
뇌-기계접속 된 동물과 사람사이의 실시간 인터넷게임

A Real time Internet Game Played with a Brain-Computer Interfaced Animal

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Abstract A Many studies have been made on the prediction of human voluntary movement intention in real-time based on invasive or non-invasive methods to help severely motor-disabled persons by offering some abilities of motor controls and communications. In the present study, we have developed an internet game driven by and/or linked to a brain-computer interface (BCI) system. Activities of two single neuronal units recorded from either hippocampus or prefrontal cortex of SD rats were used in real time to control two-dimensional movements of a robot, or a game object.

Keyword : Brain-Computer Interface(BCI), Internet game , Neuron, Hippocampus, Prefrontal cortex

1. Introduction

A brain-computer interface (BCI) is a system that translates its user's brain activity into external device control commands. The effective modulation of two adaptive controllers, the user's brain and the BCI system, is still a major challenge. In this study, we developed a neuron based internet game series called RaviDuel driven by a BCI system as one of the implementations of a virtual reality linked to a general-purpose BCI system, in which we used the BCI system developed in our previous study [1]. RaviDuel consisted of a betting game RaviDuel and a competitive game RaviDuel+. In RaviDuel, players betted on the time taken in completing a mission or on one of the subjects who competed with each other for completing a mission, in which the mission was driven by the BCI system. RaviDuel+ was a player vs. player hitting game, where one of the players was supposed to be a user (a rat, a pet, or a paralyzed person) of the BCI system. The BCI system coded a series of motor functions into prefrontal cortex (PFC), or hippocampal (CA1) region of the brain of the user and generated real-time command signals that controlled game objects of RaviDuel or RaviDuel+.

2. System

Figure 1 shows the schematic diagram of the presented system. The system consists of two parts, the BCI and the internet game systems. In the BCI system, the activities of two of m single neuronal units, $s_j (j = 1, 2, \dots, m)$ recorded, were used in real-time to control two-dimensional movements of a water disk, a robot, or game objects. A combination of the two neuronal units was assigned to the motor function of selecting a motion direction (left, right, forward, or backward) and another, to the motor function of selecting a motion power (one, two, three, or zero step count).

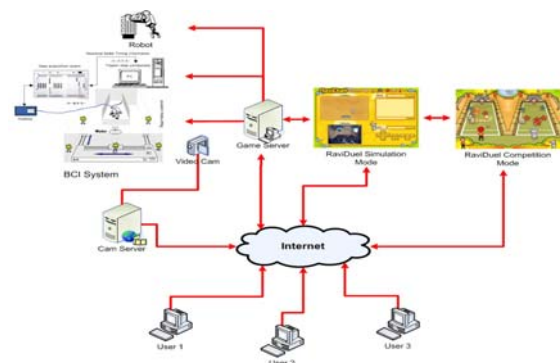


Figure 1. Schematic diagram of the system.

We quantified and coded the firing rate of each of the two neuronal units into four levels to estimate the relative neuronal activity difference and generate a corresponding command signal for a combination of the motion directions and the motion powers[2]. The game system was constructed to be driven by the command signal output of the BCI system.

3.The game system

The internet game system was constructed to be driven by the command signal output of the BCI system. Once a series of initialization steps, such as sign up, login, option selection, etc., is set up, a cam server, a game server, and the BCI system are connected to the user system, and a game session starts. The cam server controls and transfers to a game client system real time images captured from a video camera recording the two-dimensional movements of a water disk or a robot and the behavior of a user in the BCI system. The game server controls game procedures and network packet transmissions until a session of a game ends. The game server controls a betting, a competitive, and/or an interactive game.



Figure 5. Windows of a session of the game. RaviDuel⁺ & RaviDuel⁺

A betting internet game, RaviDuel, was programmed and simulated. In RaviDuel players bet on the time taken in completing a mission or on one of the subjects who competes with each other for completing a mission. The mission was animated like that a rat finds a water spring, which is linked to a target-to-goal(TG)task in the BCI system. An other competitive internet game, RaviDuel⁺, was programmed and tested. RaviDuel⁺ is a player vs. player hitting game, where one of the players was supposed to be a user (a rat, a pet, or a paralyzed person) of the BCI system. Figure 3 shows a window of a session of the game, RaviDuel⁺.

4. Conclusion

A neuron based internet game series called RaviDuel driven by a BCI system was developed as

one of the implementations of a virtual reality linked to a general-purpose BCI system. Activities of two single neuronal units recorded from PFC, or CA1 region of SD rats were used in real time to control two-dimensional movements of a game object. A betting game, named as RaviDuel, and a competitive game, named as RaviDuel⁺ were programmed and tested. RaviDuel is a betting game, where players bet on the time taken in completing a mission. RaviDuel⁺ is a player vs. player hitting game, where one of the players is supposed to be a BCI user (a rat, a robot, or a pet). The constructed game system linked to the BCI system was successfully implemented and the games, RaviDuel and RaviDuel⁺, were operated in real-time. The current development of new online communication system between animal (or paralyzed) and human showed a promising vision in the fusion technology among neuroscience, robotics and information technologies.

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