BCI Games With Motion Capture and its Possibilities in Rehabilitation

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Abstract. The last decade has seen a growing interest in the use of brain computer interfaces (BCI) in gaming for rehabilitation. There have been cases in which use game dynamics that seek to enrich the flow and entertainment BCI games, however the complexity and randomness of the electrical signals of the brain extracted often hinder the design of video games by limiting the possibilities of interaction and the commands used. In this paper we propose a hBCI that articulates the Kinect sensor as additional sensor input commands of the game, providing motion capture in real time to the interpretation of gestures and movements and the neuroheadset Emotiv EPOC for generating SSVEP by visual stimuli. Preliminary results were obtained from a patient with hemiparesis, the accuracy of the EPOC software for classifying SSVEPs within the game dynamics was 64%, lower than the levels attained in a stage of user training prior to the interaction taht was 86%. Finally, it highlights some features such as portability, fluidity of interaction, the quality of the user experience and the low cost of the mounted system, which becomes an ideal tool for rehabilitation of patients with neuromotor diseases.

Keywords: Kinect, Selective Attention, SSVEP, Emotiv Epoc, Hemiparesis, User Experience

1. Introduction

One of the most promising applications of brain computer interfaces (BCI) is the use in therapies to regain motor control because of diseases such as stroke [Tan et al., 2010]. One of the first researchers to contemplate the option of combining simulations or games in virtual reality (VR) with the BCI was Nijholt et al. [2008], who write that the first games controlled by these interfaces focused on the diagnosis of brain signals in aspects such as the measurement of the attention of the user or the relationship of affective components with the games. Despite impressive advances in BCI systems industry, product diversification and globalization of the study of this area of neuroscience; the state of art in multiple applications shows that the effective interaction with BCI applications and assistive devices control often not maintained for long periods of the time without the help of an expert assistance [Millán et al., 2010]. This statement has led to the BCI community to consider new paradigms of interaction and use BCI systems as an additional input channel for different applications. A hybridization where takes place a combination of multiple signals including at least one BCI channel is called a hybrid BCI (hBCI) [Pfurtscheller et al., 2010]. The combination of signals coming from BCI systems with other biosignals, for example particular biomechanical signals obtained through motion capture (MoCap) systems, can allow a more stable and durable control for an application or a videogame. To achieve the interaction of individuals in immersive games with BCI systems often used a mental strategy known as selective attention, which can be used visual stimuli to generate in the user Steady State Visual Evoked Potentials (SSVEP). In a typical configuration of a videogame BCI each stimulus is associated with a command that controls a specific action within the game. In order to select a command, the user has to focus him/her attention on the respective stimulation by generating the required mental intention [Bernhard et al., 2010]. The combination of motion capture sensor with BCI systems within a videogame could become a novel methodology for therapies to patients with brain problems that directly affecting their motor skills, such a stroke, Parkinson, sclerosis, neuropathies, sequelae of trauma or surgery interventions. In this paper we propose a new paradigm for immersive game where you use a combination of gestures and brain commands to achieve a unique gaming experience.

2. Material and Methods

In CIRAC (Center for interactive computer-assisted rehabilitation) motion evaluations are performed through video games with MoCap using the Kinect sensor. EEG signals are captured using EPOC, the game is made to improve the ability of movement of arms, so the user has to move constantly in order to achieve objects put in the virtual environment. The collection of objects is accounted in the videogame in order to generate positive stimuli and encourage the patient to continue efforts to get scores after each session, at the time of completing certain score, appears on stage an object that obstructs the passage and which must be removed through interaction with BCI system, the user has to fix his/her attention for a few seconds to remove the object successfully lifting mentally (through the generation of SSVEP) and to move forward. The player is trained previously by an animation to record reaction in the EEG when visual stimulus is displayed. The game engine used is Unity3D, which allows a complete integration with the Kinect sensor motion capture data, the EPOC's Cognitive Suite is used to achieve the BCI interaction within the virtual stage. MoCap data for a deep biomechanical analysis using software created by the team are finally collected.

3. Results

The resulting system is intended to serve as interactive tool that facilitates a low-cost implementation of BCI systems with MoCap in video games for rehabilitation of neuromotor diseases, the interaction of movement with the Kinect sensor contributes to physiotherapy dynamics required for the study of the kinematics of the patient; for its part, BCI system adds variables related to the ability to concentrate or different attention deficits presenting patients with brain injuries. We perform a preliminary test conducted with the assembly to a patient with hemiparesis, the classification of the SSVEP using EPOC software showed an accuracy of 64% within the dynamics of the game in only one intervention. This accuracy is lower compared with the training stage where the user reported 86% in a series of test performed to move the object outside the game. The biomechanical analysis shows the curves of movement of each joint of which arcs of movement are extracted based in measurement of Euler angles, in this case the patient has a short arc of motion in the affected shoulder of Fl/Ex 72/12/0, which shows quantitatively demonstrates the inability of the user to move freely right arm, specifically in the elevation. The game flow is kept constant during the operation, because not only EPOC commands are used but also used MoCap techniques and gesture interpretation to provide prolonged entertainment during the therapy. Besides the numerical results that reflect the type of measurements that the platform can do, we formalize an approximate costing of implementing this type of hybrid interaction laboratories in rehabilitation environments and we estimate that the entire platform with the necessary licenses in software and hardware equipment required does not exceed the sum of $ 5000.

4. Discussion

In this project we have embodied design one hBCI and its potential use in videogames for rehabilitation. We design and made a video game using a Kinect sensor as additional peripheral of input, which provides immersive features to the game allowing a better user experience [Nijholt et al., 2009]. Video games that used systems BCI for medical purposes could easily adapt MoCap systems like the Kinect, this in order to improve the disposition of a patient with the therapy, providing more elements which interact in virtual environments. With this paper we want to support the need to complement the use of BCI in games with new input devices that provide more entertainment to the patient and more variables that measure for the rehabilitator.

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