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Using BCI to Play Games With Brain Signals: an Organic Interaction Process Through NeuroBodyGame Wearable Computer

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Abstract. NeuroBodyGame consists of a wearable computer that allows the users to play games with their brain signals through an independent and non-invasive BCI integrated to its technological system that captures the user's brain activity as spontaneous inputs from EEG rhythms on the frontal lobe through two electrodes disposed on F1 and F2 channels according to 10-20 Standard.

Keywords: BCI, NeuroBodyGame (NBG)

1. Introduction

For several years, electroencephalographic activities, and other measures of brain functions, have been considered means to new non-muscular channels of communication for sending messages and commands to the external world. This possibility becomes reality with the development and application of brain-computer interfaces (BCI) responsible for actually enabling this communication process between human-machine or human-machine-human, through the acquisition and encryption of the user's biological information [Zuanon, 2011]. Many studies [Anderson 1998; Altenmüller and Gerloff, 1999; McFarland et al., 2000] have demonstrated correlations between EEG signals and real or imagined movements and between the EEG signals and those from mental tasks.

In this context NeuroBodyGame (NBG) was developed consisting of a wearable computer that allows the users to play games with their brain signals. It is a wearable wireless interface for the brain to interact with the games bundled into the system.

2. Material and Methods

The NeuroBodyGame wearable computer has an independent and non-invasive BCI integrated to its technological system in which the brain output channel is the EEG, and the generation of the EEG signal mainly depends on the user's intention, and not on the peripheral nerves and muscles [Fabiani et al., 1987; Polich, 1999; Donchin, 2000]. This BCI captures the user's brain activity as spontaneous inputs from EEG rhythms on the frontal lobe through two electrodes disposed on F1 and F2 channels according to 10-20 Standard.

In order to achieve all ages two games are being used with the NBG: NeuroBodyGame Dragon which aims at a light user and has a less complex playability and NeuroBodyGame Car which aims at a more experienced user and presents a complex playability. Both games are open source – a fundamental characteristic for providing full remodeling of the programming and integration with the games' controls and the interactor's brain commands.

The usability tests conducted with NBG users throughout the entire process include the analysis of aspects related to comfort, mobility, and adaptability of the user to the brain-computer interface and the integration of brain wave frequencies of the players to the functionalities of the game in question.

Figure 1. *NeuroBodyGame Wearable Computer with brain computer interface integrated.*

3. Results

The obtained results include the mapping and the association of user's brain activity in real time to game functionalities, which begin to react in accordance with the player's neurophysiologic state. In other words, playability is facilitated or made difficult based on the user's brain wave frequencies as well as how the wearable computer interprets these brain activities and reacts to them, altering their color (front / back) and applying vibrations (back). Specifically the user's brain activity in a frequency period of 9 to 13 Hz enhances the user's playability and the NBG mostly react by showing the color blue. The detection of brain wave frequencies between 14 to 21 Hz, displays the green color and for frequency periods between 22 to 30 Hz the user's playability is made more difficult and the NBG reacts to it by turning to yellow and applying a soft vibration in the area of the back while brain wave frequencies between 31 to 40 Hz make the user's playability even more difficult and the NBG reacts by changing its color to red and by vibrating really intensively.

4. Discussion

The results mentioned above and observed during interaction of a significant number of users – more than 5,000 – during exhibit of the wearable computer at FILE (International Festival of Electronic Art) 2010, lead to the conclusion that the use of brain signals as biological information to configure an organic playability with the games constitutes a fertile field of research, considering the immersion potential the brain-computer interfaces provide when applied to interactive digital systems, such as computer games. Our future studies aim to extend the BCI application on wearable computers to provide increasingly complex levels of interaction between the user's organism and the elements that constitute a game such as characters, scenarios, feedback, besides the playability.

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