Chapter 66
Collaboration of Rehabilitation Robot With Virtual Reality Development Engine

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ABSTRACT

Stroke rehabilitation techniques have gathered an immense attention due to the addition of virtual reality environment for rehabilitation purposes. Current techniques involve ideas such as imitating various stroke rehabilitation exercises in virtual world. This makes rehabilitation process more attractive as compared to conventional methods and motivates the patient to continue the therapy. However, most of the virtual reality based stroke rehabilitation studies focus on patient performing sedentary rehabilitation exercises. In this chapter, we introduce our virtual reality based post stroke rehabilitation system that allows a post stroke patient to perform dynamic exercises. With the introduction of our system, we hope to increase post stroke patient's ability to perform their daily routine exercises independently. Our discussion in this chapter is mainly centered around collaboration of rehabilitation system with virtual reality software. We also detail the design process of our modern user interface for collecting useful data during rehabilitation. A simple experiment is carried out to validate the visibility of our system.

1. INTRODUCTION

Recent years have shown various technological advances in the field of stroke rehabilitation. One of the main reasons for such sudden change is due to the limitations encountered in conventional rehabilitation methods. Conventional rehabilitation method requires scheduling appointments, frequent visit to the clinics, plus the therapy style is repetitive. This may result in demotivating the patient and the patient may eventually lose interest in the therapy (Burdea, 2003). Various research works have highlighted the feasibility of virtual reality (VR) for rehabilitation of post stroke patients (Holden, 2005). The main advantage provided by the VR rehabilitation is its fun to use feature. Although many rehabilitation therapists may not completely agree with the application of VR for stroke rehabilitation, various research studies have demonstrated the importance of VR approach (Burdea, 2003; Cameirao, Badia, Zimmerli, Oller, & Verschure, 2007; Holden, 2005; Kizony, Raz, Katz, Weingarden, & Weiss, 2005; Kuttuva et al., 2006; Lee et al., 2003; Ma et al., 2007; "TheraGame," n.d.). The main idea behind the application of VR is to build a virtual environment that is relevant to the patient's daily routine. This offers an opportunity for the patients to improve their motor skills by completing fun task in VR world. While the patients work with their task in VR world, data can be collected and then analyzed to judge their performances.

In this chapter, we describe the steps we implemented to collaborate rehabilitation robot with the VR development software. Our system consists of a personal computer (PC) with NVIDIA GeForce GTX 970 graphics card, a rehab machine called as KineAssist® (also called as KAMX®) provided by HDT Technologies, VR development software called as Unreal Engine 4 (version 4.72) and a head mounted display called as Oculus®. The PC can connect and collect data from the KAMX via a local area network (LAN) cable by using TCP/IP protocol. The procedure explained in this chapter can be similarly extended to any rehabilitation system that uses a rehabilitation robot, which can communicate with a PC via a LAN cable. First we introduce the system design framework, explaining the importance of each component of our system. Then we explore the steps implemented in each individual component so as to build our system. Finally the chapter discusses about the simulated experiments and observations made, followed by the conclusions and discussions about the feasibility of our system as a home oriented system.

2. RELATED WORK

It has been estimated that, around 795,000 people in US suffer stroke each year. Stroke is considered as the 4th largest cause of preventable deaths and also cause of long term disability (Go et al., 2014), ("Stroke Facts | cdc.gov," n.d.). It should also be noted that each year almost one-fourth, of the total stroke patients, have reported recurrent attack. Studies have shown that, chances of recurrent stroke attacks can be reduced, by performing regular physical activities or exercises recommended by the therapist ("Preventing Another Stroke | Stroke.org," n.d.),("Practice Guidelines: AHA/ASA Guidelines on Prevention of Recurrent Stroke - American Family Physician," n.d.). However, person who had experienced a stroke may incur substantial disability, which in-turn makes them impossible to perform various physical activities. Therefore, various stroke related research activities are focused on system that could assist stroke patient's to perform their physical activities with ease. Current research studies have introduced various VR related rehabilitation system for patients suffering from stroke (Burdea,

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