



The Research of Emotional State Influence on Quality of a Brain-Computer Interface Usage

Timofei I. Voznenko¹, Gleb A. Urvanov¹, Alexander A. Dyumin^{1*}, Svetlana V. Andrianova¹ and Eugene V. Chepin¹

¹*National Research Nuclear University MEPhI (Moscow Engineering Physics Institute)
Moscow, Russia*

Abstract

Nowadays due to the brain-computer interfaces it becomes possible to make a reasonable assumption about the cognitive activity of the user and to recognize certain mental commands, which is used for various purposes, including robotic devices control. In addition, modern brain-computer interfaces allow to monitor affective activity that contributes to real-time monitoring of the operator' emotions. In this paper the influence of affective activity on the quality of recognition of the cognitive commands is considered. For this purpose, methods of excitation of a certain emotional state are used. The result of the research is a methodology of improving the quality of recognition of mental commands by taking into account the emotional state of an operator during the command execution.

Keywords: brain-computer interface, affective computing, emotions detection, command recognition, control quality

1 Introduction

The brain-computer interface (BCI) is an interface which provides a direct transmission of information from the brain to a computing device. Any motion, perception or the inner thought causes interaction of neurons with a help of electric impulses. This interaction creates electromagnetic field which can be registered via electroencephalogram (EEG). The human brain constantly emits the electric impulses which are called the waves of brain activity (for example: alpha-, beta-, gamma-wave). The brain creates waves of one kind for the certain behavioral patterns. Several portable BCI were developed by different companies recently. Some of these BCI interfaces allow not only to receive data by EEG but also to receive data about emotional state of an operator, namely the type of wave of brain activity prevailing at the moment. In this paper the following hypothesis is explored: taking into consideration the emotional state of an operator while working with BCI it's possible to improve the recognition quality of cognitive activity and executing commands.

* Corresponding author. E-mail address: a.a.dyumin@ieec.org

2 Related works

Affective computing is relatively modern subfield in computer science that deals with human-computer interfaces that can sense or help to express emotions. There are several approaches to do so: good review of models, methods and applications of affect detection was given Calvo and D'Mello [1]. Another survey was given Kleinsmith and Bianchi-Berthouze [2] which is focused on affective body expression perception and recognition that currently is the one of most prominent ways to deal with emotion expression and analysis. But it is possible to obtain affective information not only from visual sources as body posture or facial expression. Physiological signals can be very useful sources for such kind of information, for example ECG are described by Agrafioti, et al. [3] and others, as blood pressure, temperature, electro dermal activity, etc, that are manifestations of emotions influence on autonomic nervous system are considered Wac and Tsiourti [4].

But the main neuroscience approach for emotions detections is based on several techniques of the brain-waves analysis obtained through EEG described by Calvo and D'Mello [1]. Several laboratories conduct researches in this field, so we can already observe some promising results. Some techniques of emotions detection and recognition from brain signals were described Petrantonakis and Hadjileontiadis [5] and Jenke, et al. [6].

It is possible to use common-of-the-shelf brain-computer interfaces to obtain information about operator' emotions considered Pichiliani, et al. [7]. In its turn, emotions can affect BCI performance, some of the evidence was shown Chepin, et al. [8]. However, it should be mentioned that the accuracy of these devices is less than expensive medical electroencephalograph's one (EEG - scanner). In this paper, we provide more rigorous research of how the basic emotional states, as engagement, excitements, frustration and meditation, can affect BCI performance.

3 Theory

The human brain generates waves of brain activity at any time. Some BCI allow to receive the numerical characteristic (as magnitude) of the alpha-, beta-, and gamma-waves emitted by the brain. The emotional state of an operator is a complex of numerical characteristics of these waves received via BCI. Such emotional states as Engagement, Excitement, Frustration, Meditation are observed in this paper. The detection of emotional state is produced in real time using BCI. To begin with we will develop the methodology of putting the person into the state in which one of the aforesaid states is prevailed.

3.1 The method of putting the person into the one prevailing emotional state

Originally the methodology of putting the person into the one prevailing emotional state was developed for several test subjects (people passing tests for the command's execution with help of BCI). Afterwards the general part of the methods allowed to put all the test subjects into a state of one emotion prevailing was selected.

Engagement methodology: concentration on a particular image. Engagement was observed during concentration on a certain image; also the significance of Engagement increased while making mental arithmetic (the test subject was asked to name the tenth Fibonacci number – the sequence where each subsequent number is equal to a sum of the two preceding ones). It should be mentioned that different test subjects had different peak values of Engagement while counting the tenth Fibonacci number (the first peak value 1.0; the second – 0.9) (Fig.1a).

Excitement methodology: to cause excitement. Excitement was observed during a test subject was emotionally moved. The test subject was asked to remember the funny incident or he or she was told a

Download English Version:

<https://daneshyari.com/en/article/4962293>

Download Persian Version:

<https://daneshyari.com/article/4962293>

[Daneshyari.com](https://daneshyari.com)