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A Virtual Reality Based Driving System

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ABSTRACT

Driving without license is the major cause for the road accident and the equivalent monetary losses. This paper is based on virtual reality based driving system which would enhance road safety and vehicle security. This paper helps to limit the vehicle operation on the basics of two parameters-Learn the driving by our own, category (car or bike) of the vehicle for which the driving license is issued. The hardware and software system required to improve our safety and security is developed. This driving system is apt for getting the license without bribe by gathering eye-gaze, Electroencephalography and peripheral physiological data.

Keywords: Road safety, smart driving license, vehicle security, EEG, eye-gaze and virtual reality system.

1. INTRODUCTION

In the last decade, the number of improvements for driver safety has been more than ever yet the significant number of serious accidents still occur all over the world. Those are mostly caused by human mistakes. Such as typing a text message, speaking someone on the phone, eating and drinking etc., while driving. In addition to these activities, tiredness, distraction could also result in critical accidents. According to the Large Truck Crash Causation Steady, 30% of crashes involving heavy commercial vehicles are occurring because of the driver's tiredness [1].

Up to 20% of road accidents in UK are based on the aforementioned reasons [2]. As reported by the U.S. National Highway Traffic Safety Administration every Year approximately 60,000 traffic accidents take place due to sleepiness related problems [3]. It is not only the tiredness of a driver , which is the major factor beyond the traffic accidents , but Also driver distraction is another threat for drivers' and passengers' safety[4]. Previous studies indicate that 25%-30% of driving accidents are related to tiredness [5]. All in all, tiredness and distraction are the two subjects of the study that researches have been focused on for designing driver inattention monitoring systems. Systems designed for the analysis and detection of tiredness can be broadly divided into two categories: visual features based and non-visual features based.

2. TECHNIQUES BASED ON VIRTUAL DRIVING SYSTEM

A VR-based driving system was designed to train and improve the driving skills of adolescents The Three primary components of the VR-based driving system were: a driving simulator, a data capture module and a rating module. These difficulties level were tested and validated in our previous works[6].control parameters , such as speed of vehicles, responsiveness of the agent vehicles break and accelerated, and weather conditions, were manipulated to produce a range of difficulties.

Fig.1. An example setup of VR-Based Driving system

2.1 Eye State Analysis

Eye state analysis is the most common and simple technique for detecting driver tiredness. The system applies technique focus on the state of the eyes [7]. In such solutions, the system warns the driver by generating the alarm, if the driver closes his/her eyes for the particular time. Some available system based on this technique use a data base where both closed and open templates of eye are stored [8].

In addition to non-adaptive system, there are some adaptive solutions where the open and close eye templates of a related driver are exploited. Template matching techniques on a frame–by-frame basis is used to detect the state of two eyes [9].

2.2 Eye Blinking Analysis

As the eyes of the drivers can provide observable information about fatigue level, many researches and studies exploit eye blinking frequency for drowsiness detection[10].those system are based on monitoring the changes in the eye blinking duration. According to study in the eye blinking duration is the most reliable parameter for the detection of the drowsiness

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level since whenever a driver is tired or feels sleepy, his/her eyes blinking frequency changes and the eyelid closure duration starts involuntarily to prolong.

To be more specific, when the driver is alert, his/her eye blinking frequency is low and his/her eyelid duration will be slower. However, when the driver is exhausted, his/her eye blinking frequency gets higher and his/her eyelid closure will be shorted. The overall accuracy of this approach is around 90%.

2.3 Mouth and Yawning Analysis

Most of the existing works which exploit eye state features, suffer from the presents of sunglass. With regards to drivers mouth state it is also possible to determine driver sleepy level with yawning measurements [11].Yawning is an involuntary intake of breath through a wide-open mouth; usually triggered by fatigue or boredom. This technique is one of the non-intrusive techniques for detecting driver drowsiness by applying computer vision. In this approach detecting drowsiness involves two main phases to analysis the changes in facial expressions properly that imply drowsiness. First, the driver face is detector by using cascade classifiers and tracked in the series of frame shots taken by the camera. After the locating the driver's face, the next step is to detect and track the location of the mouth. For mouth detection researchers have used the face detection algorithm proposed by Paul viola and Michael.J.Jones [12]. Afterwards, yawning has been analyzed to determine the level of the drowsiness. This is presumed to be modeled with a large vertical mouth opening and changes in the drivers mouth contour. Mouth opens wide and the distance between its counters gets larger .The normal and yawning states of the mouth.

2.4 Facial Expression Analysis

Contrary to exploit specific regions of face such as eye and mouth, this technique broadly analyzes more than one face region. Artificial Neural Network is usually used for optimization of driver drowsiness detection. In addition to that, it provides a different way to approach such a control problem, this technology is not difficult to apply and the results are usually quit surprising and pleasing. However, there are limited researches applied ANN to detect drowsiness. Driver is fatigue exhibit certain visual behaviors that are easily observable from changes in facial features such as the eyes, head, and face .visual behaviors that typically reflect the persons level of fatigue include eyelid movement ,gaze, head movement, and facial expression. To make use of these visual cues, they made artificial neural network to detect drowsiness.

Some proposed methods in [13] use a neural network to scan an input window of pixels across the image, where each gray value in the input window serves as an input for the neural network. The neural network is then trained to give a high response when the input window is centered on the eye.

2.5 Driver Physiological Analysis

Fatigue and sleepiness directly affect the physiological indexes of a person. It was mentioned that the physiological indexes of state of drowsiness could be divided from normal state. Hence it is possible to detect driver's drowsiness by measuring physiological indexes, such as electroencephalogram (EEG), heart rate (ECG) and electrooculogram (EOG), of a person. The most promising and feasible method among these technique is based on the measurement of driver's EEG. EEG reflects the state of brain's activity. It is reported that when in the state of drowsiness, the activities of the delta and theta waves are increased substantially. And the activity of the alpha wave is increased slightly. EEG is widely accepted as an indicator of the transition between the different sleep stages by researches. Researches conduct several tests in vehicle simulator and also in vehicle and the results proved that the measurement of EEG is useful to detect driver's fatigue. To apply EEG signals in driver drowsiness detection, it is compulsory to wear electrode helmet by drivers while driving. This helmet has various electrode sensors on which obtain data from the brain.

One critical issue in handling physiological signals is to eliminate noise and artifacts, which are inevitable in real world driving conditions. To overcome this problem, some noise-reducing filters and various feature extraction techniques, such as fast Fourier transform (FFT) and discrete wavelet transform (DWT) are used. Then the extracted features are classified using support vector machine (SVM), artificial neural networks (ANN), linear discriminate analysis (LDA)[14]. The reliability and accuracy, given as over than 90% in detecting drivers drowsiness based on EEG signals are high when compared to visual features and other physiological indexes, such as ECG and EOG.

However, researches revealed that personal differences, such as gender and personality, influence EEG signals and could result in low accuracy rates. On the other hand, an important limitation of EEG signal measurement is its intrusive nature. A possible solution to solve this limitation is to use wireless technologies such as Zigbee and Bluetooth for measuring physiological signals in a non-intrusive way by placing the electrodes on the steering wheel or in the driver's seat [15] .but these kind of non-instructive systems are less accurate than intrusive systems due to the lack of improper electrode contact.

2.6 Vehicle Parameter Analysis

Based on the analysis of vehicle movements, such as steering wheel movement, lane keeping, acceleration pedal movement and braking, etc., it is very likely to recognize the driver's state of drowsiness [16] .these features are related to the vehicle type and can change according to drivers driving habits, skills and experience. . The two most commonly used vehicle movement features for detecting the level of driver drowsiness the steering wheel movement and the standard deviation of lateral/lane position. Steering wheel movement (SWM) is measured using steering angle sensor mounted on the steering column. Besides micro –corrections in steering are necessary for the environmental factors such as small road bumps and cross winds. Drivers tend to reduce the number of micro corrections in the steering wheel movements with increasing level of drowsiness. Vehicle instability is also one of the important signs for insecure driving. When the vehicle senses a loss of traction or a slip, it could immediately warm the driver. Moreover the researches design several control mechanism for vehicle stability .in order to minimize car accidents. Sideslip angle estimation [17] ,an adaptive steering control system based on the human impedance properties(HIMPs) of tire force distribution control mechanism for full drive-by-wire electric vehicles are some recent studies in the literature. There are other certain signs of driver inattention which can be interpreted from standard deviation of lane/lateral position (SDLP) like leaving a designated lane and crossing into a lane of opposing traffic or going off the road.

SDLP simply monitors the cars relative position within its lane with an externally attached camera. Special software is used to analyze the data acquired by the camera and computers the cars position relative to the roads middle lane [18]. SDLP-based systems have some limitations that are caused by external factor, such as quality of road marking, weather, and lightening conditions. Overall, there is a limited research available exploiting this technique. Vehicle movements for driver drowsiness measurements are easily affected by driving habit, driving skill, vehicle speed, vehicle characteristic, and road conditions. Therefore, a robust solution could be formulated so far.

3. CONCLUSION

VR-based driving systems that is robust, accurate, and useful for real-world applications indicating commercial viability in the near future.

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