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The Design of Multi-User BCI Game System

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Abstract: The purpose of the study is using the Brain Computer Interface (BCI) device as game equipment to develop a multi-user BCI game system (MBCIGS). The MBCIGS includes a multi-user management system and three playing modes of BCI games which are a single user exercise mode, a multi-user practice mode, and a multi-user gaming mode. The multi-user management system is to handle the connection and the message transmission between players, while the three modes of BCI games are to offer the players using BCI devices from the status of practicing to competition. The MBCIGS uses a MindSet as BCI device, an Electro Server as the multi-user platform, and Flash software as client game developing system. Several suggestions are presented in the study.

Keywords: Brainwaves, Brain Computer Interface, Multi-user, Game Design

Introduction

With the rapid development of technology, Brain Computer Interface (BCI) in recent years has been one of the key research agenda. Traditionally, record and analyze brain waves are to use a large measurement machine. As the BCI technology becomes more mature, the way to measure brain waves is not limited to space and size constraints, but emphasizes the use of convenience and comfort in the increasingly widespread. Early BCI uses mainly in people with disabilities so that they do not need to rely on peripheral nerve and muscle, and can send commands through the brain to communicate with the outside world (Pfurtscheller, Guger, Müller, Krausz, & Neuper, 2000). However, because of the new BCI development, applications of today's brain wave research are not only for specific disabilities, but extend to learning and entertainment purposes (Crowley, Sliney, Pitt & Murphy, 2010; O'Hara, Sellen & Harper, 2011). In particular, many studies（Ko, Bae, Oh, & Ryu, 2009; Yoh, Kwon & Kim , 2010; Ryu, 2010) have used mobile BCI devices to develop brain wave games, such as the MindSet headset. The current technology in the single user electroencephalogram (EEG) measurement is not the problem, but multi-user brain wave detection as well as multi-player games in using BCI devices is still needing to be overcome. Therefore, this study proposes a systematic framework to simultaneously detect multi-user brain waves, and to apply to multiplayer games in order to provide a new development direction.

Related work

The function of a BCI is primarily through the use of electronic devices to receive and analyze the brain waves, including δ、θ、α and β. It usually consists of three parts: signal acquisition、signal processing、and device commands (Wolpaw, Birbaumer, McFarland, Pfurtscheller & Vaughan, 2002) (Fig.1).

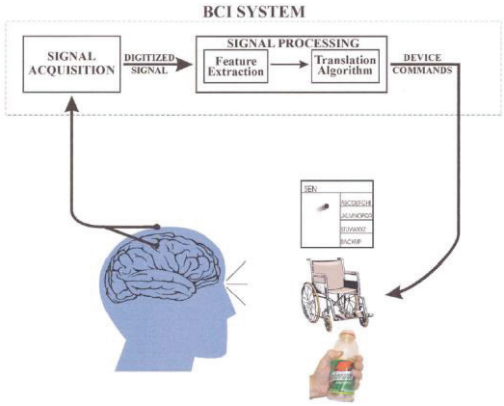

Figure 1 The basic structure of a BCI (Wolpaw et al., 2002)

Because of its special brain-computer features, the applications of using BCI technology have been widely used, such as electronic prosthesis, electronic driving, and emotional cat ears (Pfurtscheller et al., 2000; AutoNOMOS, 2011; Neurowear, 2011) With the same features and more convenient, the MindSet headset (NeuroSky, 2011) also plays a significant substantial advantage in BCI domain application.

The MindSet is non-invasive EEG equipment, and can detect the brain's state of focus and relaxation. With a dry electrode sensor placed on the human forehead, and the reference electrode and circuit ground systems placed in the left ear, the MindSet uses dry - electrode sensors to collect the biological brain signals (α, β, γ, δ, θ-wave), and sends the collected signal into ThinkGear chip, The ThinkGear then filters and amplifies the desired signal, and output to the computer through Bluetooth devices for future application. Crowley, Sliney, Pitt and Murphy (2010) found that the MindSet headset could be a measure of the level of the instrument for focus and relaxation in the Tower of Hanoi called the color test. Ko, Bae, Oh and Ryu (2009) used the MindSet to develop a brain wave game which includes practical and game mode in a single user environment and indicated the value of mobile BCI devices. Base on the needs of user interaction excitation, Alchemytech (2011) offers Zigbee synchronized brain wave evaluation system to asses multi users' brain situation. However, the Zigbee system is only to provide state of brain wave of the observing people, and cannot provide the interaction between users. Thus, in this paper we propose the design of a multi user BCI game system (MBCIGS) to enhance the effectiveness of users' interaction in MindSet gaming environment.

System design of MBCIGS

The MBCIGS system is a client-server multi-user game platform system. The Socket server uses Electro Server 5 (Electro Server, 2011), the client software is to use Flash CS5 with ActionScript 3 (Fig. 2). The function of the MBCIGS system allows users to observe their own as well as others real-time status of brain waves, and to process interactive brain game with each other. The structure of the MBCIGS system consists of two parts: zone and room. There are two kinds of zones: lobby and gaming zone in the system. The lobby is a tutorial system for novel users. The gaming zone divides into three rooms: single exercise mode, multi-users practice mode, and multi-users gaming mode. The single exercise mode is a room where the user can exercise and observe their status of brain waves through the MindSet headset (Fig. 3). The multi-users practice mode is a room where multi-users can practice each other MindSet headset and view their status of brain waves (Fig. 4). Finally,

the multi-users gaming mode (Fig. 5) is a room where multiple users can play game through each other MindSet headset and comparing the values of their brain waves.

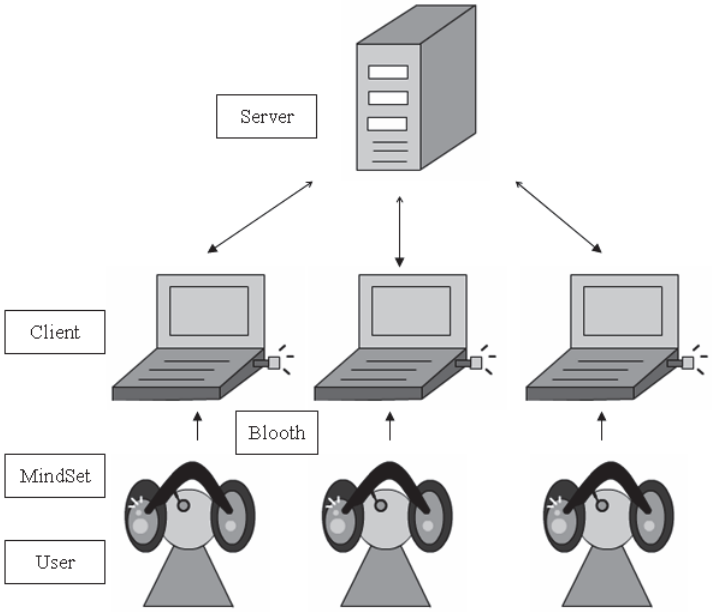

Figure 2 The system structure of MBCIGS

Figure 3 Single exercise mode

Figure 4 Multi-users practice mode

Figure 5 Multi-users gaming mode

The users could login into the MBCIGS system and choose any zone and room to practice their concentration and mediation using MindSet headset. This system, with individualized BCI functions and internet-based multi-user interactive features, will enhance the ability of the learning and gaming activities in the future application.

Conclusion

In order to achieve multi-user BCI game system, the study proposes a feasible solution. In this scenario, the MBCIGS integrates the MindSet brainwave headset, Flash software and Electro server to allow users to practice their learning ability of concentration and to interact with each other through the internet. Because of the hardware detection limitation in the traditional BCI application, the MBCIGS system could expand BCI applications, especially for users in the interactive use of incentive and interest environment, to enhance future learning.

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