

VIRTUAL REALITY: AN EMERGING COMPUTER TECHNOLOGY OF THE 21ST CENTURY

M.O. Onyesolu

Department of Computer Science,
Nnamdi Azikiwe University, Awka, Anambra State.

Abstract

Virtual Reality (VR) is an emerging computer technology that has gained wide acceptance in all aspects of human endeavours-education, manufacturing/business, exploration, defense, leisure activities, and medicine among others. VR offers to bring exciting possibilities, which were once considered science fiction. VR has become a substantial and ubiquitous technology and subsequently has penetrated various applications for education, learning and training among others. VR promised to revolutionize the way computers are used. It has the potential to change our lives in dozens of ways. VR is in itself a relatively new technology and has provided new scene for interaction. In order to understand the implications of this technology, one must first understand the concept. This work explored the definitions of VR, the various types of VR systems, applications, equipment needed, benefits, drawbacks and what the future holds of VR.

Keywords: VR, HMD, Immersion, Environment, Dataglove

1. Introduction

Imagine a time when you will be inside a car driving without actually being inside that car, a time when you as a pilot is undergoing training, flying, landing and crashing a plane without actually inside that plane, a time when you as a computer engineer diagnoses faults and assembles computer systems without actually working with the real physical components. Imagine yourself as a surgeon, walks into an operating theatre, cut open the heart of a patient to change a defective valve. The scenarios described have been made possible through a technology known as virtual reality (VR). There was no real plane, real computer systems, real car and real patient. Everything was a computer simulation [1]. VR is an emerging technology on the horizon that will virtually place anyone in any experience desired.

VR encapsulates all previous media, even books, slides, pictures, audio, video and multimedia, thus it is hard to describe what it is not. VR is a desired technology for those applications in which reality itself does not exist (yet), cannot be accessed, or is too dangerous or expensive to betray [2]. VR 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 [3]. VR is a way for humans to visualize, manipulate and interact with computers and extremely complex data [4]. 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 [5]. 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 [6]. It is a computer-based technology for

simulating visual auditory and other sensory aspects of complex environments [7]. VR incorporates 3-D technologies that give a real-life illusion.

VR creates a simulation of real-life situation [8]. VR is an emerging computer interface that strives to make simulations so realistic that users believe, if only for a moment, that they are experiencing "the real thing." With VR, highly realistic and believable simulations will be accomplished using high-speed graphics supercomputers, three-dimensional graphics accelerators, head-mounted display devices, wired gloves, spatial audio processing, psychological and cognitive skills and numerous other technologies and techniques [9].

2. Types Of Virtual Reality Systems

A major distinction of VR systems is the mode with which they interface to the user [3]. There are some non-technologically mediated methods that some people stretch to include in VR, such as books, plays, movies or pure imagination. VR systems could be:

2.1 Desktop VR/Window on World Systems (WoW)

This is a type of VR system that uses a conventional computer monitor to display the visual world. This sometimes called desktop VR or a Window on a World (WoW). This concept traces its lineage back through the entire history of computer graphics.

2.2 Video Mapping

Video Mapping VR uses cameras to project an image of the user into the computer program, thus

creating a 2D computer character. Although fully immersed in the environment, it is difficult to interact with the user's surroundings. Video Mapping is a variation of the WoW approach. It merges a video input of the user's silhouette with a 2D computer graphic. The user watches a monitor that shows his body's interaction with the world.

2.3 Immersive Systems

Immersive VR uses a Head Mounted Display (HMD) to project video directly in front of the user's eyes, plays audio directly into the user's ears, and can track the whereabouts of the user's head. Then a dataglove (or datasuit) is used to track movements of the user's body and then duplicate them in the virtual environment. When the user cannot distinguish between what is real and what is not, then immersive VR has succeeded. A nice variation of the immersive systems use multiple large projection displays to create a 'Cave' [14]. An early implementation was called "The Closet Cathedral" for the ability to create the impression of an immense environment within a small physical space.

2.4 Telepresence

A variation on visualizing complete computer generated worlds is "Telepresence". This is a technology that links remote sensors in the real world with the senses of a human operator.

2.5 Mixed Reality

Merging the Telepresence and VR systems gives the Mixed Reality or Seamless Simulation systems. Here the computer-generated inputs are merged with telepresence inputs and the users view of the real world.

3. Equipment Needed In Virtual Reality

To create a virtual world, you need several technologies, each which have advanced separately. The basis of VR is hardware, software, and electronics. These are the three computer-related technologies which are part of producing VR. Audio, visual, and tactile are the three senses in the virtual environment which can be achieved by the use of input devices, such as gloves, tracking balls, bodysuits, or many other devices. VR experts are researching to find a way to also create the senses of taste and hot/cold in a virtual environment. When the user makes movements using the input devices, the computer then gives an output showing the user's interaction which is given to the user through glasses, head mounted display units, earphones and so on. These devices are under the category of electronics; each is emerging, so it's not just one technology or technique which is causing the development of VR.

All of the above techniques must be advanced enough to be able to converge with other techniques and be used meaningfully. They must be able to create a virtual environment, which is thought to be real, allows interaction and responds quickly, and collects, perceives, and analyzes data. Computer generation of images is important to make a virtual environment seem real to the user. The speed of the machine is important because it has to be able to produce shapes, which make up mosaics to form the image. The computer must be quick enough to keep regenerating these shapes so that when the user interacts, and for instance, picks up an object, it's redrawn with shapes. Many computers have very good quality resolution, but they are not fast enough to keep up with the user's interaction, so latency occurs. Many computers are fast enough to be used for VR, but their images are not as sharp as slow-moving ones.

The technique of using input devices must also be advanced to surround the user in sounds and images so that they forget they are in a virtual environment. Head mounted displays (HMD's) are the most complex of the devices. HMD's originally used the cylindrical point of view in which the user can see the environment all around but cannot see a ceiling or a floor. With advancements, VR experts have been able to create the spherical point of view. This is where a hemisphere or dome is used and the user can see all around except the floor. With more research, VR experts will hopefully create a point of view that is as close to reality as possible.

4. Applications Of Virtual Reality

Baieier [5], pointed out that the useful applications of VR include:

...training in a variety of areas (military, medical, equipment operation, etc.), education, design evaluation (virtual prototyping), architectural walk-through, human factors and ergonomic studies, simulation of assembly sequences and maintenance tasks, assistance for the handicapped, study and treatment of phobias (e.g., fear of height), entertainment, and much more.

Therefore, applications for VR are many. Surgeons may soon use VR to walk-through the brain or rehearse a surgical operation on a virtual patient. Just as flight simulators are now an integral part of pilot training, so surgical simulators will revolutionize medical training. VR now makes possible telepresence, scientific exploration, and discovery. For example, the Jason Project for school

children features both telepresence (the feeling of being in a location other than one's actual location) and teleoperation (controlling a robot submarine) [10]. The Jason Project was designed to generate excitement about studying science, mathematics, and technology. NASA has a telepresence educational program that uses the Telepresence-controlled Remotely Operated underwater Vehicle (TROV) deployed in Antarctica. By means of distributed computer control architecture developed at NASA, school children in classrooms across the United States can take turns driving the TROV in Antarctica. Someday scientists expect to explore celestial bodies and check out lakes beneath the Antarctic ice pack using VR applications. Disabled persons, through prosthetic interfaces, may one day use tele-robotics to do tasks that are now only a dream; three-D sound may one day provide great applications for the blind.

5. Benefits Of Virtual Reality

The benefits of VR in all spheres of life cannot be overemphasized. Below are some examples, based on current research, of how we can benefit from VR [1].

5.1 Manufacturing/Business

The whole crux of competition in today's global marketplace is in the ability to shorten the cycle time from concept to delivery of the product, while factoring in the customer's desires. This is precisely what VR technology will do. By using realistic simulations of the product, the manufacturer will be able to greatly shorten his development time by being able to avoid the need for prototypes. By using "experiential prototyping," the designer can actually experience what he is building - understanding how to fix mistakes and make a better design. By sharing this experience with his customer, he can ensure requirements are met. The cycle time can also be reduced because not only can engineering be done concurrently, training can also be done concurrently. The people who will do the actual manufacturing can be trained, the people who will use the product can be trained, and the people who may need to maintain the product can be trained - all concurrently in a virtual environment - with their inputs being fed back into the design.

5.2 Education

The whole field of education and training will significantly benefit from applying VR to the classroom. By actually experiencing the laws of physics and being able to interact with historical figures, children's and adult's ability to grasp complex ideas will be greatly stretched - making learning easier and longer lasting.

5.3 Exploration and Defense

The trend has been to try to remove humans from dangerous situations through robotics or remotely piloted vehicles. The problem with this concept is that the flexibility and adaptability of the device is limited as compared to actually having a human operating it directly. Now, through a combination of telepresence (transporting yourself electronically to the environment of the device) and VR, a person can operate the device remotely with the same effectiveness as if he was there. The Japanese have demonstrated this technology by remotely controlling a robot by making it appear that the operator is the robot in the virtual world.

5.4 Leisure Activities

Numerous examples exist of the current use of VR for leisure activities. Most are still crude, but some, such as Disney World's Space Ride, are very realistic. The use of VR for leisure activities is sure to explode in the not too distant future, with a person being able to do or experience almost anything - probably from the comfort of his own home.

5.5 Impact on Quality of Life

With goods and services produced more efficiently and education and training more effective, our quality of life must certainly improve. By being able to travel to your virtual workplace over a network - in essence being able to conduct much of your business from home - our society may be able to solve other problems. For example, there may be less need for highways, cars, mass transit, and energy to heat office buildings. These changes will result in an associated reduction in pollution and a positive effect on our environment. With people at home more often, there will be less need for childcare and perhaps an increase in family unity and parental responsibility, resulting in all the positive effects these changes bring. On the downside, there is a possibility that VR could be so realistic that it becomes the narcotic of the 21st century, with people preferring the virtual experience to the troubles of everyday life. Whether any of this becomes more than just another fancy arcade game depends on the development of the technology and the investment of business.

6. Drawbacks Of Virtual Reality

Despite enormous potential practical application, VR, in its current state, has drawbacks. It is still extremely expensive, the graphics are still cartoonish, and there is still a slight, but perceptible time lag between the user's body movements and their translation in Cyberspace. The equipment the user must wear, such as headgear, gloves, and other

devices, needs refinement. At this early stage in the development of VR, no one knows what the long-term effect of using head-mounted displays might be on human eyes or what the possible psychological effect might be from spending too much time in Cyberspace. People using VR headgear sometimes complain about chronic fatigue, a lack of initiative, drowsiness, irritability, or nausea after interacting with a virtual environment for a long time. We do not know how much each of these symptoms depends on the characteristics of the VR systems themselves, or on the characteristics of the individuals using the systems.

7. The Future Of Virtual Reality

There are many applications of VR presently and there will be many more in the future. **Entertainment** industry is an obvious example of an application of VR. The average person will use VR because new developments such as small, lightweight HMD's will be made. Using VR for entertainment will be common in the household, like the Nintendo and Sega Genesis systems are for our generation.

Another form of entertainment will be creating VR museums. Without having to leave your house, you will be able to put on a head mounted display and browse through a museum with paintings and sculptures as if you were really there.

In the field of medicine, VR will make numerous improvements. Currently, a software package is being provided called *Animated Dissection of Anatomy for Medicine*, or virtual organs and body parts. There are also animated databases of the muscular and skeletal systems. With the improvements of these, virtual bodies will be used for testing instead of humans or animals. In the future, physicians will be able to perform high-risk surgery on virtual bodies in operating theaters, and they could be miles apart from each other. This will be much safer, because physicians can test the treatment and perfect it so that the real patient will not be subjected to any risk. X-ray vision is another possibility for the future. By wearing a visor, the physician will still see the real world, but have an added vision of seeing through a person's skin for example. It will be like an ultrasound machine, but the ultrasound reading will go directly to the visor, so the doctor will have an advantage while preparing for surgery or while diagnosing a problem.

In the profession of architecture, the next step of designing houses or buildings will be the use of an architectural walk-through. This is where the building is designed first on a computer, and then created into a virtual image. By walking through the buildings as if they were really built, you can easily

point out any errors, and improvements to be made that might not be detected on a flat piece of paper.

Learning will become far more advanced and enhanced with VR, and children will find school more interesting. Kids will learn beyond the classroom by visiting virtual places they are studying about. Curiosity will grow to learn more by using virtual environments and creative thinking will be evoked to intensify education.

8. Conclusion

VR is a technology that has cut across all facets of human endeavours-manufacturing/business, exploration, defense, leisure activities, and medicine among others. VR as an emerging computer interface will strive to make simulations so realistic. VR technology has found a place in education. At the University of Michigan, Ann Arbor [11 and 12] two research fellows developed Vicher (Virtual Chemical Reactors) in the department of Chemical Engineering to teach students catalyst decay, non-isothermal effects in kinetics and reactor design and chemical plant safety since they believe that humans retain up to 90% of what they learn through active participation [13]. The most exciting possibilities in terms of education and VR are found as it is implemented in the education of the disabled. In a study developed by a researcher in the North Carolina State College of Engineering, autistic children may one day learn to function in the real world due to the exploration of virtual worlds. Autism is a disease that interferes with the development of the parts of the brain that processes sensory perceptions. Autistic people are unable to correlate similar object and this makes teaching them very difficult [8]. VR has changed the definition of distance in education. Students will be able to actually share (cyber)space and time in a virtual environment. No longer will students have to view the facilitator (instructor) from a "distance". Face to face communication will become accessible and the capability of group collaboration on projects will be possible, even if there are miles or oceans between the students and teacher. In a nutshell, VR promises to revolutionize the way we use computers. It has the potential to change our lives in dozens of ways.

References

- [1] J.F. Dailey and C.S. Knode, *Virtual Realty*. Retrieved November 12, 2005 Source: <http://www.ndu.edu/library/ic6/93S12.pdf>
- [2] P.A.M. Kommers and Z. Zhiming, *Virtual Reality for Education* Retrieved: December 12, 2005. Source: <http://edte.utwente.nl>
- [3] J. Isdale, *What Is Virtual Reality? A Web-Based Introduction*. Retrieved December 12, 2005.

- Source: http://whatis.techtarget.com/definition/0.s?id9_gci213303,00.html, 1998.
- [4] J. Isdale, *What Is Virtual Reality? A Homebrew Introduction*. Retrieved November 12, 2005. Source: <http://whatis.techtarget.com>, 1993.
- [5] K.P. Baieier, *Virtual Reality: Short Introduction*. Retrieved November 15, 2005. Source: <http://www-vrl.umich.edu/intro.html/>, 1993.
- [6] K. Askew and C. King, *Definitions of Virtual Reality Systems*. Retrieved October 11, 2005. Source: <http://ksi.cpsc.ucalgary.ca/courses/547-96/askew/vr/def.html>, 1996.
- [7] M.J. Field (Ed.), *Telemedicine: A Guide to Assessing Telecommunications in Health Care*, (Washington, DC: National Academy Press, 1996) 239 250.
- [8] S. Haag, M. Cummnings and J. Dawkins, *Management Information Systems for the Information Age*. (New York: Irwin/McGraw Hill, 1998).
- [9] J.T. Bell and H.S. Fogler, *Virtual Reality In Chemical Engineering Education*, Proc. ASEE North Central Section Meeting, University of Detroit Mercy, Detroit, MI, 1998
- [10] H. McLellan, *Magical Stories: Blending Virtual Reality and Artificial Intelligence*. In *Imagery and Visual Literacy*: Proc. Annual Conference of the International Visual Literacy Association. 26th, Tempe, Arizona, 1994.
- [11] J.T. Bell and H.S. Fogler, *Vicher: A Prototype Virtual Reality Based Educational Module for Chemical Reaction Engineering*, Computer Applications in Engineering Education, 4 (4), 1996.
- [12] J.T. Bell and H.S. Fogler, *Recent Developments in Virtual Reality Based Education*, Proc. of the American Society for Engineering Education Annual Conference, Washington, DC, 1996.
- [13] D. Edgar, *Audio-Visual Methods in Teaching* (3rd Edition, New York: Holt, Rinehart, and Winston, 1969).
- [14] J. Jacobson and M. Lewis, *Game Engine Virtual reality with CaveUT*. IEEE Computer Magazine, 38 (4), 2005. 79.