Chapter 40
Adaptation and Customization in Virtual Rehabilitation

Felipe Orihuela-Espina
Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico

L. Enrique Sucar
Instituto Nacional de Astrofísica, Óptica y Electrónica, Mexico

ABSTRACT

Background. Adaptation and customization are two related but distinct concepts that are central to virtual rehabilitation if this motor therapy modality is to succeed in alleviating the demand for expert supervision. These two elements of the therapy are required to exploit the flexibility of virtual environments to enhance motor training and boost therapy outcome. Aim. The chapter provides a non-systematic overview of the state of the art regarding the evolving manipulation of virtual rehabilitation environments to optimize therapy outcome manifested through customization and adaptation mechanisms. Methods. Both concepts will be defined, aspects guiding their implementation reviewed, and available literature suggesting different solutions discussed. We present "Gesture Therapy", a platform realizing our contributions to the field and we present results of the adaptation techniques integrated into it. Less explored additional dimensions such as liability and privacy issues affecting their implementation are briefly discussed. Results. Solutions to implement decision-making on how to manipulate the environment are varied. They range from predefined system configurations to sophisticated artificial intelligence (AI) models. Challenge maintenance and feedback personalization is the most common driving force for their incorporation to virtual rehabilitation platforms. Conclusions. Customization and adaptation are the main mechanisms responsible for the full exploitation of the potential of virtual rehabilitation environments, and the potential benefits are worth pursuing. Despite encouraging evidence of the many solutions proposed thus far in literature, none has yet proven to substantially alter the therapy outcome. In consequence, research is still on going to equip virtual rehabilitation solutions with efficacious tailoring elements.

DOI: 10.4018/978-1-5225-5469-1.ch040

INTRODUCTION

Patients of acquired brain injuries from originating stroke (Sucar et al., 2014), palsy (Deutsch et al., 2008) or trauma (Betker et al., 2007) as well as spinal cord lesions (Betker et al., 2007) can benefit from virtual rehabilitation procedures. The central elements of virtual rehabilitation (VR) are the virtual scenarios or environments where the therapeutic exercises are carried out (Holden, 2005). The designers of these scenarios have absolute control not only over the aesthetics, but also over the physics ruling the virtual world (García-Martínez et al., 2015). It is this opportunity to fully control the learning environment which is the key to provide a more personalised and intensive learning experience in rehabilitation (Levin, 2011). The ultimate goal of this manipulation of the virtual rehabilitation environment is achieving optimal impact of the therapy (Rose et al., 1998, Levin, 2011, Burke et al., 2009a). A collateral goal for those solutions design to be utilized at home is reducing dependency on clinical expert supervision.

The manipulation of this learning environment can occur either during the programming of the environment at compilation time, or during its usage at runtime; in both cases the environment can be flexibly manipulated to provide the patient with a personalized experience that is also optimally efficacious in terms of motor recovery. This tailoring can be restricted to manipulation of the appearance of the environment itself keeping the environment response coupled to the background of the patient, which is often referred to as *customization;* or affect the environment's response to patient actions and behaviour and mind status as these evolve throughout therapy, which is often referred to as *adaptation*. The alternative personalization of the hardware platform as complementing that of the virtual environment itself is by itself an exciting topic but not treated in this chapter. As this chapter will reveal, many of these tailoring efforts have thus far concentrated on increasing the patient motivation and adherence to the rehabilitation programme. But there is no reason why the alteration of the virtual scene cannot be more aggressive and target brain function reorganization itself.

Customization is the alignment of the environment to the patients' profile; including aspects such as demographical, psychological, ethnographical and even individual taste, as well as long-term clinical and therapeutic goals. Under customization, the environment's response against an input action is preserved. It is more of aesthetical nature but it goes beyond the obvious modification of the graphical rendering. It also involves control of the abstraction level at which the task is presented to match the learning capabilities of the user, and it may even affect the physics and behaviour of the environment, e.g. by alighting the virtual weight of the virtual object to oppose less resistance for children, but it does so deterministically; under customization the same patient always observes the same weight until his/her profile changes, e.g. by growing older.

Adaptation is the alignment of the environment to the patient changing physical and cognitive function and present circumstances, and to her short-term clinical and therapeutic demands. It will most times involve a change in the response of the environment to the same input. For instance, the challenge of the task is altered to match the new skills, the present physical status, e.g. fatigue or pain, or the current mind status, e.g. frustration. Task abstraction, aesthetics, and physics can also be ruled by adaptation decisions, thus blurring the separation between the mechanics of customization and adaptation.

The link between these two concepts is strong. Customization and adaptation do not necessarily differ in what they change in the environment, when they do apply the changes or on the expected impact, but they do depart on the etiology for proposing those changes. The two mechanisms ruling the environment manipulation are conceptually sharply distinct but inseparable, and similar in their manifestation and impact. Although some aspects of the patient profile are unlikely to change throughout the therapy, e.g.

Related Content

The Effect of Experience-Based Tangible User Interface on Cognitive Load in Design Education
Zahid Islam (2020). *International Journal of Virtual and Augmented Reality (pp. 1-13).*
www.irma-international.org/article/the-effect-of-experience-based-tangible-user-interface-on-cognitive-load-in-design-education/283062

Comparison Analysis of Global Healthcare of virtual reality Systems Market by Geography in Existing Market Scenario
Meeta Singh, Poonam Nandaland Deepa Bura (2023). *Designing Context-Rich Learning by Extending Reality (pp. 227-245).*
www.irma-international.org/chapter/comparison-analysis-of-global-healthcare-of-virtual-reality-systems-market-by-geography-in-existing-market-scenario/323174

Impact of Blogs on Sales Revenue: Test of a Network Model
Guoying Zhang, Alan J. Dubinskyand Yong Tan (2013). *Studies in Virtual Communities, Blogs, and Modern Social Networking: Measurements, Analysis, and Investigations (pp. 106-120).*
www.irma-international.org/chapter/impact-blogs-sales-revenue/77996

Plastika [Totipotenta]
Catherine Nyeki (2011). *Metaplasticity in Virtual Worlds: Aesthetics and Semantic Concepts (pp. 228-239).*
www.irma-international.org/chapter/plastika-totipotenta/50388

A Social Framework for Software Architectural Design
Manuel Kolpand Yves Wautelet (2011). *Virtual Communities: Concepts, Methodologies, Tools and Applications (pp. 407-427).*
www.irma-international.org/chapter/social-framework-software-architectural-design/48682