Retraction

Retraction: Driving Behavior Based on Big Data Analysis and EEG Data Analysis (J. Phys.: Conf. Ser. 2066 012096)

Published 9 September 2022

This article has been retracted by IOP Publishing following an allegation that raises concerns this article may have been created, manipulated, and/or sold by a commercial entity. In addition, IOP Publishing has seen no evidence that reliable peer review was conducted on this article, despite the clear standards expected of and communicated to conference organisers.

The authors of the article have been given opportunity to present evidence that they were the original and genuine creators of the work, however at the time of publication of this notice, IOP Publishing has not received any response. IOP Publishing has analysed the article and agrees there are enough indicators to cause serious doubts over the legitimacy of the work and agree this article should be retracted. The authors are encouraged to contact IOP Publishing Limited if they have any comments on this retraction.

Retraction published: 9 September 2022
Driving Behavior Based on Big Data Analysis and EEG Data Analysis

Tao Zhang¹,², Wang Hong¹,*
¹College of Mechanical Engineering and Automation, Northeastern University, Shenyang, Liaoning, China
²College of Applied Technology, Shenyang University, Shenyang, Liaoning, China

*Corresponding author e-mail: hongwang1@neu.edu.cn

Abstract. In recent years, as the number of automobiles in my country has increased year by year, the number of automobile accidents and casualties and the direct economic losses caused by them are very high. How to improve the level of road safety has become an important research content in the field of transportation. Driving a car is a complex activity involving perception, judgment, decision-making and manipulation, and requires the brain to coordinate and guide the driver's driving functions. EEG signals can reflect the driver's psychophysiological state, and then represent the driver's perception activities. The application of EEG data analysis in driving behavior research explains the mechanism of driving behavior from a new perspective of cognitive neuroscience and brings new solutions to traffic safety problems. Driving behavior research is the main research content in the field of road safety. Recognizing and predicting the state of driving behavior is very important for the development of intelligent driving assistance systems and the improvement of road safety. This paper analyzes the EEG data while driving based on big data analysis. Firstly, the literature research method is used to summarize the EEG data analysis process and the research significance, and then the driver's EEG data is analyzed and researched through simulated driving experiments. The relationship between its parameters and driving behavior. Experimental results show that the front area and buffer area have a strong correlation with all variables of driving behavior, especially the correlation with acceleration and forward time is about 35%. In addition, compared with other driving behavior variables, time zone has the strongest correlation with speed, about 56%. Approximately 46% of the samples are beta waves that are significantly related to driving behavior. In addition, alpha waves account for about 20% of the total number of samples, while the correlation between delta waves and driving behavior is the weakest, accounting for only about 10% of the total number of samples.

Keywords: Big Data, EEG Data, Driving Behavior, Data Analysis
1. Introduction
Nowadays, with the acceleration of economic growth and urbanization, the number of cars is increasing rapidly, and the traffic problems caused by them are becoming more and more serious [1-2]. The frequent occurrence of road traffic accidents has had a serious impact on the current economy and society [3-4]. In recent years, the domestic automobile industry has developed rapidly, and the number of car owners has been increasing every year. As a country with a large population, with the development of economy and society, it has gradually become an important automobile power [5-6]. While the automobile industry promotes social and economic development and improves people's lives, it also brings unavoidable traffic safety problems, which in turn causes property and financial losses [7-8].

In the research of driving behavior based on big data analysis and EEG data analysis, many scholars have conducted research on it and achieved good results. For example, Yang Y conducted a series of studies on detachable driving with numerical problems and the sudden lane change of the previous car as an interference event. The research results show that the driver’s cognitive distraction is closely related to the power changes of frontal wave θ and β wave, and the power increase of frontal wave θ reflects the degree of cognitive distraction. On this basis, the automatic feature mapping model is used to further analyze the EEG changes under a single interference event and a double interference event, and it is concluded that there are significant differences between the two kinds of brain electrical activity changes, which will give guidance. There are different treatment methods in dual intervention events. Finally, a BCI system for EEG-based detachable driving is proposed. The system uses EEG to determine the driver's attention state with an accuracy of up to 89% [9]. In addition, addition to arithmetic problem interference events and other supplementary decision interference events, after research, Lyu N concluded that the right anterior part of the frontal lobe of the brain can be used as a spatial position marker to detect interference, and the right anterior side of the frontal lobe of the brain can be used Mark the space position to detect interference and distraction [10].

This paper analyzes the EEG data while driving based on big data analysis. First, the literature research method is used to summarize the EEG data analysis process and the research significance, and then the driver’s EEG data is analyzed and researched through simulated driving experiments. The relationship between its parameters and driving behavior.

2. EEG data analysis and driving behavior research

2.1. Research methods
(1) Literature research method
The literature research method mainly refers to the scholars obtaining research data through the books, newspapers, magazines, electronic reading materials, etc. that they consulted in a broad sense, so as to generate research inspiration. Its advantage is that we can understand the change and development history of the research object from our own origin, and understand the change status of the research object. Through the comparison with the data, we can make a more comprehensive understanding of the object we want to study.

(2) Qualitative analysis method
Qualitative analysis refers to quantitative analysis. Quantitative analysis refers to the determination of mathematical assumptions, data collection, analysis and testing.

Qualitative analysis refers to the qualitative analysis of the research object. It refers to the process of conducting research based on subjective understanding and qualitative analysis, through research and bibliographic analysis.

2.2. The process of EEG data analysis
(1) Acquisition of EEG signals
The EEG or EEG signal is received through the brain-interface. The brain-computer interface is a device that connects the brain and the outside to transmit information.

(2) Signal preprocessing
Since the EEG signal is a non-static signal, and the EEG signal will be disturbed during the acquisition process, there will be a lot of noise and artifacts in the collected EEG record, which will affect the quality of the EEG record. Therefore, the preprocessor should eliminate this interference signal as much as possible without losing useful information and reducing the impact on the feature extraction step.

(3) Feature extraction
After the preprocessing step, a relatively clear EEG signal can be obtained. However, due to the large amount of data and the large grid size of the usual EEG signal, it is difficult to directly use it for analysis, so feature extraction is required.

(4) Classification
After the attributes are derived, different classifiers are used to classify the signal into different categories for analysis and prediction.

2.3. Significance of driving behavior research on EEG data analysis
(1) Cluster analysis
Given that the observation set \( X = \{x_i\}, \ i=1,2,...n \), where each observation value is a d-dimensional real vector, k-means clustering is to divide the n observation values of the observation set \( X \) into the k set \( C = \{c_i\}, \ k=1,2,...k \), and kSn, make the sum of squares in the group the smallest, \( \mu_k \) be the mean value of \( c_i \), then the variance of each sample data and the mean value in each category is defined as:

\[
J(c_k) = \sum_{x_i \in c_k} \|x_i - \mu_k\|^2
\]

The goal of this algorithm is to minimize the variance of all K categories

\[
J(c) = \sum_{k=1}^{K} \sum_{x_i \in c_k} \|x_i - \mu_k\|^2
\]

(2) Conventional filtering algorithm
Median filtering is often used in time domain filtering, which can suppress random noise. Therefore, this paper uses a medium to smooth and filter the initial data collected by the three-axis accelerometer. The specific expression of the filter medium is

\[
x(k) = \frac{1}{m} \sum_{i=0}^{m-1} x_{k-i}
\]

Among them: \( m \) represents the size of the sliding filter window, \( X \) represents the value of the initial collection point

3. Driving behavior experiment based on EEG data analysis based on big data analysis

3.1. The purpose of the experiment
Using EEG feature parameters extracted from EEG equipment, the relationship between the derived data and driving behavior is studied to quantify the driver’s emotions. The electrode distribution method is used to divide the number of characteristic EEG into different areas of the brain (frontal lobe, parietal lobe, occipital bone, and temporal lobe regions), while Pearson correlation analysis is used to study the brain regions most relevant to driving behavior and behavior. EEG regions and feature quantities that are more related to behavior, and driving behavior parameters that are more related to EEG changes. Finally, the combination of these three analysis results further clarified the relationship between EEG parameters and driving behavior, thereby revealing the relevant mechanism between brain activity and driving behavior.
3.2. Experimental design
Create semi-realistic experimental scenes in the driving simulation environment, use driving simulators, EEG acquisition equipment and independent component analysis methods to prepare EEG variables, and extract key driving behavior variables and behavior analysis from the main driver.

3.3. Data preprocessing
Data preprocessing mainly includes partial data standardization, three-axis acceleration routine filtering and motion acceleration correction. The purpose of data standardization is to standardize the data unit to facilitate the detection of driving behavior and the calculation of the rated model of driving behavior; the conventional three-axis acceleration filter is to overcome the impact of the collected vehicle engine turbulence and collision motion filter data, movement acceleration correction is used to eliminate the influence of gravity component when the vehicle is inclined or super high corners.

4. Data analysis

4.1. Correlation analysis based on brain regions
This article uses experiments to study the distribution of brain regions most closely related to specific driving behaviors. The experimental results are shown in Table 1.

Table 1. The distribution of brain regions most closely related to specific driving behaviors

| Brain area   | Acceleration | Car spacing | Lane offset |
|--------------|--------------|-------------|-------------|
| Frontal area | 30%          | 20%         | 30%         |
| Occipital area | 30%       | 24%         | 34%         |
| Temporal area | 40%        | 56%         | 36%         |

Figure 1. The distribution of brain regions most closely related to specific driving behaviors
It can be seen from Figure 1 that the front area and buffer area have a strong correlation with all variables of driving behavior, especially the correlation with acceleration and forward time is about
In addition, compared with other driving behavior variables, time zone has the strongest correlation with speed, about 56%.

4.2. Analysis based on the frequency band of brain waves and the characteristic parameters of brain waves

In this paper, through experiments, different brainwave frequency bands contain different brain activity states, which are closely related to human psychophysiological activities. The experimental results are shown in Table 2

Table 2. Frequency distribution of brainwave frequency bands related to driving behavior

| Frequency band | overtake | Speeding | Lane change |
|----------------|----------|----------|-------------|
| alpha wave     | 23%      | 24%      | 20%         |
| beta wave      | 45%      | 48%      | 46%         |
| delta wave     | 12%      | 10%      | 11%         |
| theta wave     | 20%      | 18%      | 23%         |

It can be seen from Figure 2 that the results show that about 46% of the samples are β waves that are significantly related to driving behavior. In addition, alpha waves account for about 20% of the total number of samples, while the correlation between delta waves and driving behavior is the weakest, accounting for only about 10% of the total number of samples.

5. Conclusion

Driving behavior research is the main research content in the field of road safety. Recognizing and predicting driving behavior is essential for developing intelligent driving assistance systems and improving road safety. This article uses driving simulation experiments to collect driver EEG data and driving behavior data at the same time. With the help of cognitive neuroscience and machine learning knowledge, we have deeply studied the characteristics of micro-driving behavior, the correlation between the driver's brain electrical activity and driving behavior, and the recognition and prediction of driving behavior. This paper conducts driving simulation experimental research, and the research results show: (1) Under normal driving conditions, the frontal, parietal, occipital and temporal lobes
of the brain are all involved in driving activities. (2) The logarithm of \( \beta \) wave and \( \beta \) wave power is significantly related to driving behavior. (3) Acceleration and speed are the most typical characteristic quantities of driving behavior with brain perception.

References

[1] Yang L, Guan W, Ma R, et al. Comparison among driving state prediction models for car-following condition based on EEG and driving features[J]. Accident Analysis & Prevention, 2019, 133(Dec.):105296.1-105296.7.

[2] Zhao J, Zhu C, Huang Y. Network consumption demand analysis and structure optimization based on big data[J]. Journal of Physics: Conference Series, 2021, 1800(1):012013 (9pp).

[3] Tanaka T, Fujikake K, Yonekawa T, et al. Study on Driver Agent Based on Analysis of Driving Instruction Data — Driver Agent for Encouraging Safe Driving Behavior (1) —[J]. Ieice Transactions on Information & Systems, 2018, 101(5):1401-1409.

[4] Zhao Y, Yamamoto T, Morikawa T. An analysis on older driver's driving behavior by GPS tracking data: Road selection, left/right turn, and driving speed[J]. Journal of Traffic & Transportation Engineering, 2018, v.5;No.25(01):62-71.

[5] Xiao F, Song B, Liu K, et al. Analysis and Research Based on Method of Questionnaire Survey and the Algorithm of Big Data Analysis[J]. Journal of Physics: Conference Series, 2021, 1813(1):012040 (6pp)

[6] Zheng Y, Shen L, Zhou Y. Analysis of students' consumption and learning behavior based on the big data of campus card[J]. Revista de la Facultad de Ingenieria, 2017, 32(3):191-200.

[7] Wei G, Liu Y, Jiang S X, et al. Review on the Application of EEG in Traffic Driving Behavior Study[J]. journal of transportation systems engineering & information technology, 2016, 16(3):35-44.

[8] Yu-cheng, Zhao, Jun, et al. Driving rule extraction based on cognitive behavior analysis[J]. Journal of Central South University, 2020, 27(1):164-179.

[9] Yang Y, J Yan, J Guo, et al. Driving Behavior Analysis of City Buses Based on Real-Time GNSS Traces and Road Information[J]. Sensors, 2021, 21(3):687.

[10] Lyu N, Cao Y, Wu C, et al. Driving behavior and safety analysis at OSMS section for merged, one-way freeway based on simulated driving safety analysis of driving behaviour[J]. PLoS ONE, 2020, 15(2):228-238.