Available online www.jsaer.com

***Journal of Scientific and Engineering Research*, 2022, 9(8):98-102**

Review Article

ISSN: 2394-2630
CODEN(USA): JSERBR

A review of driving risks considering drivers' physiological characteristics

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Abstract Driving safety has always been a hot issue in the field of transportation research. In order to improve the level of road safety, it is necessary to fully grasp the driver's physiological characteristics and driving status so as to effectively identify the driving risk, give effective warning before the accident occurs, and take measures to avoid the accident. occur, reduce casualties and property losses. Deeply excavating the physiological characteristics of drivers to effectively identify risks is conducive to improving driving safety, and can also provide a theoretical basis for improving driving assistance systems. Effective identification and early warning of driving risks, and timely discovery of potential safety hazards during driving have important practical significance for reducing the number of traffic accidents, improving the level of road traffic safety in my country, and promoting the application of in-vehicle driving assistance systems.

Keywords visual characteristics; EEG characteristics; cognitive load; driving risk

1. Introduction

The driver's gaze behavior is the main visual feature. The driver recognizes the valid traffic information by looking at the external traffic environment, and then makes a judgment to operate. Brain waves are the ion exchange generated by the synapses of the brain's scalp when they are active, thereby generating biological signal waves. These changes can be amplified by recording these changes through electrodes placed on the scalp to form an electroencephalogram. The driver's actions outside the main driving task are considered to be distracted, and the effect of distraction is called distraction load. Distraction load is currently divided into four types: cognitive load, visual load, auditory load, and motor load (or physio-mechanical distraction). Therefore, on the basis of the above studies, we can analyze the characteristics of visual fixation and transfer, the time-frequency and spectral characteristics of EEG signals of drivers under different cognitive loads, and obtain the attention index and relaxation index through the deep learning network. In this way, the direct quantification of the driver's state based on EEG signals is realized, and finally, the conflict risk between vehicles and the driving risk of the vehicle based on the driver's characteristics are comprehensively identified, which makes beneficial contributions to improving the driving assistance system and driving safety.

2. Driver's Visual Features

Drivers identify valid traffic information by looking at the external traffic environment, so as to make judgments and operate. When multiple tasks have the same requirements in the same dimension or even multiple dimensions, these tasks are shared in time due to mutual competition. performance is reduced, and the corresponding performance level is also reduced. When the vehicle is driving, a certain proportion of the driver's visual channel resources will be occupied, such as sending WeChat, operating the vehicle system, etc. These secondary tasks will directly compete with the main driving task. When the driver undertakes many tasks at the same time, it is very easy to have a decrease in the level of attention, resulting in a decrease in driving performance at the same time. Yangkun Ou et al [1], studied the whole process of drivers from environmental perception to judging external traffic information, and finally taking decisions and implementing actions. They also compared the effects of making calls and using the in-vehicle artificial system on attention through experiments. The results show that the loss of attention caused by making calls makes the driver unable to have a complete and accurate understanding of the driving state, and the situational awareness decreases. Decreased driving performance.

At present, the driver's eye movement data collection mainly uses dynamic tracking technology, through image recognition, eye tracker, etc. to collect and record the driver's eye movement and other data for research. As early as 2005, the National Highway Traffic Safety Administration (NHTSA) started the research on the driver's gaze characteristics. They selected different models and conducted real-vehicle experiments on urban roads and highways to form a data set. characteristics are studied. Desmet et al. studied the effect of hands-free phone calls on eye movement patterns while driving, and the results showed that during hands-free phone calls, eyes gazed at road signs, other vehicles, and speedometers for less time, and the spatial distribution of eye gaze was wider. The load generated by distraction will have a great impact on the driver's attention distribution, transfer, reaction speed and short-term memory, which will reduce driving performance and thus affect driving safety. Meanwhile, many scholars have conducted extensive research between visual fixation and distraction tasks [2].

In terms of visual features, many researchers have achieved a series of results in the research on driving distraction and visual attention distribution and transfer. Changes in billboards, gestures, etc. outside the car, and most of the tests are carried out in a driving simulation environment. Most of the real car tests are completed on the highway. The visual attention characteristics of drivers under the influence of cognitive load have not been deeply studied, and the competitive relationship between vision and cognition is not clear enough. Therefore, in view of the problems existing in the current research, in the real vehicle environment on urban roads, the characteristics of visual attention of drivers under different cognitive loads can be studied.

3. EEG characteristics of drivers

EEG is expressed in the form of waves. The frequency range of human EEG signals is 0.5-50Hz, and the amplitude is 5μV-200μV. According to the frequency, there are five waveforms (Delta wave, Theta wave, Alpha wave, Beta wave and Gamma wave.) changes can indirectly reflect the mental activity state of the brain and are closely related to the driving behavior of drivers. Usually when people enter deep sleep mode, the brain will send out Delta waves with a frequency of 0.5-4Hz; when people's mental state is relaxed, they will send out Theta waves with a frequency of 4-8Hz; Alpha waves have a frequency of 8-13Hz. The brain has the most components and is related to human cognition and consciousness; the frequency of Beta waves is 13-30Hz, and the amplitude will rise when people are stressed and nervous. The frequency of Gamma waves is 30-50HZ, which occurs when people are extremely excited, and is related to people's learning ability and cognitive behavior. Numerous studies have demonstrated the effect of mental arithmetic on brain electrical activity.

Many scholars have done research on cognitive tasks. Common mental load tasks include N-back, math problem calculation, Stroop test, etc., and through different signal acquisition, it is proved that EEG has the best effect on the study of human EEG load. Fu Jiahao[3] et al. studied the changes in the brain electrical load of drivers under the combination of cognitive tasks of different difficulty through EEG, and found that different computational difficulties and N-back tasks can induce different levels of mental load. With the increase of mental load, the prefrontal Theta wave increase, the alpha wave weakens. With the development of digital technology, more and more complex systems methods are used to quantify brain function. Entropy is the most commonly used method to measure the complexity of the brain. Based on the entropy parameter, it can reflect the orderly changes of the complex system and study the development trend of the system. Therefore, the entropy theory can be used to evaluate the functional state of the brain. Some scholars have proposed approximate entropy, so that the

algorithm can be calculated in medium samples with a small amount of data, and it can be extended to the analysis of collected physiological signals.
In terms of EEG characteristics, the experimental environment of EEG is mainly based on driving simulation, and the method of data analysis has not changed much; for the research on the influence of cognitive load generated by mathematical calculation on EEG, the main Indoor instrument tests are mostly used for psychological or medical research. As a group prone to cognitive load, drivers have many mysteries in their EEG characteristics. From the point of view of EEG signal processing, since the interference task of the experimental design is known, the EEG activity component associated with the interference event has become the focus of distraction stress research. However, most of the current research focuses on EEG and driving. In the research on the relationship between fatigue, there is a lack of research on different degrees of distraction load, and most of the research focuses on the effects of different frequency bands, and lacks attention to the effects of different brain regions.

4. Cognitive load and driving risk

Drivers operating outside of their primary driving task are considered to produce distractions, and the effects of distraction are referred to as distractive load. Distractive loads are currently classified into four types: cognitive load, visual load, auditory load, and motor load (or physio-mechanical distraction). Visual load and cognitive load are seen as having the most profound impact on driver safety on the road. Visual characteristics can be used to analyze a driver's eye-movement characteristics, and numerous studies have shown that eye-movement metrics can determine the relationship between visual and cognitive load. Cognitive distraction occurs when the driver's cognitive thinking is distracted or attracted by other things, resulting in the driver's inability to correctly identify the road environment and thus cognitive load. Visual distraction is when drivers divert their visual attention to other tasks and do not focus directly on the current road environment beyond a certain time threshold, such as tweeting, using the in-vehicle system, etc., while imposing visual load on the driver. Cognitive tasks (e.g., recall, computation, etc.) are different from visual tasks in that they do not directly occupy the driver's visual perception channel, but they can hinder the brain's ability to further process the perceived information, resulting in a risky state of "seeing is forgetting". Common researches on driving risk under cognitive load mainly include vehicle factors and human factors. The factors of the vehicle include indicators of the vehicle's driving trajectory, lane keeping, lane departure time from the center line, vehicle acceleration, current vehicle speed and headway. Through the analysis of the test in the driving simulator and the research of the real vehicle experiment, it is found that when the driver has cognitive load, the driving speed of the vehicle will gradually decrease, the headway will be gradually increased, and sometimes there will be an emergency. Acceleration, rapid deceleration, etc[4]. Through a real driving test, Flumeri et al[5]. recorded the EEG activities of drivers during peak and off-peak periods respectively, and analyzed the driving safety under different workloads. accident risk.
In terms of the impact of cognitive load and driving safety, many studies have shown that cognitive load will have an impact on driving safety, but in the selection process of indicators, only one or more of vehicle factors or eye movement factors are usually considered. Electricity-related factors influence research. One of the important reasons is that the EEG transmits the characteristics of the driver in the form of signals. Even if the characteristics of the time domain and frequency domain are analyzed, it is difficult to directly judge the driving safety through the numerical value like the eye movement index. The regular features it shows are all recessive and need to be quantified in a certain way, so that the physiological characteristics of the driver can be directly determined from the numerical value.

5. Driving risk identification method

Driving risk identification methods mainly include: fuzzy comprehensive evaluation method, fault tree analysis method, Bayesian network method, BP neural network method, Monte Carlo simulation method, hidden Markov method, etc.

Fuzzy comprehensive assessment method is an application method that embeds fuzzy set theory into risk identification and assessment. At the same time, its limitations are also very prominent, that is, the interaction of risk assessment indicators must be defined, otherwise the accuracy of risk assessment results will be affected. Fault tree analysis is an evaluation method of systematic logic deduction and one of the main methods of driving risk identification. The fault tree method is a kind of graphic method, which finds out the real cause of the risk accident through logical reasoning. The fault tree method can identify whether the system is dangerous or not, and can be applied to both qualitative analysis of accidents and quantitative processing. Its disadvantage is that the accuracy of the probability of occurrence of a specific event will directly affect the results of risk identification, and the fault tree evaluation method has limitations in modeling complex systems. Tecalo method is a method that takes probability as the research object, calculates statistical results by sampling survey and makes reasonable inferences on unknown characteristics, and is suitable for computer simulation experiments of discrete systems. BP neural network is a multi-layer feed-forward network that propagates and trains along the error backward, and the research on the basic theory of the network and the performance of the network is very mature. Its advantage is that the nonlinear mapping ability is strong, and the network structure is more flexible. Its limitation is that the learning speed is slow. Even a very simple problem generally requires hundreds of iterations to converge, and the network promotion ability of the BP neural network is limited [6, 7].

In terms of driving risk identification methods, the current research has mainly carried out a lot of research from two aspects: the conflict risk between vehicles and the driving risk caused by the driver's behavior. The conflict risk between vehicles is mainly studied from the following aspects, overtaking, lane changing, etc. The intelligent driver model can study the car-following behavior through parameter calibration, but if the default value is used, it will cause the maximum deceleration value. Excessive phenomenon requires strict calibration of parameters. The ultimate goal of driver model research is to make the model fit the real traffic characteristics at both the micro and macro levels. In the model of driving risk identification, most of the current research considers eye movement and vehicle operation risk factors, and rarely combines the characteristics of EEG. At present, EEG technology is developing rapidly, and the equipment for collecting EEG is also becoming more and more advanced. Taking EEG indicators as a factor to identify driving risks will increase reliability, which is important for improving urban road safety and improving the transportation environment. Theoretical significance and application prospects.

5. Conclusion

Therefore, on the basis of the above studies, we can analyze the characteristics of visual fixation and transfer, the time-frequency and spectral characteristics of EEG signals of drivers under different cognitive loads, and obtain the attention index and relaxation index through the deep learning network. In this way, the direct quantification of the driver's state based on EEG signals is realized, and finally, the conflict risk between vehicles and the driving risk of the vehicle based on the driver's characteristics are comprehensively identified, which makes beneficial contributions to improving the driving assistance system and driving safety.

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