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Study on Brain Matching Based on Mobile Platform

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Abstract

Objective: The purpose is to acquire EEG signals through an external device, the EEG analysis, calculation of EEG matching values, through calculation and analysis of mobile platform, to provide users with the corresponding help. Method: Three Theory of Feature Extraction are applied to the Brain Matching, that is Short FuLiye Transform Method, Second-Order Blind Identification Method, Phase Synchronization. Conclusion: By moving the platform for EEG, calculate and output, obtain evoked EEG evoked by system design, and the design of EEG feature calculation method, calculated the different match EEG matching values, depending on the application, provide assistance to user, and through the calculation of EEG signal to the user, especially the application of help, friends, compared with other tools more in line with the essential characteristics of the user himself, more authenticity.

Keywords: *Brain Matching, EEG (electroencephalogram), Brain Computer Interface (BCI)*

1. Introduction

The EEG [1-10] analysis shows, people in the face of love, be familiar with and interested in things, EEG is generated by comparing those doesn't love, not familiar with or are not interested in the EEG, will find a lot of stable and significant differences, through the analysis to determine these differences, to decide whether the object of love, familiar things or interest.

Legends of the fall in love at first sight is really exist, whether everybody who has its special temperament? The invention provides a scientific basis from the brain signal analysis on. Today, a variety of social network is popular, dating a variety of methods are emerging, the invention uses the user EEG as a tool to move the platform for the media, from biomedical to whether can and user friends provide scientific basis; at the same time, can also provide a choice of friends and improve your interpersonal relationship, human job match is helpful to users through the EEG matching algorithm.

The BCI system research, after 20 years of development, now has been slowly out of the lab and application oriented. In order to make the process more convenient for people to help motor dysfunction of transplanted mobile platform, the traditional BCI system, it is particularly important to mobile platform, by contrast, have their own characteristics: first, the environment is complex, because it may often appear in public, so more desktop platform BCI, environment is more complex, so BCI system for mobile platform requirements on the environment adaptability. Two, real time, mobile platform BCI system development goal is to help stakeholders real-time living, so BCI system than the desktop on the real-time requirements more strict. Three, the desktop system, mobile BCI system on the accuracy requirement is not so strict. Four, stimulating mode requires

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simple. So the BCI system algorithm and stimulation of the traditional training model can play a certain role, but not the overall transplantation.

2. Stimulating Training Mode

In the event related potential EEG study, stimulating mode is an important means to generate correlated signals. The signal source refers to the signal for analysis of EEG signal, good signal source can play a multiplier effect. The research focused on three aspects: first, how to design the experiment flow induced subjects produce evoked potentials corresponding signal; second, the parameters setting; third, number and location, electrode is more, more complex algorithms, the effect may be better; the electrode is less, the algorithm is simple, the effect may be bad. Design a stimulation model suitable for identity recognition event related potential is one of the research contents of the project.

Stimulation patterns in this study is to imagine a ball movement, in the middle of the screen shows a stationary ball, as shown in the figure, the subjects looked at the ball, with the idea of controlling the ball movement to the left, to the right ball ball movement and motionless respectively corresponding to the three kinds of imagination, imagination, the experiment was divided into three groups, each group experimental data for four minutes of EEG signal, used to do feature extraction of signal source.

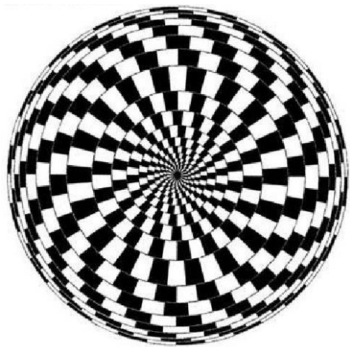

Figure 1. Mode of Stimulation Patterns

3. Data Acquisition

In this experiment, the off-line analysis and feature extraction of data to Scan for EEG acquisition tool, using the standard 10-20 32 under the cap, with bilateral mastoid as reference electrode, the sampling frequency is 1000, by using the 1Hz~70Hz band pass filter, 50Hz notch, acquisition in DC mode. Waveform as follows (figure to imagine with the idea of control of the ball moves to the right)

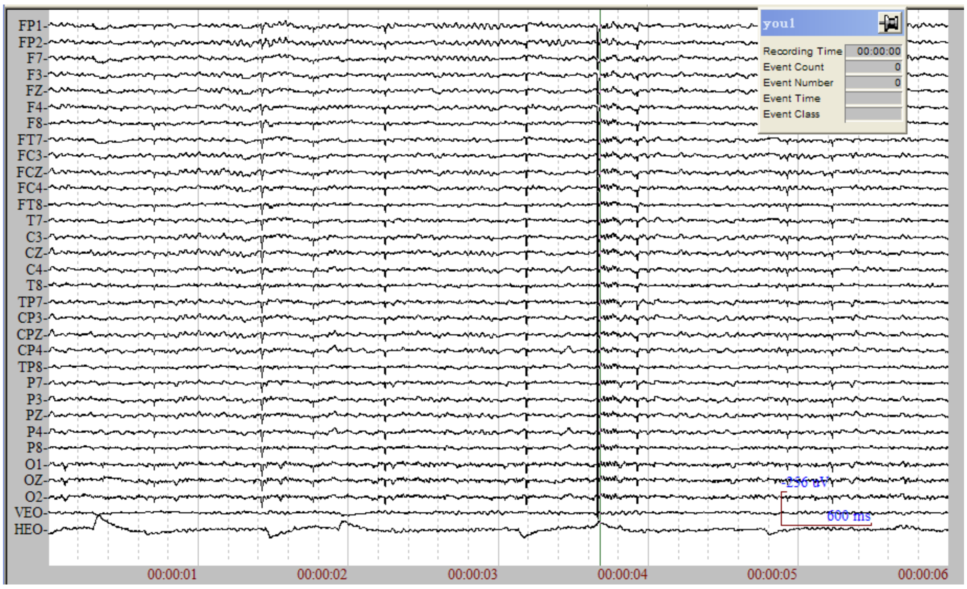

Figure 2. Data Acquisition

4. Theory of Feature Extraction [11-17]

According to the analysis, we draw a conclusion that, control the left and right movement, mainly concentrated in the C3, C4 remarkable characteristic of two electrodes, because want to control the three movement: left, right and real, so in this study, we analyze the object Cz electrode as, do the analysis only for C3, Cz and C4 of three electrodes, though loss in accuracy, but it will improve the efficiency of the algorithm greatly, EEG acquisition is also more convenient to put into practical application. With the data analysis steps are as follows:

1) the interception of data segment: the original data per second (1000 data points) as the time window, each 0.25 (250 data points) to span, C3, Cz and C4 in the three groups of EEG brain electrical signal truncation.

2) filter: EEG signal band to take 1~70Hz, 50Hz notch, in the process of feature analysis, we first performed further filtering, the band is limited to 10~50Hz.

2) time frequency conversion: the original signal is a time-domain signal characteristic is not obvious, in order to extract the features more quickly, we put the time-domain signal is converted to the frequency domain or frequency domain. We use a variety of methods for signal conversion

4.1. Short FuLiye Transform Method

Design for signal analysis, analysis window. Definition of non-stationary signal x (T) of the Fu Liye transform for short time:

$$STFT(t,w) = \int_{-\infty}^{\infty} [x(\tau)g(\tau - t)]e^{-jw\tau} d\tau \tag{1}$$

g is an even function, so the $g(\tau)g(\tau - t)e^{-jw\tau}$ to as the center, along the center, along the span of time does not depend on and, that is:

$$\sigma_t^2 = \int_{-\infty}^{+\infty} (\tau - t)^2 \left|g_{t,w}(\tau)\right| d\tau = \int_{-\infty}^{+\infty} \tau^2 \left|g(\tau)\right| d\tau \tag{2}$$

the frequency domain form continuous short-time Fu Liye transform.According to the character of Fu Liye transform, Fu Liye transform convolution product of two time domain signal is equal to the respective frequency domain, by (1) type available:

$$STFT(t,w) = e^{jwt}\frac{1}{2\pi}\int_{-\infty}^{\infty}\widehat{x}(w')w^{*}(w'-w)e^{-jw'\tau}dw \tag{3}$$

4.2. Second-Order Blind Identification Method

Let x(T) continuous time EEG n column vector corresponding to the N sensors, X(T) brain electrical signal corresponding to the first I sensor. Each x(T) can be seen as a source of n s (T) linear instantaneous mixture, mixing matrix is A, then the

$$x(t) = As(t) \tag{4}$$

SOBI only uses the sensor measured EEG signals of X (T), got close to the A-1 decomposition of matrix W, which makes the

$$\hat{s}(t) = Wx(t) \tag{5}$$

For the continuous time source signal recovery. SOBI algorithm has two steps: firstly, the sensor signal is zero mean, as shown in the following formula:

$$y(t) = B(x(t) - \langle x(t)\rangle) \tag{6}$$

Brackets $\langle\bullet\rangle$ indicate the time average, so the Y zero mean. Value of matrix B makes the correlation matrix Y as a unit matrix $\langle y(t)y(t)^{T}\rangle$, whose value is given by

$$B = diag(\lambda_i^{-1/2})U^{T} \tag{7}$$

For λi is related matrix $\langle (x(t) - \langle x(t)\rangle)(x(t) - \langle x(t)\rangle)^{T}\rangle$ characteristic value U which, in each column is the eigenvector corresponding.

$$R_{\tau} = sym(\langle y(t)y(t+\tau)^{T}\rangle) \tag{8}$$

Among with

$$sym(M) = (M + M^{T})/2 \tag{9}$$

This is an asymmetric matrix into a symmetric matrix of the associated function. The process of symmetrization is missing some information, but provides a valid solution.

Calculation of Rτ, then Rτ is diagonalized: through the rotation matrix V by using iterative method, which makes the

$$\sum_{\tau}\sum_{i\neq j}(V^{T}R_{\tau}V)_{ij}^{2} \tag{10}$$

To obtain the minimum value, estimate the separation matrix.

$$W = V^{T}B \tag{11}$$

4.3. Phase Synchronization

There are many methods to measure the signal of xi(t) and xj(t) between the synchronization method for analysis of synchronization is more common is the classic coherent (consistency) Cohij(f). The coherence function is composed of a signal xi(t) and xj(t) (representing two electrodes i,j) of the cross spectral density function is obtained, which is defined as follows:

$$S_{i,j}(f) = \frac{1}{N}\sum_{n=1}^{N} X_{in}(f) X_{jn}(f) \tag{12}$$

In the formula (12) is xi(t) of the FuLiye transform. Signal xj(t) complex conjugate signal Fu Liye transform. Complex correlation coefficient is the magnitude squared coherence spectrum for the power divided by the square of the cross spectra of two signal spectrum normalization.

$$Coh_{ij}(f) = \frac{\left|S_{ij}(f)\right|^2}{\sqrt{S_{ii}(f) S_{jj}(f)}} \tag{13}$$

Another measure two signals synchronous measurement is PLV (phase locking value phase locking value), this method only consider the phase of the signal.

$$\text{PLV}=\left|\langle \exp(j\{\Phi_i(t) - \Phi_j(t)\})\rangle\right| \tag{14}$$

Here, $\Phi_i(t)$, $\Phi_j(t)$ is the electrode, the instantaneous phase i, j. The calculation of the phase can be achieved by Hilbert transform or complex Gabor wavelet transform. Hilbert transform is adopted here, is described as follows:

$$\tilde{x}_i(t) = \frac{1}{\pi}\,\text{PV}\int_{-\infty}^{\infty} \frac{x_i(\tau)}{t-\tau} d\tau \tag{15}$$

In the type definition, $\Phi_i(t) = \arctan \frac{\tilde{x}_i(t)}{x_i(t)}$ is the time sequence of xi(t) Hilbert transform (here refers to the EEG signal), PV refers to the Cauchy principal value. Then the phase can be calculated as follows:

$$\Phi_i(t) = \arctan \frac{\tilde{x}_i(t)}{x_i(t)} \tag{16}$$

Before the instantaneous phase of each electrode is calculated, the need for the electrode signal band filter, so that it can be instantaneous phase calculation to contain mu band. The following diagram, time domain signal, when using AR transformation to the frequency domain signal as shown in Figure 3.

Set classifier: on EEG characteristics were analyzed, as shown in Figure 4, a linear classifier design.

Four: input, output of EEG signal, according to the step three, the extracted features, and the use of step four, determine the input electrical brain imagination type, output.

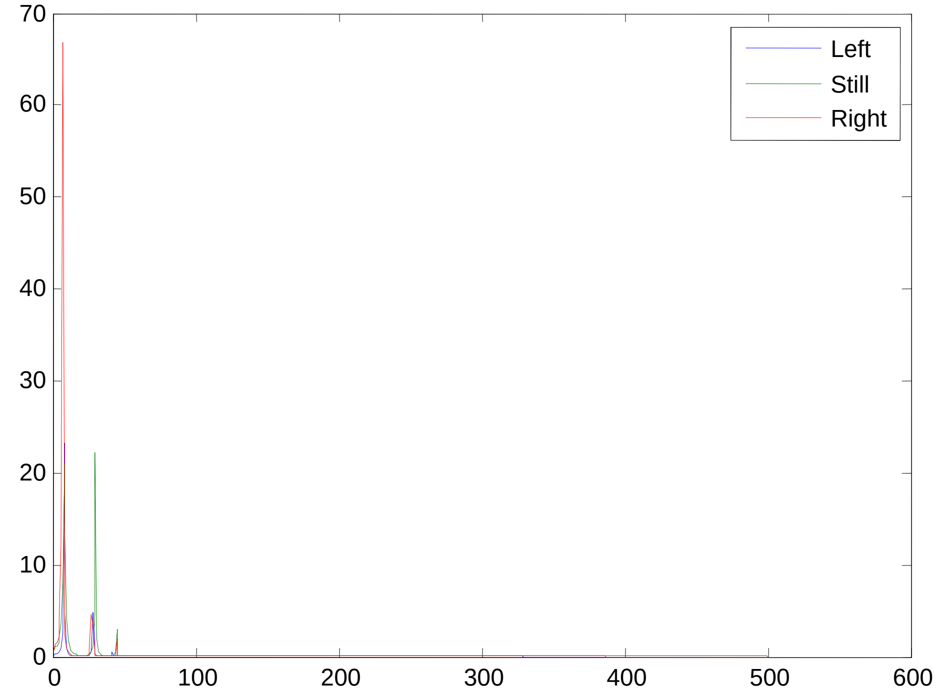

Figure 3. Frequency Signals

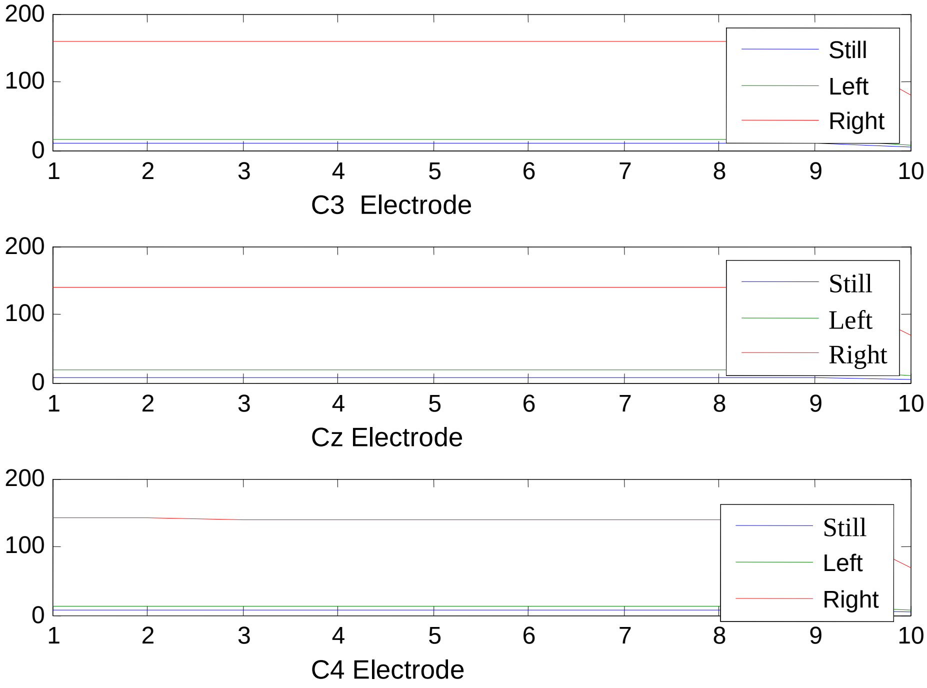

Figure 4. Linear Classifier Design

4.4. Authentication of Offline Data

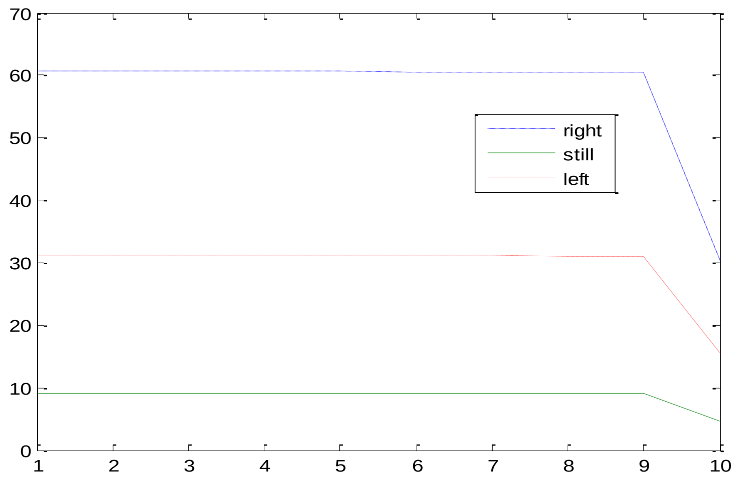

Figure 5. Classification Line of the Learning Sample

The acquisition of EEG data, using this setting method, randomly selected sample of 10 do not move, right movement of 9, the left movement of 5, a total of 24 groups of EEG data as learning samples after time-frequency transform and feature extraction, the calculated three kind boundary as shown in Figure 5 (C3 very characteristics of EEG classification line), on three groups of EEG data collected, with 1000 for windows, 300 span, off-line data validation, test results table 1 (with 200 groups of EEG data as the test sample)

5. Discussion

a. Study biological recognition problem has important application background in a new way. The traditional biological recognition methods, such as fingerprints, iris, there is no high and easy to counterfeit the shortcomings such as the recognition rate, the time evoked EEG signals based on signal as source of biological recognition have innovation in 2 aspects: first, has not yet appeared in biological recognition method at present; second, event-related EEG has its nerve the psychological basis, pioneered research ideas for identification from cognitive psychology perspective.

b. The biological recognition process consists of authentication, identification and monitoring of three kinds of mode, expand the use of biometric identification technology based on EEG, broad application prospects.

c. Extracted from the personal characteristics of event-related EEG signal, to three kinds of mode identification, the introduction and design in different ways, to the method is a new.

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