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Detection of Bus Driver Fatigue

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ABSTRACT

The International statistics shows that a large number of road accidents are caused by driver fatigue. Therefore, a system that can detect oncoming driver fatigue and issue timely warning could help in preventing many accidents, and consequently save money and reduce personal suffering. The authors have made an attempt to design a system that uses video camera that points directly towards the driver's face in order to detect fatigue. If the fatigue is detected a warning signal is issued to alert the driver. The authors have worked on the video files recorded by the camera. Video file is converted into frames. Once the eyes are located from each frame, by measuring the distances between the intensity changes in the eye area one can determine whether the eyes are open or closed. If the eyes are found closed for 5 consecutive frames, the system draws the conclusion that the driver is falling asleep and issues a warning signal. The algorithm is proposed, implemented, tested, and found workingsatisfactorily.

Keywords: Bus drivers, visual information, PERCLOS, softmax, fatigue, stress.

I. INTRODUCTION

The increasing number of traffic accidents due to a diminished driver's vigilance level has become a serious problem for society. Statistics show that 20% of all the traffic accidents are due to drivers with a diminished vigilance level [1]. Furthermore, accidents related to driver hypo-vigilance are more serious than other types of accidents, since sleepy drivers often do not take evasive action prior to a collision. For this reason, developing systems for monitoring the driver's level of vigilance and alerting the driver, when he is drowsy and notpaying adequate attention to theroad, is essential to prevent accidents. The prevention of such accidents is a major focus of effort in the field of active safetyresearch.

In the last decade many researchers have been working on the development of the driver monitoring systems using different techniques. Driver's state of vigilance can also be characterized by driver performance with a focus on the vehicle behavior. But these techniques are subject to limitations like vehicle type and characteristics of road. The other detection techniques are based on driver state. The best accurate detection techniques are based on physiological phenomena of drivers like brain waves, heart rate, pulse rate and respiration [2]. Among these methods, the technique based on human physiological phenomena is most accurate. 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. Our system relies on the eyelid movement visual cue to detect the fatigued state of the driver. By monitoring the eyes, it is believed that the symptoms of driver fatigue can be detected early enough to avoid a car accident. The eye blink frequency increases beyond the normal rate in the fatigued state. In addition, micro sleeps that are the short periods of sleep lasting 3 to 4 seconds are the good indicator of the fatigued state. Thus by continuously monitoring the eyes of the driver one can detect the state of thedriver.

II. LITERATURE SURVEY

A Survey on Driver Fatigue-Drowsiness Detection System paper by Indu R. Nair , Nadiya Ebrahimkutty , Priyanka B.R , Sreeja M, Prof. Gopu Darsan ,this paper address to one of an major reasons for road accidents now a day is due to driver fatigue. Be it long distant travelling or drunk driving drowsy state leads to risky crashes which are hazardous to lives as well. To overcome such accidents some method has to be developed which is feasible to all the vehicle drivers. This paper is based on various methods for the preventing road accidents and designs on a drowsiness detection methods which were proposed and have advantages and disadvantages.

A Review on the Driver Face Monitoring Systems for Fatigue and the Distraction Detection driver face monitoring systems is one of the main approaches for the driver fatigue or distraction detection and accident prevention. Paper by Mohamad-Hoseyn Sigari, Muhammad-Reza Pourshahabi Mohsen Soryani and Mahmood Fathy. Driver face monitoring systems capture the images from an driver face and extract the symptoms of fatigue and distraction from eyes, mouth and head. These symptoms are usually percentage of eyelid closure over time (PERCLOS), eyelid distance, eye blink rate, blink speed, gaze direction, the eye saccadic movement, yawning, head nodding and head orientation. The system estimates driver alertness based on extracted the symptoms and the alarms if needed. In this paper, after an introduction to a driver face monitoring systems, the general structure of these systems is then discussed. Then a comprehensive review on the driver face monitoring systems for fatigue and distraction detection is presented.

Jennifer F. May , Carryl L. Baldwin present a paper on Driver fatigue: The importance of identifying causal factors of the fatigue when considering detection and the counter measure technologies this paper state that the technologies currently exist which enable detection of the driver fatigue and the interventions that have the potential to dramatically reduce the crash probability. The successful implementation of these technologies depends on the cause and a type of fatigue experienced. Sleep-related (SR) forms of a driver fatigue result from accumulated sleep debt, prolonged wakefulness or troughs in the circadian rhythms. SR fatigue is resistant to the most intervention strategies. Conversely, technologies for detecting and the countering task-related (TR) fatigue (caused by mental overload or under load) are proving to be effective tools for improving transportation safety. Methods of the detecting and counteracting the various forms of driver fatigue are discussed. Emphasis is placed on examining the effectiveness of the existing and the emerging technologies for combating TR forms of the driver fatigue.

Design and Implementation of the Driving Assistance System in the Car-like a Robot .When Fatigue in the User is Detected. In this paper, it is presented an driving assistance system when drowsiness is detected in a driver; the system is tested by a car like robot that is wirelessly controlled by the computational interface developed in Visual Studio 2010, which emulates an automobile panel. Through an artificial vision system the driver´s head orientation is monitored for determining that if he/she is in the drowsiness state; if so, the robot control turn into automatic and the robot pull over to the right side of the way (built track).

Automatic Detection of Driver Fatigue Using Driving Operation Information for Transportation Safety Paper by Zuojin Li , Liukui Chen, Jun Peng and Ying Wu. The method in this paper is based on the steering wheel angles (SWA) and the yaw angles (YA) information under real driving conditions to detect the drivers' fatigue levels. It analyzes an operation features of SWA and YA under different fatigue statuses, and then calculates the approximate entropy

(ApEn) features of a short sliding window on the time series. Using the nonlinear feature construction theory of the dynamic time series, with the fatigue features as input, designs a "2-6-6-3" multi-level back propagation (BP) Neural Networks classifier to realize an fatigue detection. An approximately 15-h experiment is carried out on the real road, and the data retrieved are segmented and labeled with the three fatigue levels after an expert evaluation, namely "awake", "drowsy" and "very drowsy". The average accuracy of 88.02% in the fatigue identification was achieved in the experiment, endorsing the value of the proposed method for engineering applications.

A driver face monitoring systems can be divided into the two general categories. In one category, the driver fatigue and the distraction is detected only by an processing of the eye region. There are many researches based on this approach. The main reason of this large amount of researches is that the main symptoms of a fatigue and the distraction appear in the driver eyes. Moreover, a processing of the eye region instead of the processing of the face region has less computational complexity. In the other category, the symptoms of fatigue and the distraction are detected not only from the eyes, but also from the other regions of the face and head. In this approach, in addition to processing of the eye region, the other symptoms including yawning and the head nodding are also extracted.

Driver face monitoring system includes some of the main parts: (1) face detection, (2) eye detection, (3) face tracking, (4) symptom extraction, and (5) driver state estimation. These main parts are reviewed in a different systems in the current section.

In the most of the driver face monitoring systems, the face detection is the first part of the image processing operations. Face detection methods can be divided into the two general categories : (1) feature-based and (2) learning-based methods.

In the feature-based methods, the assumption is that the face in the image can be detected based on applying a heuristic rules on features. These methods are usually used for detecting one face in the image. Color-based face recognition is one of the fast and a common methods. In these methods, the face is detected based on the color of skin and the shape of a face. Color-based face detection may be applied on different color-space including RGB , YCbCr , or HIS . In the noisy images or in the images with low illuminations, these algorithms have a low accuracy.

Learning-based face detection uses statistical learning methods and the training samples to learn the discriminative features. These methods benefit from the statistical models and the machine learning algorithms. Generally, learning-based methods have less error rates for a face detection, but these methods usually have more computational complexity. Viola and Jones presented an algorithm for the object detection, which is very fast and robust. This algorithm was used in for an face detection.

Almost in all the driver face monitoring systems, because of the importance of a symptoms related to eye, the eye region is always processed for extracting the symptoms. Therefore, before the processing of a eye region, eye detection is required. Eye detection methods can be divided into the three general categories: (1) methods based on the imaging in an infrared spectrum, (2) feature-based methods, and (3) other methods.

One of the fast and the relatively accurate methods for the eye detection is the method based on the imaging in the infrared (IR) spectrum. In this method, physiological and optical properties of the eye in an IR spectrum are used. The eye pupil reflects a IR beams, and it seems as a bright spot when the angle of IR source and imaging device are suitable. According to this interesting property, pupil and the eye are detected. The systems proposed in used such method for eye detection.

Feature-based eye detection approach includes various methods. Image binarization and the projection are two feature-based eye detection methods which assume that the eye is darker than the face skin. Usually, more complicated processing is needed to detect an proper location of eyes, because these methods are simple and have a high error rate.

There are few methods for eye detection based on the other approaches which were used in the driver face monitoring systems. In , a geometrical face model with some feature-based methods was used to detect eyes. In addition, some systems such as used hybrid methods for eye detection. In ,the elliptical gray-level template matching and IR imaging system were used for the eye detection in day and night, respectively.

Usually, the entire image is searched for detecting an face/eye. Searching an entire image increases the computational complexity of the system. Therefore, usually after the early detection of face/eyes, in the next frames, face/eye tracking is performed. In the most of driver face monitoring systems, Kalman filter or a extended versions of Kalman filter such as Unscented Kalman Filter (UKF) were used. However, in some researches, search window and particle filter (PF) were used for tracking.

In the driver face monitoring systems, useful symptoms for fatigue and distraction detection can be divided into the three general categories:(i)a symptoms related to the eye region;(ii)symptoms related to the mouth region;(iii)symptoms related to the head.

Eye is a most important area of the face where the symptoms of fatigue and distraction appear in it. Therefore, many of the driver face monitoring systems detect a driver fatigue and distraction only based on the symptoms extracted from the eyes. The symptoms related to eye region include PERCLOS , eyelid distance, eye blink speed , eye blink rate , and gaze direction .

Yawning is one of the hypo vigilance symptoms related to the mouth region. This symptom was extracted by detecting the open mouth in .These systems detect the mouth based on the color features of an lips in the image.

Some fatigue and the distraction symptoms are related to head. These symptoms include head nodding and the head orientation . Head nodding can be used for the fatigue detection, and a head orientation can be used for both the fatigue and distraction detection. Driver nodding and the lack of driver attention to the road can be detected by estimating an angle of head direction.

After the symptom extraction, the driver state has to be determined. The determination of a driver state is considered as a classification problem. The simplest method for detecting an driver fatigue or distraction is based on applying a threshold on the extracted symptom .

Another method for determining the driver state is an knowledge-based approaches. In a knowledge-based approach, decision making about the driver fatigue and distraction is based on the knowledge of an expert which the knowledge usually appears in the form of if-then rules. In , fuzzy expert systems were used as the knowledge-based approach for estimating the driver state.

More complicated approaches such as the Bayesian network and nave dynamic Bayesian network were used for driver state determination. These approaches are usually more accurate than the threshold-based and a knowledge-based approaches; however, they are more complicated.

III. EXISTING SYSTEM

A driver falls asleep, then the driver loses control over the vehicle, an action which often results in a crash with either another vehicle or any object. In order to prevent these devastating accidents, there was a previous approach developed, in this system the state of drowsiness of an driver was monitored. The following measures were used widely for monitoring drowsiness:

(1) Vehicle-based detection: An number of actions/metrics, including deviations from a lane position, movement of the steering wheel, pressure on the acceleration pedal, etc., are constantly monitored and any change in these that crosses the specified threshold indicates a significantly increased probability that the driver is drowsy .
(2) Behavioral measures: The behavior of the driver, including yawning, eye closure, eye blinking, head pose, etc., was monitored through an camera and the driver was alerted if any of these drowsiness symptoms are detected.
(3)Physiological measures: The correlation between physiological signals (electrocardiogram (ECG), electromyogram (EMG), electrooculogram (EOG) and electroencephalogram (EEG)) and driver drowsiness was studied.

IV. PROPOSED SYSTEM

In recent days, driver drowsiness has been one of the major causes of road accidents and can lead to severe physical injuries, deaths. Statistics indicate the need of the reliable driver drowsiness detection system which could alert the driver before a incidents takes place. The proposed system is a driver eyes monitoring system that can specially works on a drivers eyes and the face region. Firstly the eyes and the face regions are monitored by camera. Secondly, Iris structuring, the jaw angle finding and the calculation is done using regression analysis, Haar (cascade classifier algorithms) which will examine the eyes are open or closed, then system will detect whether driver is sleeping or not sleeping. If driver is sleeping the alarm rings.

4.1 Advantages of Proposed System

1.System is able to distinguish the simulated drowsy and an sleepy states from the normal state of driving on the low resolution images of the faces and eyes observed from an oblique viewing angle.
2.Effectively monitors the bus driver's attention level without the extra requirement for a cameras.
3.The System approach could extend the capability and applicability of the existing vision-based techniques for the driver fatigue detection.

V. SYSTEMOVERVIEW

A flowchart of the major functions of The Drowsy Driver Detection System is shown in Figure.1.

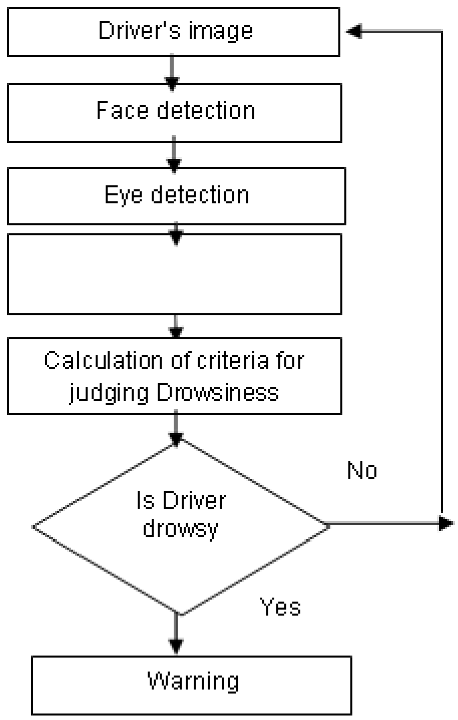


Figure 1. System flowchart

After acquiring the video file of the driver's image, it is converted into consecutive frames of images. The skin color based algorithm is applied to detect the face portion in the image. Since eyes lie in the upper half portion of the face, the lower half of the face is removed to narrow down the search area where the eyes exist. Using the sides of the face, the centre of the face is found, which will be used as a reference when comparing the left and right eyes. Movingdown from the top of the face, horizontal averages (average intensity value for each x coordinate) of the face area are calculated. Large changes in the averages are usedto define the eye area. Using the horizontal average values of both sides of the face the open or closed states of the eyes are detected. If the eyes are found closed for 5 consecutive frames, the system draws the conclusion that the driver is falling asleep and issues a warning signal. All the codes are written in MATLAB software.

5.1.Face Detection

Human face localization and detection is often the first step in applications such as video surveillance, human computer interface, face recognition and / or facial expressions analysis, and image database management. A lot of research has been done in the area of human facedetection.

In prior studies, different human skin colors from different races have been found to fall in a compact region in color spaces. Therefore, we decided to detect skin by making use of this compactness. The face detection is performed in three steps. The first step is to classify each pixel in the given image as a skin pixel or a non-skin pixel. The second step is to identify different skin regions in the skin-detected image by using connectivity analysis. The last step is to decide whether each of the skin regions identified is a face or not. After the probable location of the face is found the left and the right edges of the face are determined.

5.2.Eye detection and eye stateestimation

The next step in locating the eyes is finding the intensity changes on the face. This is done using the gray scale image and not the color image. The first step is to calculate the average intensity for each x – coordinate. These average values are found for both the eyes separately. When the plot of these average values was observed it was found that there are two significant intensity changes. The first intensity change is the eyebrow, and the next change is the upperedge of the eye, as shown in the figure. Thus with the knowledge of the two valleys the position of the eyes in the face werefound.

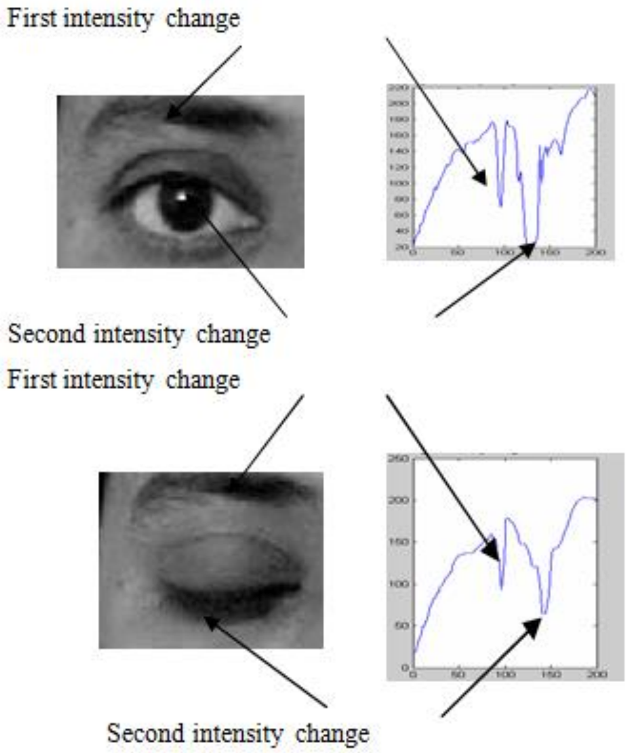


Figure 2. Average intensity variation on the face when eyes are open and close

The state of the eyes (whether they are open or closed) is determined by the distance between the first two intensity changes (valleys) found in the above step. When the eyes are closed, the distance between the x – coordinates of the intensity changes is larger compared to when the eyes are open.

5.3.Drowsinessdetection

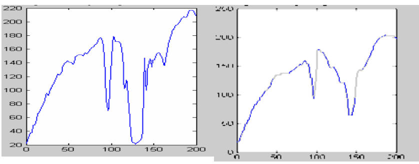
The video image captured by the camera is converted into consecutive frames. From each frame face portion is located and then eyes are localized. The eye region is observed to check whether the eyes are closed or open. Thus, if the eyes are found closed for consecutive 5 frames the system decides the occurrence of micro sleep and give a fatigue alert to thedriver.

5.4.Experimental results

All the codes were written in MATLAB. The experimental results are shown in the figure. The video recording of the driver's image is converted into consecutive frames. From each frame face is detectedand lower half of the face is removed. In the upper half portion search has done for locating eyes. Once the eyes are located, by using the intensity variations the distance between eyebrow and eyelids is measured. This distance is maximum when eyes are completely closed and minimum when eyes areopened.

(a) Open Eye (b) Closed Eye

Figure 4. Eye detection



(a) Open eye (b) Closed eye

Figure 5. Average intensity variation on theface when eyes are open and close

VI. CONCLUSION

Thus a driver monitoring system is implemented which detects the fatigued state of the driver through continuously monitoring the eyes of the driver. The basis of the method used by authors was the horizontal intensity variation on the face. One similarity among all faces is that eyebrows are significantly different from the skin in intensity, and that the next significant change in intensity, in the y-direction, is the eyes. This facial characteristic is the centre of finding the eyes on the face, which will allow the system to monitor the eyes and detect long periods of eyeclosure.

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