcohol or drugs, because sleepiness slows down reaction time, decreases awareness and impairs judgment [3].

Driver fatigue is a significant factor in a large number of vehicle accidents. Recent statistics estimate that annually 1,200 deaths and 76,000 injuries can be attributed to fatigue related crashes. There is no doubt that driver error is at the heart of road fatalities[4]. In their landmark study used 100 vehicles equipped with video and sensor logging equipment to study how people drive and why they crash. They found that 81% of accidents and 76% of near accidents they witnessed involved momentary inattention (within 3 seconds) before the incident.

Fatigue occurs in three different types: sensory fatigue, muscle fatigue and cognitive fatigue. Sensory fatigue and muscular fatigue are only measurable and there is not any way to measure cognitive fatigue [5,6]. The development of technologies for detecting or preventing drowsiness at the wheel is a major challenge in the field of accident avoidance systems. Because of the hazard that drowsiness presents on the road, methods need to be developed for counteracting its affects. The focus will be placed on designing a system that will accurately monitor the open or closed state of the driver's eyes in real-time. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. Detection of fatigue involves a sequence of images of a face, and the observation of eye movements and blink patterns.

Monotony of a certain task can reduce the concentration of person and may cause distraction. Monotony is caused by three main reasons: (1) lack of personal interest, (2) doing a repetitive task for long time and (3) external factors (like talking with mobile phone). Monotony in driving usually is caused by the second and third reasons. Prolonged driving on highways with flowing traffic has a negative effect on driver concentration. In this case, driver is not fatigued, but due to the monotony of driving, his/her concentration will gradually be decreased and the driver will not have a careful control on the vehicle. Driver distraction can also is caused by talking to people or mobile phone and listening to music [5,6]. Driver distraction can be estimated by head and gaze direction determination. The main problem for distraction detection is that if head is forward and eyes look toward the road, the driver does not necessarily pay attention to the road. In other words, looking toward the road is not paying attention to it [6].

Table 1. Comparison between the Main Approaches for Driver Drowsiness Detection

	Physiological approach	Driving Behaviour approach	Visual Feature approach
Fatigue Detection	Yes	Yes	Yes
Distraction Detection	No	Yes	Yes
Accuracy	Very Good	Good	Moderate
Simplicity	Difficult	Relatively Easy	Easy
Detection Speed	Very Fast	Slow	Fast

METHODS BASED ON DRIVER DROWSINESS

Many efforts have been made recently to develop on-board detection of driver drowsiness. A number of approaches have been investigated and applied to characterize driver drowsiness using physiological measures, ocular measures, and performance measures.The detection of driver inattention the methods used for drowsiness detection can be divided into three categories: based on driving behaviour , based on physiological features, and based on visual features.

I.DRIVING BEHAVIOUR APPROACH

Driver operation and vehicle behavior can be implemented by monitoring the steering wheel movement, accelerator or brake patterns, vehicle speed, lateral acceleration, and lateral displacement. These too are non-intrusive ways of detecting drowsiness, but are limited to vehicle type and driver conditions. The problem with this technique is that it will eventually become tiresome and annoying to the driver ,and measuring equipment that must be attached to driver's body. Body movements are measured directly, by a device called Actigraph or recorded by a camera. The Actigraph detects activity by sensing motions via an internal accelerometer (Actigraph). The subject can for example wear a wristwatch device that detects wrist movements. Several studies have found significant relationship between EEG levels and the presence of sleep that has been indicated by actigraph measures [7]. According to a study at the technical university in Prague regarding the typical course of events, driving is characterized by alertness and frequent looks in the mirrors at the beginning of the drive. This alertness is soon replaced with repetitiveness and decreased activity appears after 30-60 minutes. At this stage the driver moves his eyes rather than turning his head when looking in the mirrors. When starting to feel tired the driver stretches his body and increasing feelings of drowsiness makes him yawn and he starts bending his head to the left or to the right. Deep breaths now and then are regarded as a sign of increasing drowsiness[8].Different behavioural indicators are put into four categories representing different levels of drowsiness[9]. For example yawning is placed in the least severe group while having the eye lids closed for longer than 2.5 seconds is in the most severe group.

II.PHYSIOLOGICAL APPROACH

The other method is physiological features that measures drowsiness by measuring heart rate and brain activity.EEG has been shown a good measure of drowsiness [10]. By fixing electrodes to the scalp, alpha, beta and theta brain waves can be examined and the brain status from fully alert to falling asleep can be recognized. But EEG is unpractical to measure in the car and therefore most useful as a reference, when calibrating other measures[7]. Among these methods, the techniques that are best, based on accuracy are the ones based on human physiological phenomena. This technique is implemented in two ways: measuring changes in physiological signals, such as brain waves, heart rate, and eye blinking; and measuring physical changes such as sagging posture, leaning of the driver's head and the open/closed states of the eyes. EEG could be used to detect deficiencies in information processing, which can occur even though the eyes are wide open, and the slow eye closures would detect insufficient perceptual capabilities. The problems with both EOG and EEG are the requirement of obtrusive electrodes which make them unsuitable to use in cars, as cabling of the drivers would not achieve any acceptance. Hence, they are not feasible to be used in a real-time drowsiness detection system.

III.VISUAL FEATURE APPROACH

And the last method is visual features that uses information obtain from a camera for detecting drowsiness. The visual features methods are used by eye state information, head movement, facial expression .The methods used for eye state to measure driver drowsiness have done by calculating values like eye closure duration(ECD),frequency of eye closure(FEC) . Parameters used to describe the blink behaviour, extractable from the EOG signal, are for example blink frequency [blinks/minute], amplitude or eyelid opening level [mV] and duration [ms]. According to [11], a relaxed person blinks about 15-20 times per minute, although only 2-4 are needed from a physiological viewpoint. When performing cognitive tasks the blink frequency drops to as little as 3 blinks per minute, whereas an increase in blink frequency indicates reduced vigilance [12]. Visual information is of vital importance when driving [13]. This indicates that measurements of eye closure (i.e. eye lid is closed longer than one second), eye movements and ocular physiology are appropriate methods of detecting driver drowsiness[14]. This can be measured with EOG.

DRIVER FATIGUE SYSTEM

There is still no precise definition for fatigue. Certainly, due to the lack of precise definition of fatigue, there is not any measurable criterion to measure it [6].so processing of eye region and investigation of closed eyelids is the most important criterion used to estimate fatigue. The driver face monitoring system is a real-time system that investigates driver physical and mental condition based on processing of driver face images. Driver status can be detected from eyelids closure, blinking, gaze direction, yawning and head movement. This system will alarm in hypo-vigilance states such as drowsiness, fatigue and distraction.

Driver fatigue and distraction is detected by processing of face, head, eye region. There are many researches based on this approach. The main reason of this large amount of researches is that main symptoms of fatigue and distraction appear in driver eyes. Moreover, processing of eye region instead of total face region has less computational complexity.

Major parts of driver fatigue system are:
I. Imaging
II. Intelligent Software

I. IMAGING

The part for imaging includes lighting and camera and may include imaging controller if necessary. Since driver face monitoring system should work in all light conditions, lighting and camera selection is one of the most important stage of system design. Lighting devices not only should provide enough light in environment, but also should not hurt driver eyes. Thus, near infrared (IR) spectrum is usually used in lighting. Camera should be chosen based on the lighting spectrum as well. Visible spectrum is also used in the driver face monitoring systems, but face lighting in night is troubling for driver vision system. Thus, it seems that visible spectrum is not very useful in real conditions. Another approach for imaging is pulsed lighting/imaging. In pulsed imaging, a controller is used to synchronize lighting and imaging. In this case, the controller adjusts light source(s) turning on/off and camera aperture opening. The pulsed imaging approach usually used in near IR lighting spectrum.

II. INTELLIGENT SOFTWARE

Intelligent software is the most important part of driver face monitoring system and is divided into two main parts: image processing algorithms and decision-making algorithms. The main goals of image processing algorithms include Preprocessing, detection and tracking of face, eyes and other facial components, and extraction of appropriate symptom from facial images. Indeed, image processing algorithm is the main part of driver face monitoring system. These algorithms usually require large amounts of memory and impose a high computational load on the processor and hardware. To design an accurate and real-time system, we should focus on these algorithms. After extraction of appropriate symptom from images, decision-making algorithms determine the level of driver alertness based on extracted symptoms. Finally, an appropriate output is generated for the system. Decision-making algorithms should be able to detect driver fatigue and distraction and make an appropriate decision; hence, they are important. The shorter duration that decision-making algorithm can detect driver drowsiness or distraction result in higher performance of the system.
In Driver fatigue System, reducing error of the system in detection of face and its components, reducing error of face tracking and increasing system accuracy in detection of fatigue and distraction are considered as other problems of such systems.

EYE DETECTION

Driver fatigue systems, eye region is always processed for symptom extraction, because the most important symptoms are related to the eyes activity. Therefore, eye detection is required before processing of eye region. Eye detection methods can be divided into three general categories: (1) methods based on imaging in IR spectrum, (2) feature-based methods and (3) other methods.

I. METHODS BASED ON IMAGING IN IR SPECTRUM

One of the quick and relatively accurate methods for eye detection is the methods based on imaging in IR spectrum. In these methods, physiological and optical properties of eye in IR spectrum are used. In [15] a similar method for eye detection, except that after initial eye detection, used Support Vector Machine (SVM) for increasing accuracy of eye detection. SVM is used to increase the accuracy of eye detection.

Methods based on lighting in IR spectrum are able to detect eyes without face detection, and therefore these methods have less computational complexity than other methods. These methods are more suitable for the systems which can detect the driver fatigue and distraction only based on the processing of eye region. The main disadvantage of this method is that if eyes are closed, system is not able to detect eyes.

II.FEATURE-BASED METHODS

i. Methods based on Binarization

Image Binarization is one of the simplest methods in image segmentation which can be used in eye detection. Usually more complicated processing is needed to detect the proper location of eye, because results of binarization usually have high error rate.In [16], with assumption that eye is the darkest points in face, eye location was determined. For this purpose, after binarization of face image, large contours are detected. The first central moment of two largest contours of face image is determined as eye center.In [17] an eye detection algorithm that detects eye in the HSV color space. This method has a very good accuracy for eye detection in color images, but it fails when illumination of environment is low.

ii. Methods based on Projection

Projection is one of the simplest methods for face detection that can also be used for eye detection. In this method we assume eye is darker than skin surface. Therefore, horizontal projection of face image in eye location has smaller values.projection was used to determine initial location of eye[18]. To increase the accuracy of projection based methods for eye detection, detection is usually performed with one or more prior assumptions. For example, because eye is always in the upper half of face, projection for the bottom half of face is not calculated and beard or mustache will not reduce the accuracy of eye detection.

projection is not efficient for black people or those who have eyeglasses. This method is less sensitive to face color, but it fails for detection of eyes with sunglasses.

iii. Other Methods

There are a few methods for eye detection based on other approaches that have been used in driver face monitoring systems. These methods are usually time-consuming; therefore they are not used in real-time systems. In [18] detected eye region based on a face model. For this purpose, the estimated eyebrow area was separated from face image and was processed with Sobel edge detection operator.

Table 2 - Comparison Parameter of the systems for Eye Detection and Tracking of eye and other components

Eye Detection	Tracking Method	Parameters	Robustness
Imaging in the IR Spectrum	Adaptive filters (Kalman filter)	PERCLOS Eye blink speed Gaze direction Head rotation	Very Good
Imaging in the IR Spectrum	Adaptive filters (Kalman filter)	PERCLOS Eye blink rate Eye saccadic movement Head nodding Head orientation	Very Good
Imaging in the IR Spectrum and verification by SVM	Imaging in the IR Spectrum and verification by SVM	PERCLOS Eye blink speed Gaze direction Eye saccadic movement Yawning Head nodding Head orientation	Very Good
Explicitly by Feature-based (projection)	Search window (based on face template matching)	PERCLOS Distance between eyelids	Good
Feature-based (binarization)	Other methods (combination of hierarchical tracking method)	PERCLOS Eye blink rate Gaze direction Yawning Head orientation	Average

CONCLUSION

The novel dual-eye-tracker image retrieval system presented in this provides an excellent platform for conducting research on gaze-based image retrieval and as well as content-based image retrieval in general.The use of driver eye gaze combined with road events to estimate the to driver's observations was developed and the feasibility of the approach was verified However, it was shown that road events almost certainly missed by the driver could be identified. The systems correlate the driver eye gaze with road scene events to estimate the driver's observations. The benefit of driver observation monitoring was also demonstrated to suppress redundant warnings and cancel warning "with a glance". These systems have the potential to provide the detection or earlier warning of missed road events. The timely knowledge of these missed events would hopefully provide the precious extra seconds for human reaction time.

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