Low-cost Webcam and Off-the-shelf Game Interfaces to Produce VR Systems for Motor Rehabilitation After Traumatic Brain Injury, Spinal Cord Injury, and Amputation

Sheryl Flynn, Belinda Lange, Shih-Ching Yeh, and Albert "Skip" Rizzo

Correspondence:
Albert "Skip" Rizzo
Institute for Creative Technologies
University of Southern California
Los Angeles, California
E-mail: arizzo@usc.edu

Current research indicates that traumatic brain injury (TBI) related loss of motor function can be recovered or improved via a repetitive task-oriented motor training regimen that practices activities targeting specific relevant movement, and is intensified in a hierarchical fashion based on patient progress. Early research suggests that virtual reality game-based technology can be used to improve motor skill rehabilitation of functional deficits, including reaching, hand function and walking. However, clinic and home-based systems need to be affordable and easy to deploy and maintain, while still providing the interactional fidelity required to produce the meaningful motor rehabilitation activity needed to foster transfer to the real world. High-end laboratory-based systems do not meet cost and deployability requirements. This paper will discuss the initial setup and preliminary findings of a virtual reality and game-based motor rehabilitation area within a physical therapy clinic for patients with spinal cord injury (SCI), TBI, and amputation. The VR systems chosen for this research were the Sony PlayStation® 2 EyeToy™, Nintendo® Wiij™, and Novint® Falcon™, and a light-tracking system developed at the Institute for Creative Technologies. The main purpose of this research was to (1) define the game/model characteristics that are enjoyed most by the players; (2) develop new games, or manipulate the current games to address these user-defined characteristics; and (3) develop and start a training protocol that will improve strength, sensation, balance, cognition, reaction time, endurance and/or function. This presentation will discuss the findings from the first phase of the study. This first phase, currently in progress, is a focus study consisting of 15 participants with SCI (n = 5), TBI (n = 5), and amputation (n = 5). Participants are provided with demonstrations of the light-tracking system and standard games from the Sony PlayStation 2 EyeToy, Nintendo Wii, and Novint Falcon. Participants are then asked to complete a questionnaire regarding their perception on each system's usability, appeal and enjoyment. The participants are then able to use each of the systems for approximately 5 minutes at a time to avoid fatigue. A final questionnaire is completed by participants regarding their perception of each of the systems, and they are then given the opportunity to provide ideas or comments about what they would like from each of the systems or games. The findings from this focus group will be discussed in terms of what each group of participants (SCI, TBI and amputee) liked and disliked about each of the systems following observation of the investigators using the systems and then following their own experience with each of the systems. Future directions for the research will also be discussed. It is anticipated that this study will develop virtual reality game-based tools that can be used for motor rehabilitation training within clinics or as part of a home-based exercise regime.

Brain-Computer Interface for Virtual Reality Control

Christoph Guger, Chris Groenegress, Clemens Holzner, Günter Edlinger, and Mel Slater

Correspondence:
Christoph Guger
G.tec Medical Engineering
Guger Technologies OEG
Graz, Austria
E-mail: guger@gtec.at

A brain-computer interface (BCI) is a new communication channel between the human brain and a computer. Applications of BCI systems comprise the restoration of movements, communication and environmental control. In this study experiments were made that used the BCI system to control or to navigate in virtual environments (VE) just by thoughts. BCI experiments for navigation in VR were conducted so far with synchronous BCI and asynchronous BCI systems. The synchronous BCI analyzes the EEG patterns in a predefined time window and has 2 to 3 degrees of freedom. This means if the subject imagines foot movement, for example, it can move forward; if it imagines right-hand movement it can turn right, and with left-hand movement it can turn left. The asynchronous BCI analyzes the EEG signal continuously and if a specific event is detected then the control signal is generated. If the subject images foot movement, for example, it is moving forward as long as the foot imagination is detected. Both systems are currently limited to 1 to 3 degrees of freedom and therefore a fast control mechanism cannot be realized. Here we show that BCI systems can also be realized for VR control with a high degree of freedom and high information transfer rate. Therefore we implemented a so-called P300-based BCI system. Such a P300 system analyzes the P300 EEG response that can be detected if an unlikely event occurs. The systems show between 20 and 45 commands on a computer screen and the commands are highlighted in a random order. Whenever the target command is flashing, the P300 response can be detected and a control command is initiated. In order to control a VR implementation of a house, commands for TV control, playing music, making telephone calls, navigation in the house, controlling windows and doors, were implemented. First experiments in the CAVE system showed that the new P300-based BCI system allows a very reliable control of the VR system. Of special importance is the possibility to select very rapidly the specific command out of many different choices. This eliminates the use of decision trees as previously done with BCI systems. More generally the work showed that BCI systems can also be used for goal-oriented systems. Instead of controlling a robot with move up-move back, turn left-turn right commands, the BCI system allows a command such as grasp the glass of water and put it onto the table. This is a more natural and faster way of controlling movement.

Brain Activity During Handshake with a Virtual Avatar: A Preliminary Study

Hyeongrae Lee, Jeonghun Ku, Wonho Lee, Kiwan Han, Jinsick Park, Kang Jun Yoon, Jae-Jin Kim, In Young Kim, and Sun I. Kim

Correspondence:
Jeonghun Ku
Department of Biomedical Engineering
Hanyang University
Seoul, Korea
E-mail: kujh@bme.hanyang.ac.kr