Clinical Application for Assistive Engineering – Mixed Reality Rehabilitation

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Abstract

Mixed reality (MR) is a collective term for technologies that merge the real and the virtual. In medical applications of MR technologies, research is in progress for applications in surgical procedure simulation systems designed for therapy and medical training and increasing proficiency in fields such as ophthalmology, brain surgery, and orthopedic surgery. MR rehabilitation holds the potential for substantial advances and contributions in respect to therapeutic efficiency, recovery from psychosomatic disorders, and heightening of patient desire, motivation, and acceptance through the patient’s own appraisal of physical and mental disability. This study focused on the development of a medical device system using a head mounted display (HMD) for examination and treatment of the visuospatial cognitive disorder known as unilateral spatial neglect as an illustration of MR rehabilitation.

Keywords: Head mounted display (HMD), Unilateral spatial neglect (USN), Mixed reality rehabilitation

1. Introduction

Mixed reality (MR) is a collective term for technologies combining the real and the virtual. It encompasses augmented reality (AR), in which computer graphic (CG), alphanumeric, or other forms of information are superposed on the actual field of vision, and augmented virtuality (AV), in which real-world information is superposed on a virtual space in the computer. Research and development in MR technologies includes "3D spatial synthesis", which seamlessly entrains and fuses photographic images in 3D computer images, small, light, transparent HMDs, and display devices. The display devices provide a brightness and field of vision approximating those of the natural environment and affect the sense of balance and other perceptions while avoiding adverse effects.

In medical applications, research is in progress for applications in surgical procedure simulation systems designed for therapy and medical training and increasing proficiency in fields such as ophthalmology, brain surgery, and orthopedic surgery, and for applications serving human information and psychological needs, such as psychosomatic anxiety analysis and anxiety-relief training, and support of relaxation for recovery from stress and mental fatigue. For applications in cognitive science, research has begun on human perception and response to stimulations using MR technology to provide presentations for perception and cognition. In our study, research based on motor learning theory has begun for utilization of MR technologies in what is termed “mixed reality rehabilitation” in certain fields of rehabilitation, in which the patient receives various forms of biofeedback (auditory, visual, and somatosensory inputs). MR rehabilitation holds the potential for substantial advances and contributions with regard to therapeutic efficiency, recovery from psychosomatic disorders, and heightening of patient desire, motivation, and acceptance through the patient’s own appraisal of physical and mental disability.

This paper focused on the development of a medical device system using a head mounted display (HMD) for examination and treatment of the visuospatial cognitive disorder known as unilateral spatial neglect (USN) as an illustration of MR rehabilitation. USN is a common syndrome in which a patient fails to report or respond to stimulation from the side of space opposite a brain lesion, where these symptoms are not due to primary sensory or motor deficits [1]. Patients with severe neglect often collide with objects, ignore food on one side of the plate, and in general tend to rely on just one side of the body [2]. Patients with USN of the left hemispace require longer hospital stays and have more difficulty resuming activities of daily living [3]. Neglect is associated with lower performance on measures of impairment, as well as on measures of disability in ADL. Recently, several studies have singled out USN as one of the major disruptive factors impeding functional recovery and rehabilitation success [4].

From a rehabilitation perspective, the traditional assessment of USN centers on a variety of simple perceptual motor tasks. Investigations have used line crossing [5], cancellation task [6] and more recently, an indented reading