Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 123 (2018) 528–533

Procedia Computer Science

www.elsevier.com/locate/procedia

8th Annual International Conference on Biologically Inspired Cognitive Architectures, BICA 2017

The Experimental Study of 'Unwanted Music' Noise Pollution Influence on Command Recognition by Brain-Computer Interface

Timofei I. Voznenko[1]*, Alexander A. Dyumin[1,2]†, Evgeniya V. Aksenova[3], Alexander A. Gridnev[1]‡, and Vladislav A. Delov[1]

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

[2] Moscow Institute of Physics and Technology
Dolgoprudny, Russia

[3] Mental Health Research Center
Moscow, Russia

Abstract

Nowadays, the alternative methods of human-computer interactions are in development. These methods can drastically improve usability of cyber-physical systems and devices, as mobile robots, especially for disabled people. Brain-computer interfaces (BCI) are among them. Unfortunately, BCIs aren't reliable enough to handle critical devices outside lab environments since the quality of command recognition can be influenced by external conditions, as noise pollution that can distract the user of BCI. In this paper, we are presenting the experimental study results of the noise pollution influence in the form of unwanted music on the quality of control through BCI. In general, the obtained results showed the negative impact on the accuracy of control for the most of participants.

Peer-review under responsibility of the scientific committee of the 8th Annual International Conference on Biologically Inspired Cognitive Architectures

Keywords: brain-computer interface, music influence, command recognition, robotics

1 Introduction

The brain-computer interface (BCI) provides data on brain electrical activity (EEG data) as described by Curran and Stokes [1]. The BCI can be trained to recognize the user's mental images. In order to do this, when the user focuses on the image, his EEG data is fed into the EEG pattern recognition system. Thus, if the user thinks about this mental image again, the EEG pattern recognition system will detect that, as described by Lotte et al. [2]. This

*Corresponding author. E-mail address: snaipervti@gmail.com
†Corresponding author. E-mail address: a.a.dyumin@ieee.org
‡Corresponding author. E-mail address: aleksgridnev@gmail.com

Peer-review under responsibility of the scientific committee of the 8th Annual International Conference on Biologically Inspired Cognitive Architectures
10.1016/j.procs.2018.01.080

technology can be used to translate brain activity into a command, for example to execute some command when the user envisions the mental image he or she used to train the BCI. The main drawback of the BCI is the low recognition accuracy in comparison with the medical electroencephalograph (EEG scanner) as considered by Duvinage et al. [3]. Therefore, a considerable time is devoted to various studies to improve the BCI. In particular, some studies are related to various methods of EEG data processing, for example described by Shishkin et al. [4] or Trofimov et al. [5].

The external factors play an important role in working with BCI, for example sound noise that surrounds the user while she or he is using BCI. In this paper, we present the study of sound noise impact on BCIs' efficiency. The participants had been affected by noise in the form of 'unwanted music'. The influence of different music styles were tested.

2 Related Works

There are several works taking in the consideration influence of external factors on BCI usage, such as environmental noise, visual noise, or music. Some researchers, as Reuderink et al. [6], are considering lost of control as another external factor affecting BCI performance.

Nam et al. [7] examined two environmental noise simulations to simulate the effects of real-world noise. They showed that higher noise levels seem to increase user concentration. According to Vidal et al. [8] visual noise leads to decrease of BCI efficiency to control a robotic arm. Zhou et al. [9] explored the influence of background music on BCI usage. They obtained that different performance measures did not reveal any significant performance effect when comparing background music vs. no background. However, Lin et al. [10] consider that music could affect users' emotions that could make BCI users feel comfortable during BCI usage.

In order to research the music influence on the BCI usage quality, the following music styles were chosen: classical music, electronic music, jazz, pop music, rap and rock. These styles were chosen as the most known, and they represent intersection of classifications ISMIR2004 described by Baniya et al. [11] and GTZAN described by Tzanetakis and Cook [12]. However, instead of the hip-hop, the rap musical style was chosen to simulate a noise in the form of background conversations.

3 Methods

3.1 Participants

The research was conducted on 32 healthy participants (aged 20 to 25, with mean in 23, six women, all are Russian students) in accordance with the Helsinki Declaration. All participants gave the verbal consent. Eight participants (11, 15, 17, 18, 23, 24, 26, 28) have already participated in several experiments similar to the one described in this paper. The other participants didn't have experience of BCI usage.

3.2 The Procedure

The scheme of the experiment is shown in Figure 1. In the beginning, the participant has passed the training stage for BCI usage. At this stage, the participant has been trained to execute the forward motion command using the BCI. In order to do that, he or she had to think about the mental image she or he wants to execute the command with.