The design of the virtual driving experiment platform based on EEG

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Abstract: With the growing popularity of the car, the safety and comfort of car is becoming more and more important. By studying the driver while driving the overall changes in brain waves can analyze different scenarios, weather, chairs, road conditions, the influence of such variables to the driver it also become a research hotspot currently. In this paper, one type of Virtual driving system was designed for research of driver's EEG. This system is composed by virtual driving, EEG acquisition, EEG analysis modules. It can be used to record the driver's EEG under different driving conditions, at the same time there is a real-time analysis and processing in the system, and then the identification results feedback back to the system.

Introduction

As the growth of the economy and the continuous improvement of residents' living standard, car ownership in China also swelling, car traffic safety problem increasingly because the attention of people. How to prevent and reduce traffic accidents, scientists has become an active research topic, main research direction for ahead of time so as to prevent or reduce damage. Now at home and abroad to study is more vehicle warning device, such as installed in the car radar, cameras, or other sensing equipment state monitoring vehicles, or monitoring cars and roads or other objects and the location of the relationship, analysis to judge the possibility of conditions.

Car drivers is people - car - one of the most important factors in the three elements of environment, is one of the biggest factors of traffic accident hidden danger. The driver as subjective person, his driving, driving experience, emotional state, will affect his driving process. So by monitoring the driver's various parameters to reflect the current driving situation and take advantage of and control is a feasible way to reduce the number of traffic accidents. Fatigue driving has always been one of the main factors of traffic accident, when the driver fatigue, the pilot of the attention of the external environment will reduce the ability and the reaction ability, which may cause accidents, therefore, how to monitor whether the driver is in a state of fatigue is an important issue worth studying. By collecting the driver's brain waves to analyze the fatigue and comfort index can understand the influence of different driving conditions to driver, can improve the comfort and fatigue early warning method to improve the safety of motorists.

System Architecture

The Architecture diagram of the virtual driving experiment platform based on EEG is shown in Fig. 1, which includes five units: 1)subject and dedicated EEG cap; 2)the adjustable driver's seat; 3)signal acquisition and amplification unit; 4)signal processing computer; 5)three screen splicing display. The five units and driver constitute a complete data chain.

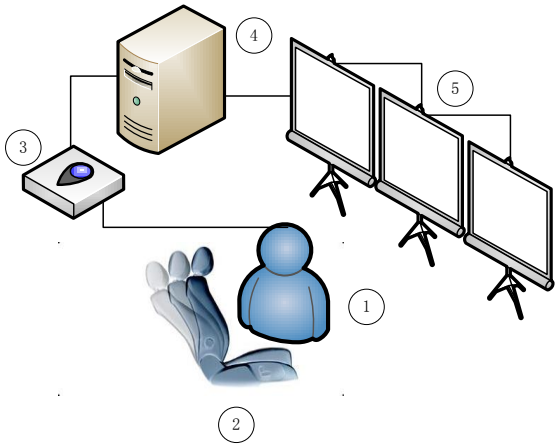

Figure 1. Architecture of virtual driving experiment platform

There are four steps in this data cycle. 1) Human's driving activity and adjustment of the seat will make the changes in cortical potentials. This change can be acquisition by The EEG cap which can acquire this change by high sensitivity electrode. This signal is send to Signal acquisition and amplification unit by data cable of EEG cap. The device supports 8 analog input channels digitized at 16 bit resolution and sampled at a fixed 256 Hz sampling rate. 2) By Signal acquisition and amplification unit, the original signal is transform to formatted data like a huge data matrix. Signal processing computer take the data matrix for signal analysis and pattern recognition, the computer will store the recognition results and send to virtual driving system. The virtual driving system will get feedback and then displayed it in three screen splicing display.

System Analysis

One of the most important UML diagrams is activity diagram. Activity diagrams are used to model the behaviors of a system, and the way in which these behaviors are related in an overall flow of the system. The following figure 2 is the activity diagram of virtual driving experiment platform:

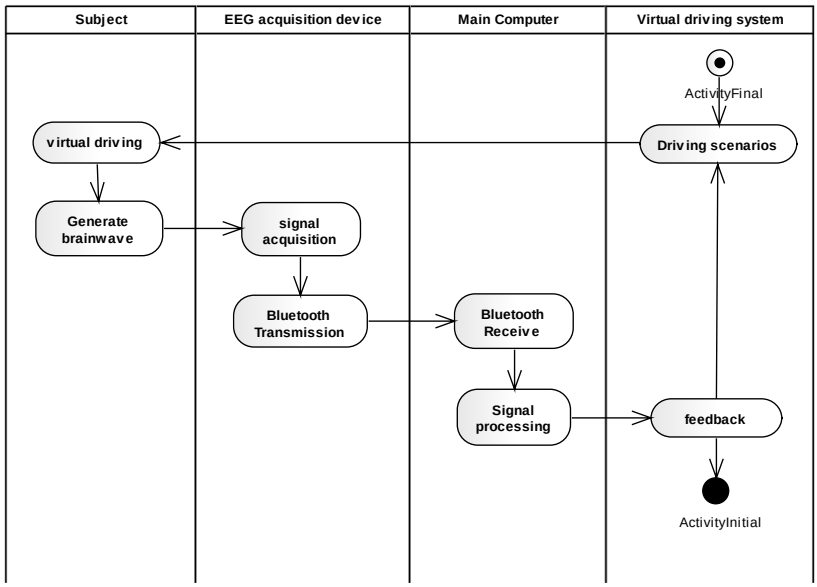

Figure 2. Use case diagram of electric car BCI System

As figure 2 shows, there are four activity partition, Subject, EEG acquisition device, Main Computer and Virtual driving system. Virtual driving system first scene, can produce all kinds of driving in the process of virtual driving will be Subject different scenario induced by the various characteristics of brain waves. After collecting the EEG signals, EEG acquisition device package and send data to Main Computer via Bluetooth. Main Computer make get processing results after receiving data via Bluetooth, and then stores the result and feedback to Virtual driving system at the same time. The signal processing procedure has a sub activity.

The system received the formatted EEG data sent from acquisition module. And then through four steps such as signal preprocessing, feature extraction, feature selection, classification. If certain classification results were obtained the system will send signals to the controller, or to give up the analysis results, continue to the next data analysis.

System Design

In the experiment, we through the adjustable seat to study the effect of comfort of brain waves. The following figure 3 is the map of adjustable seat:

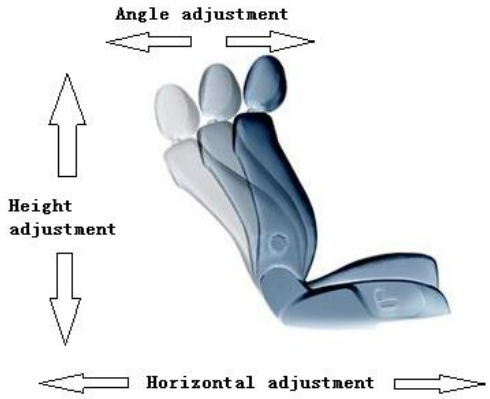

Figure 3. Adjustable seat

As can be seen from the figure 3, the driver's seat can make horizontal adjustment, height adjustment and Angle adjustment. By the three dimensions of variables influence on brain electrical signal, we can study a different seat position of driver fatigue and comfort features such as manageability which makes the adjustment of seat and the auto makers for the driver's seat design have very practical significance. The figure 4 is a virtual drive system operating interface.

Figure 4. Architecture of electric car BCI System

There is a virtual drive system operating interface in the figure, the above of figure is the road and the surrounding environment, the top is the main rearview mirror image, on both sides of the rearview mirror image below. At the bottom of the steering wheel and the control panel, there is a variety of dashboard display with the related parameters in the process of the vehicle.

Discussion

By adjusting the parameters of driving simulation experiment platform, the system can analyze the influence of various parameters on the driver and the EEG relevance. Such as doze to the driving influence which can let a bit of a sleepy subjects operating software. There may be some problems, such as the brake is not timely, accuracy is not enough, a lane change speed is not good, and so on. The synchronization of the EEG changes associated. Of course, the external environment influence on the subjects, such as rain, slippery, suddenly the obstacles, picturesque, etc., which can also be used to simulate the system.

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References

[1]G. Pfurtscheller, C. Guger, G. Müller, G. Krausz, and C. Neuper, Brain oscillations control hand orthosis in a tetraplegic,“ Neurosci. Lett., vol. 292, pp. 211-214, 2000..

[2]Ince N.F., Arica S., Tewfik A., “Classification of single trial motor imagery EEG recordings with subject adapted nondyadi arbitrary time-frequency tilings,” J Neural Eng, Vol. 3, pp. 235-244, 2006.

[3]Jianfeng Hu,Dan Xiao,Zhendong Mu. Application of Energy Entropy in Motor Imagery EEG Classification. International Journal of Digital Content Technology and its Applications,2009,3(2)：83-90

[4]RAMOSER H，MULLER-GERKING J，PFURTSCHELLER G. Optimal spatial filtering of single trial EEG during imagined hand movement[J]. IEEE Transaction son Rehabilitation Engineering. 2000. 8(4)：441-446

[5]KRAJEWSKIJ,SOMMERD,TRUTSCHELU,etal. Steering wheel behavior base destimation off atigue[C]. Proceedings of the 5th International Driving Symposiumon Human Factorsin Driver Assessment，Training and Vehicle Design，2009：118-124.