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Understanding Virtual Reality Technology: Advances and Applications

Moses Okechukwu Onyesolu[1] and Felista Udoka Eze[2]
[1]*Nnamdi Azikiwe University, Awka, Anambra State.*
[2]*Federal University of Technology, Owerri, Imo State, Nigeria*

1. Introduction

Virtual Reality (VR) is not an entirely new concept; it has existed in various forms since the late 1960s. It has been known by names such as synthetic environment, cyberspace, artificial reality, simulator technology and so on and so forth before VR was eventually adopted. The latest manifestation of VR is desktop VR. Desktop VR is also known by other names such as Window on World (WoW) or non-immersive VR (Onyesolu, 2006). As a result of proliferation of desktop VR, the technology has continued to develop applications that are less than fully immersive. These non-immersive VR applications are far less expensive and technically daunting and have made inroads into industry training and development. VR has perhaps at last come within the realm of possibility for general creation and use most especially in education where computer-based virtual learning environments (VLE) are packaged as desktop VR. This, in turn, points the way for its inclusion in educational programs (Ausburn & Ausburn, 2004). These computer-based virtual learning environments (VLEs) have opened new realms in the teaching, learning, and practice of medicine, physical sciences and engineering among others. VLEs provide students with the opportunity to achieve learning goals. VLE-based applications have thus emerged in mainstream education in schools and universities as successful tools to supplement traditional teaching methods. These learning environments have been discovered to have greater pedagogical effectiveness on learners. Virtual learning environments provide three-dimensional (3D) insights into the structures and functions of any system desired. Students can thereby learn the principles of such system in a fast, effective and pleasurable way by interacting with and navigating through the environment created for such system (Onyesolu, 2009a; Onyesolu, 2009b). It is known that VR can make the artificial as realistic as, and even more realistic than, the real (Negroponte, 1995).

2. The technology: Virtual Reality

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 real-life 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).

3. Virtual Reality components

The components necessary for building and experiencing VR are divided into two main components-the hardware components and the software components.

3.1 Hardware components

The hardware components are divided into five sub-components: computer workstation, sensory displays, process acceleration cards, tracking system and input devices.

3.1.1 Computer workstation

A computer workstation is a high-end microcomputer designed for technical or scientific applications. Intended primarily to be used by one person at a time, workstations are commonly connected to a local area network and run multi-user operating systems. The term workstation has also been used to refer to a mainframe computer terminal or a personal computer (PC) connected to a network.

Workstations had offered higher performance than personal computers, especially with respect to CPU and graphics, memory capacity and multitasking capability. They are optimized for the visualization and manipulation of different types of complex data such as 3D mechanical design, engineering simulation animation and rendering of images, and mathematical plots. Workstations are the first segment of the computer market to present advanced accessories and collaboration tools. Presently, the workstation market is highly

commoditized and is dominated by large PC vendors, such as Dell and HP, selling Microsoft Windows/Linux running on Intel Xeon/AMD Opteron. Alternative UNIX based platforms are provided by Apple Inc., Sun Microsystems, and Silicon Graphics International (SGI) (http://en.wikipedia.org/wiki/Workstation). Computer workstation is used to control several sensory display devices to immerse you in 3D virtual environment.

3.1.2 Sensory displays

Sensory displays are used to display the simulated virtual worlds to the user. The most common sensory displays are the computer visual display unit, the head-mounted display (HMD) for 3D visual and headphones for 3D audio.

3.1.2.1 Head mounted displays

Head mounted displays place a screen in front of each of the viewer's eyes at all times. The view, the segment of the virtual environment generated and displayed, is controlled by orientation sensors mounted on the "helmet". Head movement is recognized by the computer, and a new perspective of the scene is generated. In most cases, a set of optical lens and mirrors are used to enlarge the view to fill the field of view and to direct the scene to the eyes (Lane, 1993).



Fig. 1. Visette 45 SXGA Head Mounted Display (HMD)

3.1.2.2 Binocular Omni-Orientation Monitor (BOOM)

The BOOM is mounted on a jointed mechanical arm with tracking sensors located at the joints. A counterbalance is used to stabilize the monitor, so that when the user releases the monitor, it remains in place. To view the virtual environment, the user must take hold of the monitor and put her face up to it. The computer will generate an appropriate scene based on the position and orientation of the joints on the mechanical arm (Aukstakalnis & Blatner,



Fig. 2. A Binocular Omni-Orientation Monitor (BOOM)

1992). Some of the problems associated with HMDs can be solved by using a BOOM display. The user does not have to wear a BOOM display as in the case of an HMD. This means that crossing the boundary between a virtual world and the real world is simply a matter of moving your eyes away from the BOOM.

3.1.2.3 Visual Display Unit (VDU) or monitors

There are two types of computer visual display unit. The CRT monitors and the LCD monitors. The distinguishing characteristics of the two types are beyond the scope of this piece.

3.1.3 Process acceleration cards

These cards help to update the display with new sensory information. Examples are 3D graphic cards and 3D sound cards.

3.1.4 Tracking system

This system tracks the position and orientation of a user in the virtual environment. This system is divided into: mechanical, electromagnetic, ultrasonic and infrared trackers.



Fig. 3. Patriot wireless electromagnetic tracker



Fig. 4. Logitech ultrasonic tracker

3.1.5 Input devices

They are used to interact with the virtual environment and objects within the virtual environment. Examples are joystick (wand), instrumented glove, keyboard, voice recognition etc.

3.2 Software components

The software components are divided into four sub-components: 3D modeling software, 2D graphics software, digital sound editing software and VR simulation software.



Fig. 5. An instrumented glove (Nintendo power glove)

3.2.1 3D modeling software

3D modeling software is used in constructing the geometry of the objects in a virtual world and specifies the visual properties of these objects.

3.2.2 2D graphics software

2D graphics software is used to manipulate texture to be applied to the objects which enhance their visual details.

3.2.3 Digital sound editing software

Digital sound editing software is used to mix and edit sounds that objects make within the virtual environment.

3.2.3 VR simulation software

Simulation software brings the components together. It is used to program how these objects behave and set the rules that the virtual world follows.

4. Classification of Virtual Reality systems

VR is classified into three major types: (a) Non-Immersive VR Systems, (b) Semi-Immersive VR Systems and (c) Immersive (Fully Immersive) VR systems. Other forms of classification are levels of VR and methods of VR. Levels of VR deals with efforts employed to develop VR technology. Under this classification we have entry level, basic level, advanced level, immersive systems and big-time systems. Methods of VR classification deals with methods employed in developing VR system. Under this class we have simulation based systems, projector based systems, avatar-image based systems and desktop based system.

4.1 Non-immersive VR systems

As the name suggests, are the least implementation of VR techniques. It involves implementing VR on a desktop computer. This class is also known as Window on World (WoW) (Onyesolu, 2006). Using the desktop system, the virtual environment is viewed through a portal or window by utilizing a standard high resolution monitor. Interaction with the virtual environment can occur by conventional means such as keyboard, mouse or trackball

4.2 Semi-immersive VR systems

A semi immersive VR system comprise of a relatively high performance graphics computing system which can be coupled with either a large screen monitor; a large screen projection

system or multiple television projection system. Using a wide field of view, these systems increase the feeling of immersion or presence experienced by the user and stereographic imaging can be achieved using some type of shutter glasses.

4.3 Immersive (fully immersive) VR systems

An Immersive VR system is the most direct experience of virtual environments. Here the user either wears an head mounted display (HMD) or uses some form of head-coupled display such as a Binocular Omni-Orientation Monitor (BOOM) to view the virtual environment, in addition to some tracking devices and haptic devices. An HMD or BOOM uses small monitors placed in front of each eye which provide stereo, bi-ocular or monocular images.

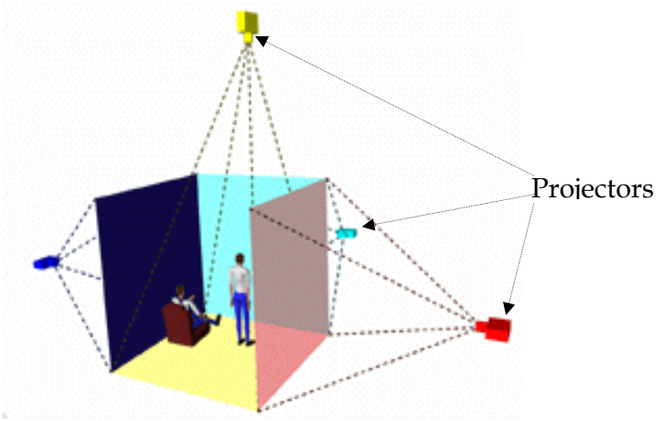


Fig. 6. Schematic representation of a CAVE

5. Low-cost VR technology

Low-cost VR, also called personal computer (PC)-based VR, uses inexpensive devices such as PC workstations and VR glasses, combined with VR-enabled software applications or playstations and projectors, to partially immerse viewers in a virtual scene (Fang et al., n.d.). Fig 5 is a low-cost VR system developed with three playstations, a network switch and two projectors.



Fig. 7. PlayStation2 VR system

The benefits of low cost virtual reality hardware are obvious; high performance systems which were previously exclusive to research institutions with well funded budget can now be constructed relatively cheaper. The reduced price/performance ratio has positive implications for hospitals, educational institutions, museums and other organizations where funding of new technologies are often limited. Previously disadvantaged communities can also benefit from this new technology. In education, cheap VR can provide massive quality education through the interactive learning environment; in medicine, cheap virtual environment has been shown to provide promising results in the field of exposure therapy (Fang et al., n.d.).

6. How Virtual Reality works

The idea behind VR is to deliver a sense of being there by giving at least the eye what it would have received if it were there and, more important to have the image change instantly as the point of view is changed (Smith & Lee, 2004). The perception of spatial reality is driven by various visual cues, like relative size, brightness and angular movement. One of the strongest is perspective, which is particularly powerful in its binocular form in that the right and left eyes see different images. Fusing these images into one 3D perception is the basis of stereovision.

The perception of depth provided by each eye seeing a slightly different image, eye parallax, is most effective for objects very near you. Objects farther away essentially cast the same image on each eye. The typical dress code for VR is a helmet with goggle-like displays, one for each eye. Each display delivers a slightly different perspective image of what you would see if you were there. As you move your head, the image rapidly updates so that you feel you are making these changes by moving your head (versus the computer actually following your movement, which it is). You feel you are the cause not the effect.

7. VR development tools and resources

There are many VR development tools and resources. Some of these tools and resources are free (open source to use), some are proprietary (closed source) (Wang & Canon, 1996). VR related development is in progress regarding the availability, usability and capability of customization for existing development tools and resources. VR development tools and resources are quite numerous; some examples are presented:

7.1 Virtual Heroes Inc. (VHI)

This is an "Advanced Learning Technology Company" that creates collaborative interactive learning solutions for Federal Systems, Healthcare and Corporate Training markets (http://www.virtualheroes.com/about.asp). VHI applications facilitate highly interactive, self-paced learning and instructor-led, distributed team training on its Advanced Learning Technology (ALT) platform. Major components of this platform include the Unreal® Engine 3 by Epic Games, and Dynamic Virtual Human Technology (DVHT). ALT leverages simulation learning and digital game-based learning paradigms to accelerate learning, increase proficiency and reduce costs. DVHT combines best-in-class electronic computer game technology with a digital human physiology engine, digital pharmacokinetic drug models, accurate biomechanical parameters and artificial intelligence subroutines for the most realistic virtual humans available anywhere.

7.2 On-Line Interactive Virtual Environment (OLIVE)

This is a product of Forterra Systems Inc. Forterra Systems Inc. builds distributed virtual world technology and turnkey applications for defense, homeland security, medical, corporate training, and entertainment industries (http://company.mmosite.com/forterra /index.shtml). Using the On-Line Interactive Virtual Environment (OLIVE) technology platform, customers can rapidly generate realistic three-dimensional virtual environments that easily scale from single user applications to large scale simulated environments supporting many thousands of concurrent users. Forterra's technology and services enable organizations to train, plan, rehearse, and collaborate in ways previously considered impossible or impractical.

OLIVE combines multimedia, scalable computing and network enabled connectivity to provide a complete IT-ready platform for developing and supporting truly collaborative, multiplayer interactive virtual environments. It is a 3D client-server virtual world platform using PC clients connected to a central server via a network. The architecture scales from a Windows based development environment to large scale Linux clusters. This architecture supports many thousands of concurrent, geographically distributed users (http://www.webbuyersguide.com/product/brief.aspx?src=rss&kc=rss&id=52841)

7.3 Icarus Studios Inc.

The company offers tools and products for creating massively multi-player online (MMO) environments, virtual worlds, and serious games for major entertainment, corporate, and government clients (Mousa, n.d). Icarus provides next generation technology, tools and production services enabling publishers and marketers to develop immersive environments to create new revenue streams and branding opportunities (http://www.icarusstudios.com/). Icarus Studios products include compatibility with industry standard tools such as 3D Max, Collada, and other 3D applications with simple editors.

7.4 OpenSimulator (OpenSim)

OpenSimulator is a 3D application server. It can be used to create a virtual environment (world) which can be accessed through a variety of clients, on multiple protocols (Mousa, n.d). OpenSimulator allows you to develop your environment using technologies you feel work best. OpenSimulator has numerous advantages which among other things are:

i. OpenSimulator is released under BSD license, making it both open source, and commercially friendly to embed in products.
ii. It has many tools for developers to build various applications (chat application, buildings, and avatars among others).
iii. OpenSimulator can be extended via modules to build completely custom configuration.
iv. It is a world building tools for creating content real time in the environment.
v. Supports many programming languages for application development such as Linden Scripting Language / OpenSimulator Scripting Language (LSL/OSSL), C#, and/or Jscript and VB.NET
vi. It incorporates rich and handy documentations and tutorials.

7.5 Croquet

Croquet is an open source 3D graphical platform that is used by experienced software developers to create and deploy deeply collaborative multi-user online virtual world

applications on and across multiple operating systems and devices (http://www.opencroquet.org/index.php/Main_Page). Croquet is a next generation virtual operating system (OS) written in Squeak. Squeak is a modern variant of Smalltalk. Squeak runs mathematically identical on all machines. Croquet system features a peer-based messaging protocol that dramatically reduces the need for server infrastructures to support virtual world deployment and makes it easy for software developers to create deeply collaborative applications. Croquet provides rich tutorials, resources and videos as educational materials for developers.

7.6 Ogoglio

Ogoglio is an open source 3D graphical platform like Croquet. The main goal of the Ogoglio is to build an online urban style space for creative collaboration. Ogoglio platform is built from the languages and protocols of the web. Therefore, it's scripting language is javascript; it's main data transfer protocol is hypertext transfer protocol (HTTP), it's 2D layout is hypertext markup language (HTML) and cascading style sheet (CSS), and it has lightwave object geometry format for its 3D (http://foo.secondlifeherald.com/slh/2007/01/interview_with_.html). Ogoglio is very different from the other virtual reality world development platforms because it uses Windows, Linux, Solaris operating system platforms and runs on web browsers such as Internet Explorer, Firefox, and Safari.

7.7 QuickDraw 3D (QD3D)

QuickDraw 3D is a 3D graphics API developed by Apple Inc. in 1995. It was delivered as a cross-platform system, though originally developed for their Macintosh computers. QD3D provides a high-level API with a rich set of 3D primitives that is generally much more full-featured and easier to develop than low-level APIs such as OpenGL or Direct3D.

7.8 Autodesk 3d Max (3D Studio MAX)

Autodesk 3d Max (formerly known as 3D Studio MAX) is a modeling, animation and rendering package developed by Autodesk Media and entertainment. 3d Max is the third most widely-used off the shelf 3D animation program by content creation professionals. It has strong modeling capabilities, a flexible plugin architecture and a long heritage on the Microsoft Windows platform. It is mostly used by video game developers, television commercial studios and architectural visualization studios. It is also used for movie effects and movie pre-visualization.

7.9 Blink 3D Builder

Blink 3D Builder is a proprietary authoring tool for creating immersive 3D environments. The 3D environments can be viewed using the Blink 3D Viewer on the Web or locally.

8. Applications and advancements in VR technology

There are a lot of applications and advancements in VR technology. VR is being applied in all areas of human endeavour 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.

Sulbaran and Baker (2000) created an online learning system to study the effectiveness of VR in engineering education. They used VR to train participants on how to operate a lock and to identify construction machines. They found that 82% of learners thought learning with VR was more engaging than learning from reading books and listening to lectures using overheads containing graphics or pictures. They also found, in their first survey, that 69% of the students thought they had learned how a lock operates, and 57% thought they had learned how to identify construction machines. 7 to 21 days later, 92% of the students were still able to operate a lock and identify construction machines. Finally, in their second survey, 91% of the learners strongly agreed or agreed that the learning experience benefits from the use of VR.

VR technology promises to shorten a product development cycle greatly by skipping the need for physical mockups (Vince, 1995). The Ford's Alpha simultaneous engineering team developed a VR system for evaluating process installation feasibility in automotive assembly. In Japan, customers bring the architectural layout of their home kitchen to the Matsushita store and plug it into the computer system to generate its virtual copy (Newquist III, 1993). They can install appliances and cabinets, and change colors and sizes to see what their complete kitchen will look like without ever installing a single item in the actual location. Similarly, Mike Rosen and Associates has been using an interactive and immersive VR technology to assist its building industry clients in the design, visualization, marketing, and sales (Neil, 1996). The applications let the customers become actively involved in the visualization process, such as making changes of colors, textures, materials, lighting, and furniture on the fly.

Researchers at NASA Johnson Space Center in Texas have developed an impressive virtual learning environment for high school students--a virtual physics laboratory which enables students to explore such concepts as gravity, friction, and drag in an interactive, virtual environment. Students have several balls and a pendulum with which to work. They also

have several investigative tools, such as a distance measuring device and a digital stopwatch. In addition, the computer provides several interesting capabilities such as the ability to view dynamic events in slow motion or to show trails on objects to better show their movements (Dedula, 1997).

9. The impact of VR

There has been increasing interest in the potential social impact of VR. VR will lead to a number of important changes in human life and activity (Cline, 2005). Cline (2005) argued that: VR will be integrated into daily life and activity and it will be used in various human ways; techniques will be developed to influence human behavior, interpersonal communication, and cognition (i.e., virtual genetics); as we spend more and more time in virtual space, there will be a gradual "migration to virtual space," resulting in important changes in economics, worldview, and culture and the design of virtual environments may be used to extend basic human rights into virtual space, to promote human freedom and well-being, and to promote social stability as we move from one stage in socio-political development to the next. VR has had and is still having impact in heritage and archeology, mass media, fiction books, television, motion pictures, music videos, games, fine arts, marketing, health care, therapeutic uses, real estates and others numerous to mention.

9.1 Heritage and archaeology

The first use of a VR presentation in a Heritage application was in 1994 when a museum visitor interpretation provided an interactive "walk-through" of a 3D reconstruction of Dudley Castle in England as it was in 1550 (Colin, 2006). This comprised of a computer controlled laser disc based system designed by British-based engineer Colin Johnson. The use of VR in Heritage and Archaeology has enormous potential in museum and visitor centre applications. There have been many historic reconstructions. These reconstructions are presented in a pre-rendered format to a shared video display, thus allowing more than one person to view a computer generated world, but limiting the interaction that full-scale VR can provide.

9.2 Mass media

Mass media has been a great advocate and perhaps a great hindrance to the development of VR over the years. In 1980s and 1990s the news media's prognostication on the potential of VR built up the expectations of the technology so high as to be impossible to achieve under the technology then or any technology to date. Entertainment media reinforced these concepts with futuristic imagery many generations beyond contemporary capabilities (http://en.wikipedia.org/wiki/virtual reality).

9.3 Fiction books

There are many science fiction books which described VR. One of the first modern works to use this idea was Daniel F. Galouye's novel "Simulacron-3". The Piers Anthony's novel "Killobyte" follows the story of a paralysed cop trapped in a VR game by a hacker, whom he must stop to save a fellow trapped player with diabetes slowly succumbing to insulin shock. The first fictional work to fully describe VR was included in the 1951 book-"The Illustrated Man". The "Otherland" series of novels by Tad Williams shows a world where

the Internet has become accessible via VR. It has become so popular and somewhat commonplace that, with the help of surgical implants, people can connect directly into this future VR environment. Some other popular fictional works that use the concept of VR include William Gibson's "Neuromancer" which defined the concept of cyberspace, Neal Stephenson's "Snow Crash", in which he made extensive reference to the term avatar to describe one's representation in a virtual world, and Rudy Rucker's "The Hacker and the Ants", in which programmer Jerzy Rugby uses VR for robot design and testing.

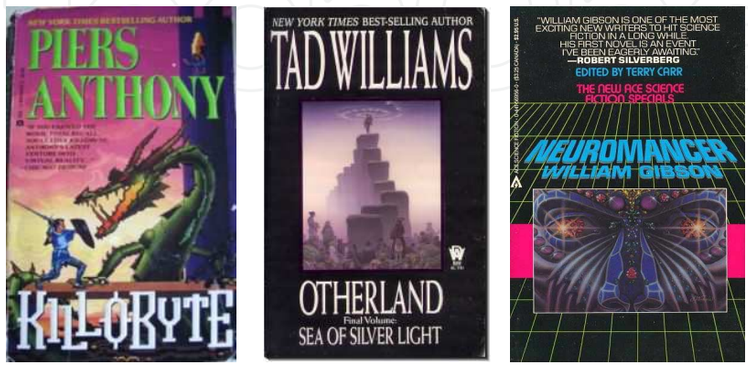


Fig. 8. Fiction books that described Virtual Reality

9.4 Television

Perhaps the earliest example of VR on television is a Doctor Who serial "The Deadly Assassin". This story introduced a dream-like computer-generated reality known as the Matrix. The first major television series to showcase VR was "Star Trek: the Next Generation". They featured the holodeck, a VR facility on starships that enabled its users to recreate and experience anything they wanted. One difference from current VR technology, however, was that replicators, force fields, holograms, and transporters were used to actually recreate and place objects in the holodeck, rather than relying solely on the illusion of physical objects, as is done today.

9.5 Motion pictures

There are a lot of motion pictures that explored and used the idea of VR. Steven Lisberger's film "TRON" was the first motion picture to explore the idea. This idea was popularized by the Wachowski brothers in 1999's motion picture "The Matrix". The Matrix was significant in that it presented VR and reality as often overlapping, and sometimes indistinguishable. Total Recall and David Cronenberg's film "ExistenZ" dealt with the danger of confusion between reality and VR in computer games. Cyberspace became something that most movies completely misunderstood, as seen in "The Lawnmower Man". Also, the British comedy "Red Dwarf" used in several episodes the idea that life is a VR game. This idea was also used in "Spy Kids 3D: Game Over". Another movie that has a bizarre theme is "Brainscan", where the point of the game is to be a virtual killer. A more artistic and philosophical perspective on the subject can be seen in Avalon. There is also a film from 1995 called "Virtuosity" with Denzel Washington and Russell Crowe that dealt with the creation of a serial killer, used to train law enforcement personnel, that escapes his VR into the real world.

9.6 Music videos

The lengthy video for hard rock band Aerosmith's 1993 single "Amazing" depicted VR, going so far as to show two young people participating in VR simultaneously from their separate personal computers (while not knowing the other was also participating in it) in which the two engage in a steamy makeout session, sky-dive, and embark on a motorcycle journey together.

9.7 Games

A lot of industries sprang up and started developing VR games. In 1991, the W Industries released a VR gaming system called the 1000CS. This was a stand-up immersive HMD platform with a tracked 3D joystick. The system featured several VR games including "Dactyl Nightmare", "Legend Quest", "Hero", and "Grid Busters". There were other games developed such as "VR World 3D Color Ninja", "VR Wireless TV Tennis Game", "Mage: the Ascension", "Kingdom Hearts II", "System Shock", "System Shock2", and "VR 3D Drangonflight" among others.

9.8 Fine art

Fine art is also influenced by VR. Artists stated to create impressions using VR. David Em was the first fine artist to create navigable virtual worlds. Jeffrey Shaw explored the potential of VR in fine arts with early works like "Legible City", "Virtual Museum", and "Golden Calf". Char Davies created immersive VR art pieces in "Osmose" and "Ephémère". Works such as "Is God Flat", The "Tunnel under the Atlantic ", and "World Skin", by Maurice Benayoun introduced metaphorical, philosophical or political content, combining VR, network, generation and intelligent agents. There are other pioneering artists working in VR.

9.9 Marketing

Advertising and merchandise have been associated with VR. There are a lot of television commercials using VR. TV commercials featuring VR have been made products, such as Nike's "Virtual Andre". This commercial features a teenager playing tennis using a goggle and gloves system against a computer generated Andre Agassi. There are some others commercials as seen in most English premier league commercials.

9.10 Health care

VR is finding its way into the training of health care professionals. Use ranges from anatomy instruction to surgery simulation. VR also has numerous applications that can be directly related to health care. In a white paper on the use of Virtual Environments for Health Care, Moline (1995) indicated several areas where patient care can be assisted by VR techniques. These include the use of VR for remote tele-surgery; the use of VR techniques in local surgery such as endoscopy, where the surgeon manipulates instruments by viewing a TV monitor; the use of virtual environments as surgical simulators or trainers; the use of virtual environments as therapy devices to reduce anxiety or fear. One example is dentists using 3D eyeglasses to divert a patient's attention during dental operations and the use of virtual environments to reduce phobias such as agoraphobia and vertigo. North et al (1996) provided an overview of current work in the use of VR techniques to reduce phobias in their book VR Therapy.

9.11 Therapeutic uses

The primary use of VR in a therapeutic role is its application to various forms of exposure therapy, ranging from phobia treatments, to newer approaches to treating Post Traumatic Stress Disorder (PTSD) (Goslin & Morie, 1996; Krijn, 2005; Schuemie, 2003; Schuemie et al., 2001). A very basic VR simulation with simple sight and sound models has been shown to be invaluable in phobia treatment as a step between basic exposure therapy such as the use of simulacra and true exposure (North et al., 1996). A much more recent application is being piloted by the U.S. Navy to use a much more complex simulation to immerse veterans (specifically of Iraq) suffering from PTSD in simulations of urban combat settings. Much as in phobia treatment, exposure to the subject of the trauma or fear seems to lead to desensitization, and a significant reduction in symptoms.

9.12 Real estate

The real estate sector has used the term VR for websites that offer panoramic images laced into a viewer such as QuickTime player in which the viewer can rotate to see all 360 degrees of the image.

10. Advantages and uses of VR

Researchers in the field have generally agreed that VR technology is exciting and can provide a unique and effective way to learn and that VR projects are highly motivating to learners (Mantovani et al., 2003). From research, several specific situations have emerged in which VR has strong benefits or advantages. For example, VR has great value in situations where exploration of environments or interactions with objects or people is impossible or inconvenient, or where an environment can only exist in computer-generated form. VR is also valuable when the experience of actually creating a simulated environment is important to learning. Creating their own virtual worlds has been shown to enable some students to master content and to project their understanding of what they have learned (Ausburn & Ausburn, 2004).

One of the beneficial uses of VR occurs when visualization, manipulation, and interaction with information are critical for its understanding; it is, in fact, its capacity for allowing learners to display and interact with information and environment that some believe is VR's greatest advantage. Finally, VR is a very valuable instructional and practice alternative when the real thing is hazardous to learners, instructors, equipment, or the environment. This advantage of the technology has been cited by developers and researchers from such diverse fields as firefighting, anti-terrorism training, nuclear decommissioning, crane driving and safety, aircraft inspection and maintenance, automotive spray painting and pedestrian safety for children (Ausburn & Ausburn, 2004).

11. Disadvantages and limitations of VR

One important issue in the use of VR is the high level of skill and cost required to develop and implement VR, particularly immersive systems. Very high levels of programming and graphics expertise and very expensive hardware and software are necessary to develop immersive VR, and considerable skill is needed to use it effectively in instruction. While desktop VR technology has dramatically reduced the skill and cost requirement of virtual environments, it still demands some investment of money and time.

Another set of limitations of VR environments stems from the nature of the equipment they require. A long-standing problem with immersive VR has been health and safety concerns for its users. The early literature was top-heavy with studies of headaches, nausea, balance upsets, and other physical effects of HMD systems. While these problems have largely disappeared from current VR research as the equipment has improved, and appear to be completely absent in the new desktop systems, little is known about long-term physical or psychological effects of VR usage. A second equipment limitation of VR arises from the fact that it is computer-based and requires high-end hardware for successful presentation. Inadequate computing gear can dramatically limit the response time for navigation and interaction in a virtual environment, possibly destroying its sense of presence for users and damaging or destroying its usefulness as a simulation of reality. This response situation sometimes referred to as the "latency problem" of VR, can also arise from bandwidth limitations when VR is distributed over a network or the Internet.

12. Conclusion

A lot of advancements have been made using VR and VR technology. VR has cut across all facets of human endeavours-manufacturing/business, exploration, defense, leisure activities, and medicine among others. The exciting field of VR has the potential to change our lives in many ways. There are many applications of VR presently and there will be many more in the future. Many VR applications have been developed for manufacturing, education, simulation, design evaluation, architectural walk-through, ergonomic studies, simulation of assembly sequences and maintenance tasks, assistance for the handicapped, study and treatment of phobias, entertainment, rapid prototyping and much more. VR technology is now widely recognized as a major break through in the technological advance of science.

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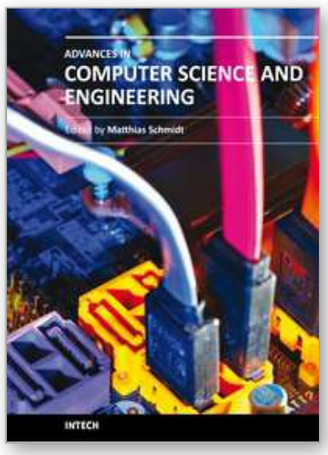
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