Fatigue Detection Method based on Common Spatial Subspace Decomposition

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Abstract: Fatigue has been a common problem in modern society, it is constantly eroding the people's health, and there is not an effective method for fatigue testing. Based on the brain waves are analyzed using methods Common Spatial Subspace Decomposition fatigue analysis to determine a clear value as a reference, other acquisition of EEG and the extent of this reference comparison, the final calculation of fatigue, by people at different times of monitoring, data showed that the extent of the reaction can be human fatigue to some extent.

Introduction

With the quickening pace of society, people's living standards continue to improve at the same time, people's health status is increasingly worse, there is fatigue in one of the factors affecting people's health, often seen on the internet, there's a young staff due to fatigue died, but people do not have a valid means to monitor the person's fatigue.

With the in-depth study of EEG, more and more research shows that by monitoring brain waves can be detected by human fatigue, but this research study were performed in the laboratory of a state, how to detect fatigue and displayed in the form of value, there is no effective method.

By Common Spatial Subspace Decomposition methods to achieve two states characterized by comparison to the waking state standards to collect the EEG as an object, to achieve the ratio between the two as a basis to measure fatigue, the successful solution of this problem.

Method

Common Spatial Subspace Decomposition(CSSD)，Need to design experiments for comparison of two groups, respectively comprising the activities caused by different tasks, and also contains the same task-independent background activity. By comparing the two sets of data, you can put the task-induced activity patterns extracted.

Data Matrix Let A and B are two tasks were achieved under X_A and X_B, they are written in the form of temporal source model

$$\underset{N\times T}{X_A} = [C_a C_c]\begin{bmatrix} S_a \\ S_c^A \end{bmatrix} \qquad \underset{N\times T}{X_B} = [C_b C_c]\begin{bmatrix} S_b \\ S_c^B \end{bmatrix} \tag{1}$$

Here, N is the number of channels, T is the sampling points; C_a only contains the m_a task A related EEG spatial mode, C_b contains the m_b only task B related space mode. C_c contains m_c simultaneous with A and B associated mode. S_a, S_b , S_c^A, S_c^B is the corresponding source activities. Number Without loss of generality, it is assumed linearly independent source does not exceed the number of channels, namely.

$$m_a + m_b + m_c \leq N \tag{2}$$

CSSD is calculated as follows:

1, calculate the covariance matrix of X_A and X_B:

$$R_A = X_A X_A^{'}, R_B = X_B X_B^{'} \tag{3}$$

2, set $R = R_A + R_B$, a primary component of the decomposition of the R

$$R = U_0 \sum U_0^{'} \tag{4}$$

Define $P = \sum^{-1/2} U_0^{'}$, $W = U_0 \sum^{1/2}$ (5)

3, set $S_A = PR_A P^{'}$, $S_B = PR_B P^{'}$. And then decide on the S_A and S_B component decomposition.

$$S_A = U_A \sum_A U_A^{'}, \quad S_B = U_B \sum_B U_B^{'} \tag{6}$$

4, For tasks A, U out the first m_a columns, denoted U_a, define $SP_a = WU_a$, $SF_a = U_a^{'} P$, and then signal A component of the task can be estimated:

$$\widehat{X}_A = SP_a SF_a X_A \tag{7}$$

Result

The EEG data used in this paper is the BCI Laboratory of Jiangxi Institute of technology through the EEG acquisition of College students. EEG acquisition is the use of 40-Neuroscan amplifier, were obtained by scan4.3 software, the reference electrode by way of the right mastoid as reference electrode, using 1000Hz sampling rate, band acquisition using 200Hz low-pass, high-pass 0.05Hz and 50Hz notch. Each experiment were collected continuously for 5 minutes, each subject every 4 experiment.

Respectively, 20 subjects were collected EEG experiments, through artificial selection, each subject section 600 can be used to select the available EEG, which under section 300 as a quiet state, under section 300 as fatigue, EEG after filtering the initial processing, the fatigue calculation using the above methods.

Fatigue calculation results shown in Figure 1:

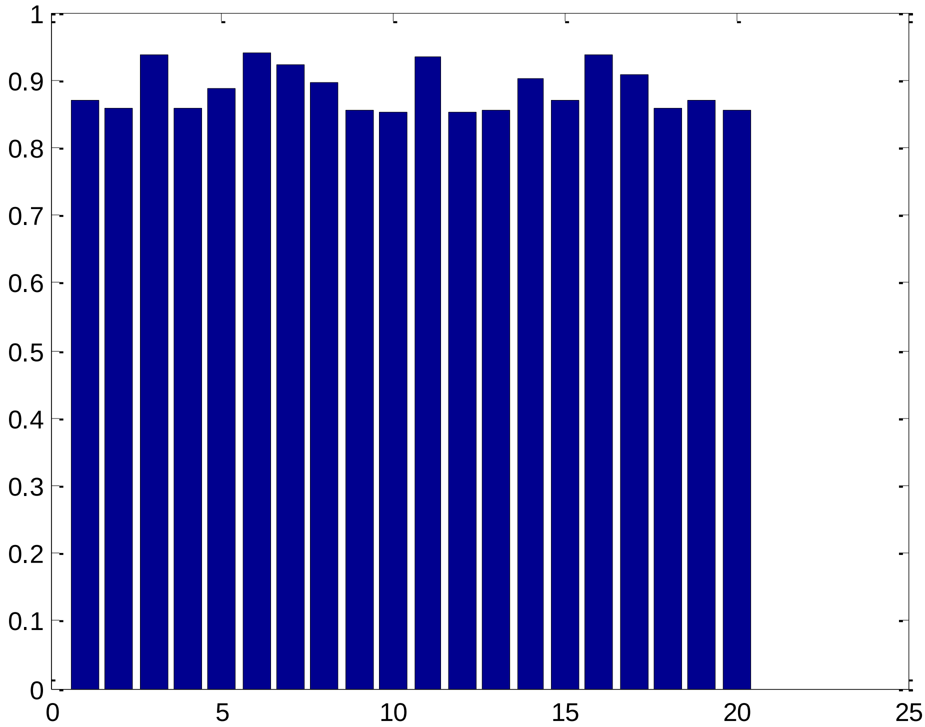

Figure. 1 Fatigue calculation accuracy.

X-axis in Figure 1 represents an individual subject; y-axis represents the EEG for 300 fatigue calculation accuracy.

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