Virtual Reality use, application and challenges

Shikha Dhoriyani[1]

[1] B E Student, CE Department, Saffrony institute of technology, Gujarat, India

ABSTRACT

Virtual Reality (VR), sometimes called Virtual Environments (VE) has drawn much attention in the last few years. Extensive media coverage causes this interest to grow rapidly. Very few people, however, really know what VR is, what its basic principles and its open problems are. In this paper a historical overview of virtual reality is presented, basic terminology and classes of VR systems are listed, followed by applications of this technology in science, work, and entertainment areas. An insightful study of typical VR systems is done. All components of VR application and interrelations between them are thoroughly examined: input devices, output devices and software. Additionally human factors and their implication on the design issues of VE are discussed. Finally, the future of VR is considered in two aspects: technological and social. New research directions, technological frontiers and potential applications are pointed out. The possible positive and negative influence of VR on life of average people is speculated.

Keyword: - *VR , Technical application, Cultural application, Advancement*

1. INTRODUCTION

Virtual Reality is described in various and sometimes inconsistent ways in some publications and conferences because this technology is new and writers attempt to define it based on different perspectives such as the tools it uses, its functions, etc . If we consider the perspective based on functionality, Virtual reality (VR) is a term that applies to computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds. In other word, virtual Reality is a simulation in which computer graphics is used to create a realistic looking world. Moreover the synthesized world is dynamic and responds to user inputs such as gestures and verbal commands. Virtual Reality is a real-time and interactive technology. It means that the computer is able to detect user inputs and modify the virtual world instantaneously. Interactivity and its captivating power contribute to the feeling of being the part of the action on the environment that the user experience. All human sensorial channels can be used to have a high level interaction. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced simulators, use haptic systems which include tactile information, generally known as force feedback. So, we can summarize the above ideas of Virtual Reality in one definition: Virtual Reality is a high-end user interface that involves real time simulation and interaction through multiple sensorial channels like visual, auditory or tactile. Samples of Virtual Reality interaction are illustrated in Figure 1. In1962, inspired by holographic movies, Morton Heilig patented the design called “sensorama”. The patent is the first video device of virtual reality by which a user can feel the vibration, sound, smell, and wind recorded in advance. The head-mounted video is similar to the head mounted display seen in the early 1990s. In1965, the founder of computer graphics, Sutherland inherited and developed the design of Heilig. Sutherland presented the basic concept of a virtual reality system which had multi-senses, immersion, and interaction. In1966, funded by the navy scientic research office, American MIT Lincoln Laboratory developed the first head-mounted display (HMD) and applied the feedback devices which simulate the force and tactile in the system later. In1967, inspired by the conception of Sutherland’s system, the University of North Carolina launched the GROPE project which researched and developed force feedback devices that made users feel computer simulated force. In 1968, organized by Harvard University, Sutherland designed the helmet mounted display and later a virtual system which was considered as the first virtual reality system. In 1970, American MIT Lincoln Laboratory developed a full-fledged HMD system. In 1973, Krurger presented the term “artificial reality”, which was the early term of virtual reality. In 1987, Foley published a paper entitled “Interfaces for Advanced Computing” in the journal “Scientifc American”. Another pape about data gloves was also published in this journal. These published papers about virtual reality attracted people greatly. In 1989, American Jarn Lanier formally presented the term “virtual reality”. In 1994, Burdea and Coiffet published a book about virtual reality in which they summarized the basic characters of VR as 3I (imagination, interaction and immersion). From 1995 up to now, by development of computer graphic science, “Virtual Reality” has become one of state of the art topics and researchers attempt to create more realistic environment and more active interfaces for high quality interaction in this field.

Virtual Reality technology has been a promising technology applicable in various domains of application such as training simulators, medical and health care, rehabilitation, education, engineering, scientific visualization, and entertainment industry. In addition, Virtual reality can lead to state of the art technologies like Second Life, too. Like many advantageous technologies, beside opportunities of Virtual Reality and Second Life, inevitable challenges appear, too. This paper is a technical brief on Virtual Reality technology and its opportunities and challenges in different areas.

2. What is VR?

There are some people to whom VR is a specific collection of technologies; that is, headset, glove and walker (Haag et al., 1998; Williams & Sawyer, 2001; Isdale, 1993). VR is defined as a highly interactive, computer-based multimedia environment in which the user becomes the participant in a computer-generated world (Kim et al., 2000; Onyesolu, 2009a; Onyesolu & Akpado, 2009). It is the simulation of a real or imagined environment that can be experienced visually in the three dimensions of width, height, and depth and that may additionally provide an interactive experience visually in full real-time motion with sound and possibly with tactile and other forms of feedback. VR is a way for humans to visualize, manipulate and interact with computers and extremely complex data (Isdale, 1998). It is an artificial environment created with computer hardware and software and presented to the user in such a way that it appears and feels like a real environment (Baieier, 1993). VR is a computer-synthesized, three-dimensional environment in which a plurality of human participants, appropriately interfaced, may engage and manipulate simulated physical elements in the environment and, in some forms, may engage and interact with representations of other humans, past, present or fictional, or with invented creatures. It is a computer-based technology for simulating visual auditory and other sensory aspects of complex environments (Onyesolu, 2009b). VR incorporates 3D technologies that give a reallife illusion. VR creates a simulation of real-life situation (Haag et al., 1998). Therefore, VR refers to an immersive, interactive, multi-sensory, viewer-centered, 3D computer-generated environment and the combination of technologies required to build such an environment (Aukstakalnis & Blatner, 1992; Cruz-Niera, 1993). By immersing viewers in a computer-generated stereoscopic environment, VR technology breaks down barriers between humans and computers. VR technology simulates natural stereoscopic viewing processes by using computer technology to create right-eye and left-eye images of a given 3D object or scene. The viewer’s brain integrates the information from these two perspectives to create the perception of 3D space. Thus, VR technology creates the illusion that on-screen objects have depth and presence beyond the flat image projected onto the screen. With VR technology, viewers can perceive distance and spatial relationships between different object components more realistically and accurately than with conventional visualization tools (such as traditional CAD tools).

2.1 Evolution of VR

The very first idea of it was presented by Ivan Sutherland in 1965: “make that (virtual) world in the window look real, sound real, feel real, and respond realistically to the viewer’s actions” [Suth65]. It has been a long time since then;a lot of research has been done. Let us have a short glimpse at the last three decades of research in virtual reality and its highlights:

•**Sensorama**–The Sensorama Machine was invented in 1957 and patented in 1962 under patent # 3,050,870.Morton Heilig created a multi-sensory simulator. A prerecorded film in color and stereo,was augmented by binaural sound, scent, wind and vibration experiences. This was the first approach to cre-ate a virtual reality system and it had all the features of such an environment, but it was not interactive.

•**The Ultimate Display**–In 1965 Ivan Sutherland proposed the ultimate solution of virtual reality: an artificial world con-struction concept that included interactive graphics, force-feedback, sound, smell and taste.

3. USE of VR

It is not easy to define all the uses of VR because now it's enough develop in many fields. Here, some uses of VR are explained. EDS Jack is an example of a commercially available virtual reality software package. It is mainly used for visibility and ergonomics study. These are two of the areas that using Virtual Reality really benefits. For example when designing a large mechanical device such as a bulldozer or even a car, visibility and ergonomics are very important to the operators. Would you buy a car that was uncomfortable to drive or had poor visibility,probably not? Many companies spend a large amount of money making their products interface better with the operators. The cost of building prototypes is very expensive, upwards of a few million dollars for one machine using the bulldozer example. By using virtual reality the company could check out the viability and ergonomics of their machine quickly and make changes to it without ever spending money on building hardware.

Another area that Virtual Reality is heavily used in is driving or flying simulations. These provide the users a chance to gain expertise operating a vehicle without the real world con-sequences of making a mistake. MPI Vega Prime is an example of a software package that supports any type of driving simulation. The user builds the virtual environment within the software package. It biggest advantage is its realistic physics engine which supports collision detection. Flight simulators are the most common type of machine simulation. Some other examples would be the US Army's use of simulators to train tank solders with virtual tank wars. NASA also trains its astronauts on how to land the space shuttle with a virtual reality simulator.

4. Application and Advancement in VR

The virtual domain offers reliability, speed, ease of access, compactness and security, and is easily transmitted to other virtual domains for example computers located in distant parts of the world. Due to these facts, VR technology has been a promising technology applicable in various domains of application. These most popular domains of application are training simulators, medical and health care, education, defense, engineering, ergonomics and human factors research, database and scientific visualization, and entertainment industry. Training simulators are used for planes, submarines, power plants, surgery, endoscopes and air traffic control. Such simulation uses a replica of the real operational environment and real time computer to model its dynamics. Training through simulation provides significant benefits over other methods. Hazardous environment, such as a nuclear power station, or an aircraft landing in a fog can be accurately simulated without any danger to the trainee. Other benefit is the ability of computer software in providing flexibility to structure training programs and even monitor and measure the progress of a training session. Many simulators employ image processing and machine vision techniques to feel more real images in the virtual environments. The key components of medical and health care where Virtual Environment can be applied are diagnosis, therapy, education and training and medical records. Diagnosis using virtual endoscopy is one of the areas that can achieve clinical efficiency in the earliest time frame. Virtual environments can be used in computer assisted surgery, image guided surgery, tele-surgery, and treatment of phobias and other psychological disorders. The VR system offers a sense of realism in a safe environment. By gradually exposing the person to their fear - for example, fear of flying -with a Virtual Environment the patient becomes accustomed to the trigger of their problem to an extent that it no longer becomes an issue. One of the advantages of this technology is that it allows healthcare professionals to learn new skills as well as refreshing existing ones in a safe environment. Plus it allows this without causing any danger to the patients and can record improvement stages of the patient. Thus Technology can therefore be used in innovative ways to provide support for those with mental health problems and nowadays Virtual Reality Therapy (VRT) is one of the newest treatment technologies. Education is another area which has adopted virtual reality for teaching and learning situations. Virtual Environments can be used for learning of the kind expected to occur in schools, colleges and universities, that is, the acquisition of general problem solving skills, mastery of facts and concepts, and improvement of the learning progress itself. The advantage of this is that it enables large groups of students to interact with each other as well as within a three dimensional environment. It is able to present complex data in an accessible way to students which is both fun and easy to learn. Plus these students can interact with the objects in that environment in order to discover more about them.

There are a lot of applications and advancements in VR technology. VR is being applied in all areas of human endeavor and many VR applications have been developed for manufacturing, training in a variety of areas (military, medical, equipment operation, etc.), education, simulation, design evaluation (virtual prototyping), architectural walk-through, ergonomic studies, simulation of assembly sequences and maintenance tasks, assistance for the handicapped, study and treatment of phobias (e.g., fear of height), entertainment, rapid prototyping and much more (Onyesolu, 2006). This has been made possible due to the power of VR in transporting customers to a virtual environment and convincing them of their presence in it (Wittenberg, 1993). In industry, VR has proven to be an effective tool for helping workers evaluates product designs. In 1999, BMW explored the capability of VR for verifying product designs (Gomes de Sa & Zachmann, 1999). They concluded that VR has the potential to reduce the number of physical mockups needed to improve overall product quality, and to obtain quick answers in an intuitive way during the concept phase of a product. In addition, Motorola developed a VR system for training workers to run a pager assembly line (Wittenberg, 1995). They found that VR can be used to successfully train manufacturing personnel, and that participants trained in VR environments perform better on the job than those trained for the same time in real environments. In 1998, GE Corporate Research developed two VR software applications, Product Vision and Galileo, which allowed engineers to interactively fly through a virtual jet engine (Abshire, & Barron, 1998). They reported that the two applications were used successfully to enhance design communication and to solve maintenance problems early, with minimal cost, delays, and effort. They also reported that using the VR applications helped make maintenance an integral part of their product design process. The success stories from industry show that VR-technology-literate professionals are a present and future industry need. However, most students currently do not have an opportunity to experience VR technologies while they are in school. Therefore, introducing VR into design and graphics curricula is imperative, to keep pace with the changing needs of industry. Boeing (the largest aircraft manufacturers in the world) developed the Virtual Space eXperiment (VSX). VSX is a demonstration of how virtual environment systems can be applied to the design of aircraft and other complex systems involving human interactions (Kalawsky, 1993). It is a 3D virtual model of the interior and exterior of a tilt-rotor aircraft in virtual space that allows persons to interact with various items such as maintenance hatch, cargo ramp. McDonnell Douglas uses a ProVision 100 VPX system to evaluate how a virtual environment can aid the design of new engine types. The system is utilized to explore the processes for installing and removing engines, especially for detecting the potential interface with other devices. The automotive industry starts to use the VR technology to design and build cars. It can take two years or more to advance from the development of an initial concept for a new type of car to the moment that a production version rolls off the assembly line. A virtual reality-based point-and-direct (VR-PAD) system was developed to improve the flexibility in passive robot inspection (Wang & Cannon, 1996). An operator in a remote control room monitors the real working environment through live video views displayed on the screen and uses the virtual gripper to indicate desirable picking and placing locations. The robot in the inspection system completes material handling as specified so that the system can achieve flaw identification. The CERN, European Laboratory for Particle Physics, performed the pilot project that evaluated and promoted the use of virtual environment technology to help design, building and maintaining the Large Hedron Collider (LHC) premises and equipment (Balaguer & Gennaro, 1996). The project consists of several applications, such as network design and integration, territory impact study, and assembly planning and control to respond to the needs of LHC engineers. Virtual Reality is a powerful tool for education since people comprehend images much faster than they grasp lines of text or columns of numbers. VR offers multisensory immersive environments that engage students and allow them visualize information (Eslinger, 1993). Mathematics and science teachers have used VR for explaining abstract spatial data. Winn and Bricken (1992) used VR to help students learn elementary algebra. They used three-dimensional space to express algebraic concepts and to interact with spatial representations in a virtual environment. They concluded that VR has the potential for making a significant improvement in the way students learn mathematics. Haufmann et al (2000) used VR in mathematics and geometry education, especially in vector analysis and descriptive geometry. Their survey showed that all participants (10 students) rated VR as a very good playground for experiments, and all participants wanted to experience VR again. Students also thought it was easier to view a 3D world in VR rather than on a flat screen. VR was used to demonstrate molecular mechanisms in chemical engineering courses (Bell, 1996; Bell & Fogler, 1998). Though no statistical analysis was provided, some evidence of enhanced learning in some cases was reported. At the University of Michigan, Vicher (Virtual Chemical Reactors) was developed in the department of Chemical Engineering to teach students catalyst decay, non-isothermal effects in kinetics and reactor design and chemical plant safety (Bell & Fogler, 1996a; Bell & Fogler, 1996b). The developers believed that humans retain up to 90% of what they learn through active participation. The most exciting possibilities in terms of education and VR are found as it is implemented in the education of the disabled.

5. Challenges

Virtual reality can lead to state of the art technologies like second life. In fact, virtual reality program Second Life poses new challenges to its more than millions of users that include economic interactions, methods of communication and documentation. In other words, Second Life is a MUVE, or Multi-user Virtual Environment. Second Life is an online virtual world developed by an American company named Linden Lab. It was launched on June 23, 2003. A number of free client programs, or Viewers, enable Second Life users, called Residents, to interact with each other through avatars. Residents can explore the world (known as the grid), meet other residents, socialize, participate in individual and group activities, and create and trade virtual property and services with one another. In the other hand, Second Life comprises the viewer (also known as the client) executing on the user's personal computer, and several thousand servers operated by Linden Lab. Second Life is intended for people aged 16 and over. Now that worlds like Second Life have a stable and growing user base, various organizations and businesses are beginning to colonize, build and grow in these worlds [23]. Built into the software is a three-dimensional modeling tool based on simple geometric shapes that allows residents to build virtual objects. There is also a procedural scripting language, Linden Scripting Language, which can be used to add interactivity to objects. Sculpted prims (sculpties), mesh, textures for clothing or other objects, animations, and gestures can be created using external software and imported. Like many advantageous technologies, beside opportunities of Virtual Reality and Second Life, unavoidable challenges appear, too. In fact, using Virtual Reality and Second Life offers both technical and cultural challenges. We can describe these challenges in two following sections.

a. TECHNICAL CHALLENGES

Second Life in Virtual Reality environments functions by streaming all data to the user live over the Internet with minimal local caching of frequently used data. The user is expected to have a minimum of 300kbit/s of Internet bandwidth for basic functionality, with 1Mbit/s providing better performance. Due to the proprietary communications protocols, it is not possible to use a network proxy/caching service to reduce network load when many people are all using the same location, such as when used for group activities in a school or business. Due to Virtual Reality's and Second Life's rapid growth rate, it has suffered from difficulties related to system instability. These include increased system latency, and intermittent client crashes. However, some faults are caused by the system's use of an "asset server" cluster, on which the actual data governing objects is stored separately from the areas of the world and the avatars that use those objects. The communication between the main servers and the asset cluster appears to constitute a bottleneck which frequently causes problems Typically, when asset server downtime is announced, users are advised not to build, manipulate objects, or engage in business, leaving them with little to do but chat and generally reducing confidence in all businesses on the grid. Cost is another issue. In addition to appropriate internet band width and virtual reality environment and interfaces charges, establishing Second Life in virtual environments offers several membership plans, too. For example for virtual learning, a premium account is required to purchase land, which is necessary to create a sustained and safe learning environment for students. However, increasingly powerful computer systems are becoming more affordable each year, but commercial VR systems that are sophisticated enough to offer complex models and diverse functionality are still expensive relative to personal computers.

b. CULTURAL CHALLENGES

Liability issues are still at question in virtual worlds. In Second Life private land can be purchased. Private land can be restricted to only authorized users. However, users in public areas may be subjected to violence or disruptive players (LaChapelle, 2007). There are many unresolved legal issues surrounding virtual violence, virtual assault, and sexual harassment that take place in Second Life and in other Virtual Reality worlds. And unfortunately no one is liable in these events, now. So, It would seem the virtual world and second life is facing criminal problems of real-world. Nowadays, the concept of "Virtual Reality" is new to law enforcement agencies around the world. Yet every day, millions of people connect in these worlds to socialize, shop and learn. Unfortunately, lawbreakers have also joined these virtual worlds and the full range of criminal activities is now also present. Common crimes are occurring every day in virtual worlds, including money-laundering, theft of intellectual property, exchange of child abuse images and even suspected terrorist activities. For these reasons, new virtual worlds and communities pose a unique set of challenges for the criminal justice system. Moreover, the near total lack of requisite jurisprudence means that criminals are often free to act with impunity. A more disturbing fact, believed to be caused by the same issue, is "inventory loss" in which items in a user's inventory, including those which have been paid for, can disappear without warning or permanently enter a state where they will fail to appear in-world when requested (giving an "object missing from database" error). Linden Lab offers no compensation for items that are lost in this way, although a policy change instituted in 2008 allows accounts to file support tickets when inventory loss occurs. Many in-world businesses will attempt to compensate for this or restore items, but they are under no obligation to do so and not all are able to do so. Although "inventory loss" is much less from past years but it does still exists. Second life and most virtual Reality worlds do not have appropriate tools for system management. For instance virtual worlds and Second Life were not created for educational purposes, inherently. Nonetheless, they are being adapted by educators for teaching and learning. Faculty can integrate text information in the form of note cards and use Web sites, content slides, video, and audio in addition to creating 3-D objects. However, many of the features educators take for granted in Learning Management Systems do not exist in Virtual Reality and Second Life. Additionally, Second Life is a random access environment thus giving instructors very little control over lesson sequencing. Nowadays some of the Learning Management features that are lacking in virtual worlds are beginning to be addressed and efforts are underway to facilitate the use of these systems, in future.

The big challenges in the field of virtual reality are developing better tracking systems, finding more natural ways to allow users to interact within a virtual environment and decreasing the time it takes to build virtual spaces. While there are a few tracking system companies that have been around since the earliest days of virtual reality. Likewise, there aren't many companies that are working on input devices specifically for VR applications. Most VR developers have to rely on and adapt technology originally meant for another discipline, and they have to hope that the company producing the technology stays in business. As for creating virtual worlds, it can take a long time to create a convincing virtual environment -the more realistic the environment, the longer it takes to make it. It could take a team of programmers more than a year to du-plicate a real room accurately in virtual space. Another challenge for VE system developers is creating a system that avoids bad ergonomics. Many systems rely on hard-ware that encumbers a user or limits his options through physical tethers. Without well-designed hardware, a user could have trouble with his sense of balance or inertia with a decrease in the sense of telepresence, or he could experience cyber sickness, with symptoms that can include disorientation and nausea.

6. CONCLUSIONS

At the present time a good choice of commercial products exists for visual, tracking, and user input interfaces. Auditory and haptic interface technologies currently are almost restricted to research applications, but are becoming ready for use in practical applications. Full-body motion interfaces are limited to specialized entertainment systems, support for more general types of movement still is exclusively a research topic. Olfactory interface is the least mature of all the technologies. Even the most mature technologies (visual and tracking) still suffer from some limitations, and in no instance VR interface technology perfectly match human sensory capabilities. It is important to note, however, that it now possible, as opposed to the situation of only a few years ago, to have devices that provide a fairly good quality and are useable for many, if not all, applications. As full fidelity of sensory cues is not achievable even with the most advanced and expensive devices, it is thus of primary importance when developing a VR application, to carefully study the specific fidelity required and the most appropriate devices and trade-offs needed for satisfying those requirements at best. Virtual Reality is now involved everywhere. You can't imagine your life without the use of VR Technology. In this paper we define the Virtual Reality and its history. We also define some important development which gives the birth of this new technology. Now we use mail or conference for communication while the person is not sitting with you, but due to technology distance is not matter. This technology give enormous scope to explore the world of 3D and your own imagination. It has many applications from product development to entertainment. It is still very much in the development stage with many users creating their own customized applications and setups to suit their needs.

7. REFERENCES

[1]. Steur, J. (1995). Defining virtual reality: Dimensions determing telepresence. In F. L. Biocca (Ed.),Communication in the age of virtual reality. Hillsdale, NJ: Lawrence Erlbaum Associates.
[2]. Sutherland, I. E. (1965). "The Ultimate Display". Proceedings of IFIP 65, vol 2, pp.506–508
[3]. Burdea, G. and P. Coffet (2003). Virtual Reality Technology, Second Edition. Wiley-IEEE Press.
[4]. J. Allard, J. Lesage and B. Raffin, "Modularity for Large Virtual Reality Applications", Journal Presence: Teleoperators and Virtual Environments, Vol. 19 (2), pp. 142-161, April 2010.
[5]. D. de Nood and J. Attema, "The Second Life of Virtual Reality", EPN - Electronic Highway Platform, December 2006.
[6]. J. Helmer, "Second Life and Virtual Worlds", Learning Light Institute, October 2007.
[7]. G. Derpanis, "A Review of Vision-Based Hand Gestures", York University, 2004.
[8]. J. Vince, "Virtual Reality Systems", Wokingham Addison-Wesley, 1995.
[9]. Ausburn, L. J. & Ausburn, F. B. (2004). Desktop virtual reality: A powerful new technology for teaching and research in industrial teacher education. Journal of Industrial Technical Education, Vol. 41, No.4, [Online], Available: http://scholar.lib.vt.edu/ejournals/JITE/v41n4/ausburn.html