

Virtual World Technology for Healthcare: A survey

B. Janani⁺, R. Arthy and M. Somasundaram

IV year B.E., Department of Computer Science and Engineering (CSE),
R.M.K. Engineering College, Kavaraipettai, India,

Abstract: Information Technology (IT) has seen dramatic improvements in the recent past, and laid foundations in the area of Virtual Reality (VR) technology. VR applications have branched out into numerous domains from education and entertainment to critical applications like Healthcare enabling virtual surgery, telemedicine and further medical applications. One of the key technologies in VR in recent times is Virtual World (VW) using Second Life as a part of Web 2.0 and Social Computing. The objective of the paper is to survey the various Virtual Reality and Virtual World applications in Healthcare and present the status of such applications, the expertise available and the challenges ahead in using it for Healthcare. As a part of the objective, the applications were studied from the perspective of usefulness, feasibility and cost of implementation of applications. Based on this, the paper highlights that the Second Life has advantages of better feasibility of implementation and proposes a phased approach to implement VW in hospitals from initial low-critical to high-critical applications. Second Life approach also enables customized applications for healthcare based on the specific needs and medical challenges of the hospitals and the local people.

Keywords: Information Technology (IT), Healthcare, Virtual Reality (VR), Virtual World (VW), Second Life, Three dimensional imaging.

1. Introduction

Virtual Reality (VR) has already been applied widely in the fields of education, engineering, law enforcement, and entertainment. One of the fastest growing and most potent sectors is the healthcare sector. The virtual reality gave birth to an interesting technology called the Second Life. Second Life (SL) [1] is a virtual world that is accessible on the Internet. It enables users to create and connect with virtual world entities called avatars. Second Life finds wide applications in business, education and entertainment. In medicine, staff can use virtual environments to train in everything from surgical procedures to diagnosing a patient. Surgeons have used virtual reality technology to not only train and educate, but also to perform surgery remotely by using robotic devices. If further progress is made in this field of VR in healthcare, it has the ability to revolutionize the world of medicine. Second Life can provide cost effective, widespread access to training scenarios that have the capability to enhance general or specialist healthcare training.

2. Overview of the Virtual Reality

Virtual reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment. On a computer, virtual reality is primarily experienced through two of the five senses: sight and sound. As shown in the fig.1 the simplest form of virtual reality is a 3-D image that can be explored interactively at a personal computer, usually by manipulating keys or the mouse so that the content of the image moves in some direction or zooms in or out. More sophisticated efforts involve such approaches as wrap-around display screens, actual rooms augmented with wearable computers, and haptics devices that let you feel the display images.

⁺ Corresponding author. Tel.: +04426870251
E-mail address: g8_janu@yahoo.co.in

3. Virtual Reality Applications in Healthcare

Over the past decade, Information technology has progressed and costs have declined, there has been a steady growth in the use of virtual reality (VR) in health care. Virtual reality techniques, involving three-dimensional imaging and surround sound, are increasingly being used in diagnosis, treatment, and medical education. Healthcare industry [9] has expanded tremendously due to extensive product development and the growing implementation of healthcare information technology (HIT) infrastructure.

Starting from the medical student stage these systems can help in assisting students to become more proficient in initial exam history and physicals; to become more proficient in the analysis of MRIs, CTs and X-rays. In addition awareness programs for TB and AIDS can also be conducted with the help of VR systems, as they will enable the people to understand the complex patterns of the disease.

Some of the applications of VR in medicine are :



Fig.1: Virtual Reality Application in PCs with additional hardware



Fig 2: Learning human anatomy through Web based 3 dimensional Virtual Body Structures

- Design of **Web-based three-dimensional Virtual Body Structures (W3D-VBS)**, for interactive assembly and efficient viewing, exploring, and manipulating hundreds of organs, and their connected (or proximal) structures. The Fig.2 provides a simple instance of W3D-VBS; it provides a three-dimensional Structure of human rib cage. The Visible Human Project of the National Library of Medicine makes it possible to create virtual reality-based applications for teaching anatomy. Integration of traditional cadaver and illustration-based methods with Internet-based simulations brings us closer to this goal.
- **Three-dimensional Virtual Body Structures** [7] is a next-generation immersive anatomical training system for teaching human anatomy over the Internet. It uses Visible Human data to dynamically explore, select, extract, visualize, manipulate, and stereoscopically palpate realistic virtual body structures with a haptic device. The size and shape of 3D models as shown in Fig. 3 are very realistic because they come directly from the visible data at the pixel level. These virtual body structures can be touched using G2h to make them haptic. This technique allows us to generate life like images.



Fig.3: Learning human anatomy through Web based 3 dimensional Virtual Body Structures



Fig.4: Virtual Environments for pain distraction and pain management

- **Pain Management** is one of the products developed by VRMC. The pain distraction application is uniquely created from the imagination of the mind. The virtual environments for this application avoid the realms of reality, instead of simulating it. As shown in Fig 4, Enchanted Forest, Dream Castle, Icy Cool World, and Vista View are currently the virtual environments created for pain distraction which can be experienced using a head mounted display (HMD) [6].
- **Combating Phobias:** By entering virtual worlds, people who are enslaved by irrational fears can come to terms with the source of their distress in a safe, clinical setting. At the Virtual Reality Medical Center (VRMC) in San Diego, clinicians use cognitive-behavioral therapy (CBT) in concert with virtual reality to treat patients with a number of phobias, including fear of flying, driving, closed-in spaces, open spaces, spiders, and public speaking. [5]
- In the **Clinical Simulation Center** [14], doctors-in-training can practice their skills on extremely realistic procedural simulators as shown in Fig 5, including those designed for developing surgical skills. These sophisticated simulators mimic the look and even the feel of performing an actual surgical procedure, allowing surgical trainees to practice techniques before they ever reach the operating room. This technique ensures patient safety and the quality of patient care.

4. Technology Required to Implement VR and Second Life VW Applications

To create a virtual reality, you need several advanced technologies of hardware, software, and electronics. For a system to be recognizably 'real' the computer must be able to 'sample' the sensors about sixty times per second. The Virtual Reality Modeling Language (VRML) [17] allows the creator to specify images and the rules for their display and interaction using textual language statements.

Second Life uses a different paradigm of creation of virtual world applications. Building Second Life applications is by using the creation tools. Prims are the building blocks of Second Life. All objects in Second Life are made of prims, except for avatars, the natural ground, and trees.

A free client program called the Viewer enables its users, called Residents, to interact with each other through Avatars. Built into the software is a three-dimensional modeling tool based around simple geometric shapes that allows a resident to build virtual objects. This can be used in combination with the Linden Scripting Language which can be used to add functionality to objects. More complex three-dimensional sculpted prims (colloquially known as "sculpties"), textures for clothing or other objects, and animations and gestures can be created using external software.

Avatars may take any form users choose (human, animal or other non living object) or residents may choose to resemble themselves as they are in real life, or they may choose even more abstract forms, given that almost every aspect of an avatar is fully customizable. Avatars can communicate via local chat, group chat, global instant messaging (known as IM), and voice.

Land ownership is another feature in the virtual world that can make the Second Life experience even more compelling and rewarding. When you have land in Second Life, you're actually renting storage/server space at Linden Lab. Each piece of land takes up a certain amount of dedicated storage space. It's like renting a hard drive.

Popular products for creating virtual reality effects on personal computers include Bryce, Extreme 3D, Ray Dream Studio, true Space, 3D Studio MAX, and Visual Reality. Linden Lab provides official viewers for XP / Vista, Mac OS X, and most distributions of Linux. A third-party version is available for Solaris and Open Solaris. The viewer renders 3D graphics using OpenGL technology. Since the viewer is open source, users may recompile it to create their custom viewers; modified viewer software is available from third parties. One such example is the Nicholaz Edition.

With this paradigm, Second Life enables users to use the software on a cloud computing model with payment based on usage of time and resources. With more simulation on the software, the cost of sophisticated hardware is reduced. Custom application development is relatively easier as it uses scripting language in which the software developers can be trained and as the multimedia effects are developed using industry standard packages.

Social and legal issues :

- Can government offer the real world services to real-world citizens and businesses more effectively and efficiently in Social Virtual Worlds (SVW)? Will e-government evolve to v-government? How will our virtual social interactions impact our real social behavior? How will real life laws and rules apply to VWs? Is it necessary to define special laws and rules for VWs? What are the users' responsibilities when committing crimes through their avatars? What is the ethics related to virtual marketing? How will consumers be protected from some kinds of virtual marketing?

7. Phased implementation of VW in Hospitals

Designing, implementing and using the virtual world systems in hospitals is a multi-step process. The expertise needed has not been fully developed yet. But despite this, all those involved in the area of virtual reality believe that it has real therapeutic potential.

The implementation process can broadly be divided into three stages-

- VW applications available in the Internet or the market can be used for training the doctors, nurses and other hospital authorities for learning anatomy, emergency management etc
- VW applications can be used for more sophisticated applications like medical advice, medical consultancy, surgery simulation etc
- VW applications can be developed specifically as customer development for the hospitals and the type of patients with expertise from the doctors providing domain knowledge and with the technology expertise from the software and multimedia designers. The applications developed specifically for the hospitals may include (a) training services, training on the medical equipments, emergency services training, hospital management training etc , awareness creation on specific medical challenges in that area or country (eg rural healthcare, child mortality, precautions during pregnancy etc) (b) simulations like body simulation, human body diseases simulation, medical treatment simulation, surgery simulation etc. and finally (c) treatment and therapies.

This process can be aligned well to enable VW features in hospitals namely Video simulation, Interactivity, Multi user scenario simulation, testing users learning etc. In this implementation model the learning curve increases linearly with the improved features.

8. References

- [1] Second Life facts - www.absolouteastronomy.com
- [2] Tomasz Mazuryk and Michael Gervautz, "Virtual Reality- History, Applications, Technology and Future"
- [3] Science and Technology Library – ThinkQuest "www.thinkquest.org"
- [4] Marek Czernuzenko, Dave Pape, Daniel Sandin, Tom DeFanti, Gregory L.Dawe, Maxine D.Brown "The ImmersaDesk and Infinity Wall projection-based virtual reality displays" Univ. of Illinois at Chicago, Chicago.
- [5] Bruno Herbelin, Francoise Riquier, Frederic Vexo and Daniel Thalmann "Virtual Reality In Cognitive Behavioral Therapy: a study on Social Anxiety Disorder", Switzerland.
- [6] <http://www.vrphobia.com/Products/painman.htm>
- [7] Bharti Temkin, Eric Acosta, Paul Hatfield, Erhan Onal, and Alex Tong "Web-based Three-dimensional Virtual Body Structures: W3D-VBS" July 23, 2002.
- [8] <http://blog.indusgeeks.com/>
- [9] Virtual reality in healthcare "<http://www.prlog.org/11276990-virtual-reality-technologies-and-how-are-they-being-used-in-us-healthcare-market-through-bharatbook.html>"
- [10] <http://secondhealth.wordpress.com/clinical-scenarios/>
- [11] IBM Virtual Health Island "<http://digital-medicine.blogspot.com/2011/01/virtual-healthcare-center-in-second.html>"
- [12] VR systems "<http://www.bilawchuk.com/mark/technology.html>"
- [13] Imperial College London, www.sciencereel.com
- [14] Virtual Surgery Simulations, "www.sciencedaily.com"
- [15] Applications of Virtual Reality-Example "science.jrank.org/Virtual-Reality-Applications-virtual-reality.html"
- [16] Adel Hendaoui, Moez Limayem and Craig W.Thompson, "3D Social Virtual Worlds, Research Issues and Challenges"
- [17] Virtual Reality, http://connet.us/virtual_reality.htm