

Chapter 61

Virtual Reality Enhanced Robotic Systems for Disability Rehabilitation

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ABSTRACT

This chapter mainly introduced the virtual reality as many benefits of robots involved in disability rehabilitation. According to the vision feedback and force feedback, the therapist can adjust his operation. Virtual reality technology can provide repeated practice, performance feedback and motivation techniques for rehabilitation training. Patients can learn motor skills in a virtual environment, and then transfer the skills to the real world. It is hopeful to achieve satisfactory outcome in the field of rehabilitation in the future. VR is mainly used for the upper-limb rehabilitation robot system in this article. The objective of robotic systems for disability rehabilitation are explored to divide the whole rehabilitation training process into three parts, earliest rehabilitation training, medium-term rehabilitation training and late rehabilitation training, respectively. Accordingly, brain-computer training modes, the master-slave training modes and the electromyogram (EMG) signals training modes are developed to be used in rehabilitation training to help stroke patients with hemiplegia to restore the motor function of upper limb. Aimed at the rehabilitation goal, three generations of VR rehabilitation system has designed. The first generation of VR rehabilitation system includes haptic device (PHANTOM Omni), an advanced inertial sensor (MTx) and a computer. The impaired hand grip the stylus of haptic device, the intact hand can control the impaired hand's motion based on the virtual reality scene. The second generation of the VR rehabilitation system is the exoskeleton robots structure. Two virtual upper limbs are portrayed in the virtual environment, simulated the impaired hand and the intact hand, respectively. The third generation is a novel VR-based upper limb rehabilitation robot system. In the system, the realization of virtual reality environment is implemented, which can potentially motivate patients to exercise for longer periods of time. Not only virtual images but also position and force information are sent to the doctors. The development of this system can be a promising approach for further research in the field of tele-rehabilitation science.

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1. INTRODUCTION

There is a data analysis report on the rehabilitation of the people with disabilities need and a baseline survey on rural disabled in poverty of certificated disability based on the China Disabled Population Database. The results show that there are more than 85 million disabilities in China until April 2013. In terms of the need of rehabilitation, 31.9% of the disabled people require rehabilitation care, 30.9% need for function training, and 91.9% need for accessory equipment (Z. Jun, 2013). There is a huge potential market on rehabilitation. We focused on discussing function training in this paper.

Data from the feedback of rehabilitation demands show that one-third of disability need for function training. Function training is mainly aimed at people who lose their motor function, such as people who are disabled after stroke. There are many training devices at present, especially focused on limb function training, and virtual reality technology is widely used in these devices.

Virtual reality (VR), also known as immersive multimedia, can trace its roots to the 1860s, when 360-degree art through panoramic murals began to appear, but the term of it was popularized by Jaron Lanier in 1980s. Virtual reality is a computer-simulated environment, and it can simulate physical presence both in the real world and imagined worlds. Sensory experiences, such as virtualsight, sound, smell, taste and touch can be recreated by virtual reality, and it can be shown on the screen for users. Users move from one place to another and computers have a complicated computing at the same time, then a virtual world similar to the real is created. Technically, virtual reality has three essential characteristics: immersion, interaction and imagination, which emphasized the leading role of people. Most current virtual reality environments are visual experience, and are displayed either on a computer screen or with special stereoscopic displays. It was not been used as a technology originally, and appeared in science-fiction novel in 1983, then it was cited by the Oxford English Dictionary in 1987 from an article titled "Virtual reality".

Virtual reality technology develops quite quickly. It can be used in many fields, for instance, it can be attached to the video games. Now all kinds of online games cannot run without the technology of virtual reality. Just like the online game CS (Counter-Strike), the League of Legends (LoL), the Defence of the Ancient (DOTA) and so on, these games are very famous all over the world. The game environment can give players a novelty experience that does not exist in the real world.

Not only VR be used to train soldiers like in CS, but also it can be used to train real soldiers in the real world. Virtual reality is widely used in the field of military training. It allows soldiers training in a virtual environment where they can improve their skills without causing actual destruction, and it is economical both on money and time. The virtual training environment provides a wider space than the real condition. VR also can be used in flight simulation for the Air Force. It is cost-saving and riskless during the training of proficiency. Similarly, VR can be used in the Driving License Test in the future.

In the field of therapy and rehabilitation, VR plays an important role in assisting doctors and therapists. In clinical therapy, virtual reality, especially for immersive kind, is developed to assist cognitive psychologists and therapists to cure brain-damaged patients. Virtual Reality plays an important role in psychotherapy. Originally, it was used in various forms of exposure therapies, especially for variety of mental diseases, like phobia treatments and post-traumatic stress disorder (PTSD). In phobia treatment, VR simulation has been shown to be invaluable with its simple sight and sound models, like zoophobia, and acrophobia, as a step before true exposure. A much more complex simulation based on VR is applied to veterans suffering from PTSD recently (G. Riva, 2005), which was piloted by the U.S. Navy. Veterans

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