Study on EEG Control Vehicle

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Abstract

The emergence of brain-computer interface technology is to spy out the mysteries of the brain is the most direct and effective method, is also a very challenging study at the same time, it provides - a brain direct channels of communication with the outside world, has extremely important realistic meaning and are of great application value, this paper applied the technology design of brain-computer interface system based on motion imagine eeg signals, The intelligent vehicle is discussed and studied as the controlled object. In this paper, the concept of brainwave is briefly introduced, the composition of the brain computer interface system is systematically analyzed, the function of each component module is explained, and the theoretical and practical application value of this technology research is clarified. The eeg data is collected by the eeg sensor, and then the bluetooth 2.0 technology is used to send the data to the microcontroller to analyze the current state of the user's brain activity, and then it is converted into action instructions to realize the control of the car model, so as to complete the idea of controlling the car movement by mind. Then the data are collected, processed and analyzed to obtain the experimental results.

Keywords

Brain Wave, BRAIN Computer Interface, Bluetooth, Microcontroller.

1. Introduction

The human brain generates its own electrical waves as it works, and by monitoring these signals, we can detect brain activity and learn about the brain's potential to achieve great things such as knowledge. Eeg products based on eeg signal acquisition and detection analysis can not only be used for brain health training (including concentration training, brain relaxation in anxiety state, etc.), but also give users a brand new entertainment experience.

According to the understanding of brainwave, the intelligent car system based on brainwave signal control is designed and developed. Mindband brainwave sensor is used to collect brainwave data, and the data is introduced into technology processing through internal Think Gear chip. Data is transmitted through Bluetooth, and data packets are analyzed and extracted by MSP430 microcontroller. Finally, the stable and effective control of smart car is achieved with high quality.

2. Brain Wave Resolution

By exploring the brain in different stages of the brain wave changes, with the brain wave sensor to identify and process the brain wave signal, and eliminate the interference of the external environment, extraction and use of brain wave. In this design, Neuro Sky's headband is used to process and output

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three parameters, namely EEG frequency spectrum, eeg quality and original EEG data, to collect data. Studies have found that blinking signals are relatively easy to identify. The brainwave data collected by the sensor is sent to the main processor through Bluetooth 2.0 to analyze the sensor data, analyze the current state of the user's brain, and then convert it into the next command, so as to complete the control of the smart car's movement function.

3. Brain Computer Interface Performance Test

3.1 SSVEP Experiment

In order to test the quality of the collected signal of SSVEP experiment in the system, the experimenter blinks and smiles to observe whether the signal acquisition is good.

In the test, subjects need to concentrate, imagine smiling and blinking, and make actions.

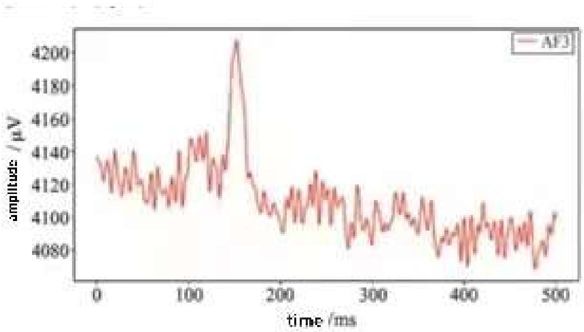

Figure 1. Blink signal diagram at a certain time

Wavelet transform can reduce noise and extract useful signals. The formula of wavelet is:

$$WT(\alpha,\tau) = \frac{1}{\sqrt{\alpha}}\int_{-\infty}^{+\infty} f(t) \times \Psi\left(\frac{t-\tau}{\alpha}\right)dt$$

$$\begin{aligned} DWTx(\alpha,\tau) &= \langle x(n), \Psi_{\alpha,\tau}(n) \rangle \\ &= 2^{-\frac{\alpha}{2}}\int_{-\infty}^{+\infty} x(n) \times \Psi(2^{-\alpha}n - \tau)dt \end{aligned}$$

The scale parameter and the shift are discretized. In the process of processing the signal, the signal is decomposed into the signal as shown in the figure to obtain the characteristic signal points:

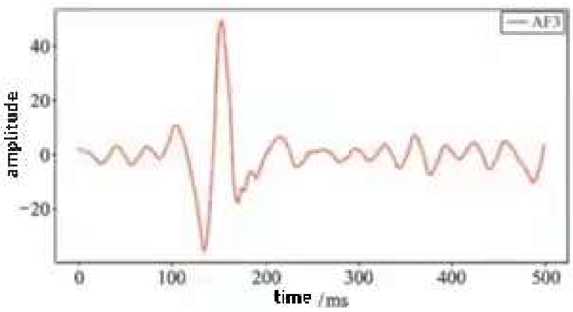

Figure 2. Processed waveform pattern

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3.2 Data Preprocessing

Because the collected EEG signals generally contain background noise such as eye electricity, electromyography and power frequency clutter, in order to reduce the background noise of EEG signals and improve the signal-to-noise ratio, the following preprocessing process is carried out for EEG data.

(1) Take the mean value.

(2) 8 ~ 30 Hz bandpass filtering. In the process of two-way motor imagination, it is mainly EEG signals μ Rhythm (8 ~ 13Hz) and β The rhythm (14 ~ 30 Hz) changes, so 8 ~ 30 Hz band-pass filtering is performed on EEG signals.

(3) Normalization. Normalize the original data so that the sample value of EEG data is between [0,1].

3.2.1 Transform Denoising

Wavelet transform can decompose the spectrum of the signal into different frequency bands, and then concentrate the energy of the signal on several coefficients in some frequency bands. By setting the coefficients decomposed in other frequency bands to zero or giving small weights, it can better suppress the noise.

Wavelet transform is defined as a given basic function ψ (t):

$$\psi_{a,b}(t) = \frac{1}{\sqrt{a}}\psi\left(\frac{t-b}{a}\right)$$

Where a and B are constants, and a > 0. ψ a. B (T) is the basic function ψ (T) functions obtained after translation and scaling.

3.2.2 Short Time Fourier Transform

In order to understand the time-frequency information of EEG signals, short-time Fourier transform is used to process EEG signals, which makes up for the lack of time-domain positioning function of traditional Fourier transform. The image of the original data in the time domain is shown in Figure. 3, and the image of the transformed data in the frequency domain is shown in Figure. 4.

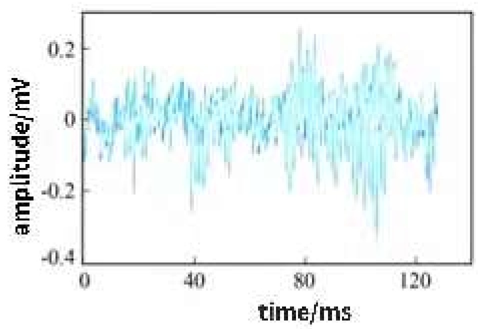

Figure 3. Time

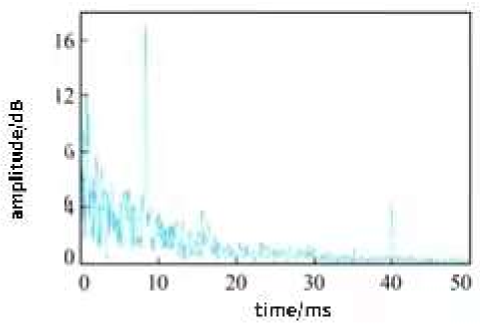

Figure 4. Rate

3.3 Data Acqusition

Mindband EEG sensor exists in the form of data packet in the process of data acquisition [4]. The think gear packet format consists of three parts, which can be expressed as: [1] packet header; [2]Information payload; [3]Valid data checksum.

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[SYNC] [SYNC] [PLENGTH] [PAYLOAD...] [CHKSUM]

~~~~~~ (Header)~~~~~~ ~ (Payload) ~ ~ (Checksum) ~

3.4 Data Parameter Setting

Neuro sky think gear technology integrates the functions of EEG signal acquisition, filtering, amplification, A / D conversion, data processing and analysis into an ASIC chip, and outputs e-Sense parameters (including "concentration" and "Relaxation" and other parameters) and original EEG data through standard interfaces, which highly simplifies and speeds up the process of EEG acquisition, processing and analysis, The cost of EEG application is reduced.

The e sense parameter represents the user's concentration level and relaxation level with a specific value between 1 and 100.

Table 1. Concentration and relaxation level

E sense parameter value	In state
1-20	Low value area
20-40	Lower value area
40-60	"Baseline" (normal range) of EEG measurement
60-80	A state of relaxation and high concentration
80-100	Concentration and relaxation reach a very high level

3.5 Data Acquisition and Analysis

The system was applied to different subjects for many experiments. The training scheme was set to do blinking and smiling once each as a group, 10 groups, with an interval of 3min. The interval was the relaxation time of the subjects. The test training was carried out in a quiet environment.

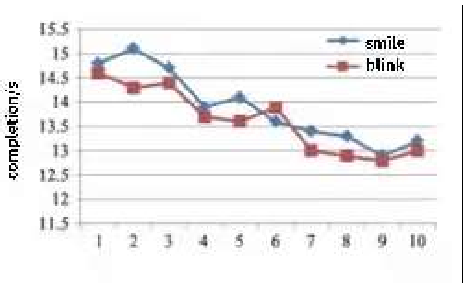

Figure 5. Frequency

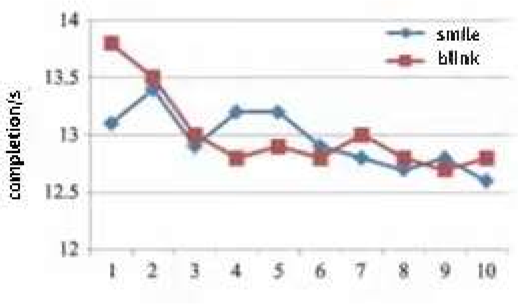

Figure 6. Frequency
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Through the test, it is found that the test results are related to whether the equipment is in good contact and whether the environment is quiet.

3.6 Experimental Result

Table 2. Result

Experimenter	Number of commands issued	Correct number of executions	Accuracy/%
A	10	10	100
B	15	12	80
C	15	12	80
D	16	14	88
E	25	21	94

Acknowledgments

Thank my teacher very much for his guidance, solving problems and pointing out the direction. This is a field I'm not very good at, but I believe that under your leadership, we can all realize our value here and find the most suitable way for ourselves!

In view of my limited ability, the research and application of EEG can only be described based on basic practice. There are still many deficiencies. In the future, I will work harder to make up for my vacancy in this field in continuous practice and learning.

Finally, thank you again!

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