Chapter 3.4
Semantic Web Services for Healthcare

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ABSTRACT

This chapter explores the technological quest of virtual reality within the field of medicine. Although the author does not intend to provide an exhaustive review of the various health informatics applications of VR over the past 15 years of its development, he presents some of the major technological breakthroughs and their impact in the provision of healthcare services to the point-of-need (i.e., the patient).

INTRODUCTION

The continuing technological achievements of the modern era are changing dramatically the ways in which we conduct our daily activities and life. The medical field, through the provision of high-quality healthcare to the patient, is not an exception. The technological advances that we have witnessed during the past few decades have had an enormous impact on the manner in which we diagnose and treat disease. Today's innovations in science and engineering raise the potential for medical technology to expand the frontier of healthcare delivery to unimaginable accomplishments. In this context, virtual-reality (VR) technologies have played an important role in revolutionising the practical provision of patient care. In recent years, VR technology and its application to medicine are not a research curiosity anymore; in several areas of clinical disciplines, the technology and innovation are developing in

such a way that they can be adopted in routine practice, providing powerful tools in diagnostics, therapeutic planning, and interventions.

The enhancement of human health and, as a consequence, the improvement of the quality of human life, is one of the main objectives of scientific endeavour in the field of medicine. The provision of high-quality patient care is the ultimate outcome of any medical research and its related clinical implementation. The scientific advancements in medicine have always benefited from simultaneous developments in engineering and technology. Virtual reality is one of the important and recent technological innovations that have made a significant impact in medicine, more specifically in its quest for the high-quality provision of healthcare.

The medical applications of virtual reality originated in the early 1990s from the need of healthcare practitioners to visualise large amounts of complex medical data, particularly in surgical planning, preoperative training, and image-guided navigation during surgical procedures (Chinnock, 1994). Since the first surgical abdominal VR simulator in 1991 by Satava (1993), the scope of virtual reality in medicine has broadened, with applications ranging from 3-D (three-dimensional) immersive visualisation and manipulation of the cellular environment (Guan et al., 2004) to clinically applied diagnostic tools (e.g., virtual endoscopy technologies; Lorensen, Jolesz, & Kikinis, 1995), advanced medical education and training (Zajtchuck & Satava, 1997), augmented or enhanced surgery (Shuhaiber, 2004), medical therapy (Vincelli, Molinari, & Riva, 2001), and the virtual design of healthcare processes and environments (Kaplan, Hunter, Durlach, Schodek, & Rattner, 1995). Biomedical VR "has changed from [being] a research curiosity to a commercially and clinically important area of medical informatics technology" (Székely & Satava, 1999).

This chapter will explore the technological quest of virtual reality within the field of medicine. Although we do not intend to provide an exhaustive review of the various health-informatics applications of VR over the past 15 years of its development, we aspire to present and discuss some of the major technological breakthroughs and their impact in the provision of healthcare services to the point of need, that is, the patient. Our analysis will focus mainly on the research motivations and challenges in the routine use of the technology, while our argument will be about the socioeconomic effects and medicoethical concerns that relate to its implementation within the clinical practice.

THE CONCEPT OF VR IN THE CONTEXT OF MEDICINE

Traditionally, virtual reality is defined as a form of human-machine interaction technology, in which human users are fully immersed within a synthetic 3-D virtual environment (Ellis, 1994). Users can interact, through all their senses, with any virtual objects and scenes of such an environment as they are immersed in it with the assistance of appropriate graphical displays (usually, in the form of head-mounted display technologies, HMD) and other nonvisual technological modalities (e.g., auditory, haptic, etc.; Pratt, Zyda, & Kelleher, 1995). Such an interaction gives a full sense of virtual presence to the user.

This technology-oriented definition of VR, although valid for many scientific, industrial, and entertainment applications, is restrictive when considered within the context of the observed technological evolution of medical VR. Since the early years, many researchers and clinical practitioners have embraced the concept and technology of medical VR by adopting a broader definition and scope for its application in the field. Depending on the requirements of the healthcare application at hand, the implementation of immersion, in terms of technological devices used and sensory modalities involved, may vary. For instance, "in some applications, real and virtual