From Past to Future Virtual Reality's Introduction Application and Challenges

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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: - *Evolution of VR, Sensorama, HMD, CAVE, Immersive Virtual Reality, Levels of immersion, Telepresence, Cyberspace, Virtual reality, Scientific Visualization, Virtual reality device*

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1. INTRODUCTION

Virtual reality (VR) is a technology which allows a user to interact with a computer-simulated environment, whether that environment is a simulation of the real world or an imaginary world. It is the key to experiencing, feeling and touching the past, present and the future. It is the medium of creating our own world, our own customized reality. It could range from creating a video game to having a virtual stroll around the universe, from walking through our own dream house to experiencing a walk on an alien planet. With virtual reality, we can experience the most intimidating and grueling situations by playing safe and with a learning perspective.

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. An insightful study of typical VR systems is done and finds the challenges of Virtual Reality.

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2 History

Nowadays computer graphics is used in many domains of our life. At the end of the 20th century it is difficult to imagine an architect, engineer, or interior designer working without a graphics workstation. In the last years the stormy development of microprocessor technology brings faster and faster computers to the market. These machines are equipped with better and faster graphics boards and their prices fall down rapidly. It becomes possible even for an average user, to move into the world of computer graphics. This fascination with a new (ir)reality often starts with computer games and lasts forever. It allows to see the surrounding world in other dimension and to experience things that are not accessible in real life or even not yet created. Moreover, the world of three-dimensional graphics has neither borders nor constraints and can be created and manipulated by ourselves as we wish – we can enhance it by a fourth dimension: the dimension of our imagination... But not enough: people always want more. They want to step into this world and interact with it – instead of just watching a picture on the monitor. This technology which becomes overwhelmingly popular and fashionable in current decade is called Virtual Reality (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" . It has been a long time since then, a lot of research has been done and status quo: "the Sutherland's challenge of the Promised Land has not been reached yet but we are at least in sight of it".

Let us have a short glimpse at the last three decades of research in virtual reality and its highlights:

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

*• **"The Sword of Damocles"** – the first virtual reality system realized in hardware, not in concept. Ivan Sutherland constructs a device considered as the first Head Mounted Display (HMD), with appropriate head tracking. It supported a stereo view that was updated correctly according to the user's head position and orientation.*

*• **GROPE** – the first prototype of a force-feedback system realized at the University of North Carolina (UNC) in 1971.*

*• **VIDEOPLACE** – Artificial Reality created in 1975 by Myron Krueger – "a conceptual environment, with no existence". In this system the silhouettes of the users grabbed by the cameras were projected on a large screen. The participants were able to interact one with the other thanks to the image processing techniques that determined their positions in 2D screen's space.*

*• **VCASS** – Thomas Furness at the US Air Force's Armstrong Medical Research Laboratories developed in 1982 the Visually Coupled Airborne Systems Simulator – an advanced flight simulator. The fighter pilot wore a HMD that augmented the out-thewindow view by the graphics describing targeting or optimal flight path information.*

*• **VIVED** – VIrtual Visual Environment Display – constructed at the NASA Ames in 1984 with off-the-shelf technology a stereoscopic monochrome HMD.*

*• **VPL** – the VPL company manufactures the popular DataGlove (1985) and the Eyephone HMD (1988) – the first commercially available VR devices.*

*• **BOOM** – commercialized in 1989 by the Fake Space Labs. BOOM is a small box containing two CRT monitors that can be viewed through the eye holes. The user can grab the box, keep it by the eyes and move through the virtual world, as the mechanical arm measures the position and orientation of the box.*

*• **UNC Walkthrough project** – in the second half of 1980s at the University of North Carolina an architectural walkthrough application was developed. Several VR devices were constructed to improve the quality of this system like: HMDs, optical trackers and the Pixel-Plane graphics engine.*

*• **Virtual Wind Tunnel** – developed in early 1990s at the NASA Ames application that allowed the observation and investigation of flow-fields with the help of BOOM and Data Glove.*

*• **CAVE** – presented in 1992 CAVE (CAVE Automatic Virtual Environment) is a virtual reality and scientific visualization system. Instead of using a HMD it projects stereoscopic images on the walls of room (user must wear LCD shutter glasses). This approach assures superior quality and resolution of viewed images, and wider field of view in comparison to HMD based systems.*

*• **Augmented Reality (AR)** – a technology that "presents a virtual world that enriches, rather than replaces the real world". This is achieved by means of see-through HMD that superimposes virtual three-dimensional objects on real ones. This technology was previously used to enrich fighter pilot's view with additional flight information (VCASS). Thanks to its great potential – the enhancement of human vision – augmented reality became a focus of many research projects in early 1990s.*

3. What is VR? What is VR not?

At the beginning of 1990s the development in the field of virtual reality became much more stormy and the term Virtual Reality itself became extremely popular. We can hear about Virtual Reality nearly in all sort of media, people use this term very often and they misuse it in many cases too. The reason is that this new, promising and fascinating technology captures greater interest of people than e.g., computer graphics. The consequence of this state is that nowadays the border between 3D computer graphics and Virtual Reality becomes fuzzy.

4. Some basic definitions and terminology

Virtual Reality (VR) and Virtual Environments (VE) are used in computer community interchangeably. These terms are the most popular and most often used, but there are many other. Just to mention a few most important ones: Synthetic Experience, Virtual Worlds, Artificial Worlds or Artificial Reality. All these names mean the same:

• "Real-time interactive graphics with three-dimensional models, combined with a display technology that gives the user the immersion in the model world and direct manipulation."

• "The illusion of participation in a synthetic environment rather than external observation of such an environment. VR relies on a three-dimensional, stereoscopic head-tracker displays, hand/body tracking and binaural sound. VR is an immersive, multi-sensory experience."

• "Computer simulations that use 3D graphics and devices such as the Data Glove to allow the user to interact with the simulation."

• "Virtual reality refers to immersive, interactive, multi-sensory, viewer-centred, three-dimensional computer generated environments and the combination of technologies required to build these environments."

• "Virtual reality lets you navigate and view a world of three dimensions in real time, with six degrees of freedom. (...) In essence, virtual reality is clone of physical reality."

Although there are some differences between these definitions, they are essentially equivalent. They all mean that VR is an interactive and immersive (with the feeling of presence) experience

Telepresence–The term was coined by Marvin Minsky (1980) in reference to teleportation systems for remote manipulation of physical objects. It is a specific kind of virtual reality that simulates a real but remote (in terms of distance or scale) environment. Another more precise definition says that telepresence occurs when "at the work site, the manipulators have the dexterity to allow the operator to perform normal human functions; at the control station, the operator receives sufficient quantity and quality of sensory feedback to provide a feeling of actual presence at the worksite".

Cyberspace–was invented and defined by William Gibson as "a consensual hallucination experienced daily by billions of legitimate operators (...) a graphics representation of data abstracted from the banks of every computer in human system". Today the term Cyberspace is rather associated with entertainment systems and World Wide Web (Internet).

5. LEVELS OF IMMERSION IN VR SYSTEMS

In a virtual environment system a computer generates sensory impressions that are delivered to the human senses. The type and the quality of these impressions determine the level of immersion and the feeling of presence in VR. Ideally the high-resolution, high-quality and consistent over all the displays, information should be presented to all of the user's senses. Moreover, the environment itself should react realistically to the user's actions. The practice, however, is very difficult

Non-Immersive (Desktop VR) systems –

Desktop Virtual Reality is a lower level of immersive VR that can be easily employed in many applications without the need for special devices. Sometimes called Window on World (Wow) systems. This is the simplest type of virtual reality applications.

Desktop VR is when a computer user views a virtual environment through one or more computer screens. A user can then interact with that environment, but is not immersed in it. It uses a conventional monitor to display the image (generally monoscopic) of the world. No other sensory output is sup-ported.

Desktop Virtual Reality has begun to make its way and popularity in modern education because of its ability to provide real time visualization and interaction within a virtual world that closely resembles a real world.

• Semi-Immersive (Fish Tank VR) systems-

Improved version of Desktop VR. These systems support head tracking and therefore improve the feeling of "of being there" thanks to the motion parallax effect. They still use a conventional moni-tor (very often with LCD shutter glasses for stereoscopic view-ing) but generally do not support sensory output.

• **Immersive systems** –
The ultimate version of VR systems. They let the user totally immerse in computer generated world with the help of HMD that supports a stereoscopic view of the scene accordingly to the user's position and orientation. These systems may be enhanced by audio, hepatic and sensory inter-Face.

CHARACTERISTICS OF IMMERSIVE VR

The unique characteristics of immersive virtual reality can be summarized as follows:
• Head-referenced viewing provides a natural interface for the navigation in three-dimensional space and allows for look-around, walk-around, and fly-through capabilities in virtual environments.
• Stereoscopic viewing enhances the perception of depth and the sense of space.
• The virtual world is presented in full scale and relates properly to the human size.
• Realistic interactions with virtual objects via data glove and similar devices allow for manipulation, operation, and control of virtual worlds.
• The convincing illusion of being fully immersed in an artificial world can be enhanced by auditory, haptic, and other non-visual technologies.
• Networked applications allow for shared virtual environments.

TYPES OF IMMERSION

Immersion means the extent to which high fidelity physical inputs.
inputs (e.g., light patterns, sound waves) are provided to the different sensory modalities (vision, audition, touch) in order to create strong illusions of reality in each.
According to Ernest Adams, immersion can be separated into three main categories:
• **Tactical immersion** –Tactical immersion is experienced when performing tactile operations that involve skill. Players feel "in the zone" while perfecting actions that result in success.
• **Strategic immersion** –Strategic immersion is more cerebral, and is associated with mental challenge. Chess players experience strategic immersion when choosing a correct solution among a broad array of possibilities.
• **Narrative immersion** –Narrative immersion occurs when players become invested in a story, and is similar to what is experienced while reading a book or watching a movie. Staff-fan Björk and Jussi Holopainen, in Patterns In Game Design, divide immersion into similar categories. They call them sen-sory-motoric immersion, cognitive immersion and emotional immersion, respectively. In addition to these, they add three new categories:
• **Spatial immersion** –Spatial immersion occurs when a player feels the simulated world is perceptually convincing. The player feels that he or she is really "there" and that a simulated world looks and feels "real".
• **Psychological immersion** –Psychological immersion oc-curs when a player confuses the game with real life.
• **Sensory immersion** –The player experiences a unity of time and space as the player fuses with the image medium, which affects impression and awareness.

6. USES OF VIRTUAL REALITY

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 Virtu-al 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.

7. ADVANTAGES

Virtual reality has also been used extensively to treat phobias (such as a fear of heights, flying and spiders) and post traumatic stress disorder. This type of therapy has been shown to be effective in the academic setting, and several commercial entities now offer it to patients.

Although it was found that using standardized patients for such training was more realistic, the computer-based simulations afforded a number of advantages over the live training. Their objective was to increase exposure to life-like emergency situations to improve decision-making and performance and reduce psychological distress in a real health emergency.

8. DISADVANTAGES

Some psychologists are concerned that immersion in virtual environments could psychologically affect a user. They suggest that VE systems that place a user in violent situations, particularly as the perpetuator of violence, could result in the user becoming desensitized. In effect, there's a fear that VE entertainment systems could breed a generation of sociopaths. Engaging virtual environments could potentially be more addictive.

Another emerging concern involves criminal acts. In the virtual world, defining acts such as murder or sex crimes has been problematic. At what point can authorities charge a person with a real crime for actions within a virtual environment? Studies indicate that people can have real physical and emotional reactions to stimuli within a virtual environment, and so it's quite possible that a victim of a virtual attack could feel real emotional trauma.

9. CHALLENGES

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 sys-tem 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.

10. FUTURE WORK

The future of Virtual Reality depends on the existence of say the future of Virtual Reality depends on the existence of systems that address issues of 'large scale' virtual environments. In the coming years, as more research is done we are bound to see VR become as mainstay in our homes and at work. As the computers become faster, they will be able to create more realistic graphic images to simulate reality better. It will be interesting to see how it enhances artificial reality in the years to come.

It is very possible that in the future we will be communicating with virtual phones. Nippon Telephone and Telegraph (NTT) in Japan is developing a system which will allow one person to see a 3D image of the other using VR techniques.

10. CONCLUSION

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 gives 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.

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