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Overview of Virtual Reality

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Abstract
Virtual Reality (VR), sometimes called Virtual Environments (VE) have 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. Finally, the future of VR is considered aspects of technology.

1. Introduction

1.2 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… The 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" .[6]

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

Sensorama – in years 1960-1962 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 create 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 construction concept that included interactive graphics, force-feedback, sound, smell and taste.

VIDEO PLACE – 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.

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.

2. What is Virtual Reality?

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 now a day the border between 3D computer graphics and Virtual Reality becomes fuzzy. Therefore in the following sections some definitions of Virtual Reality and its basic principles are presented.

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." [1]

• "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-centered, 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 in a simulated (autonomous) world and this measure we will use to determine the level of advance of VR systems.

There are two important terms that must be mentioned when talking about VR: *Telepresence* and *Cyberspace*. They are both tightly coupled with VR,[1] but have a slightly different context:

• **Telepresence** – 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 consensu 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).

3. Levels of immersion in VR systems

In a virtual environment system a computer generates sensory impressions that are delivered to the human senses.[2] 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 different from this ideal case. Many applications stimulate only one or a few of the senses, very often with low-quality and unsynchronized information. We can group the VR systems accordingly to the level of immersion they offer to the user .

• **Desktop VR** – sometimes called Window on World (WoW) systems. This is the simplest type of virtual reality applications. It uses a conventional monitor to display the image (generally monoscopic) of the world. No other sensory output is supported.

• **Fish Tank VR** – improved version of Desktop VR. These systems support head tracking and therefore improve the feeling of "of being there" thanks to this a motion parallax effect.[3] They still use a conventional monitor (very often with LCD shutter glasses for stereoscopic viewing) 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, haptic and sensory interfaces.

4. Applications of VR

4.1 Motivation to use VR

Undoubtedly VR has attracted a lot of interest of people in last few years. Being a new paradigm of user interface it offers great benefits in many application areas. It provides an easy, powerful, intuitive way of human-computer interaction. The user can watch and manipulate the simulated environment in the same way we act in the real world, without any need to learn how the complicated interface

works. Therefore many applications like flight simulators, architectural walkthrough or data visualization systems were developed relatively fast. Later on, VR was applied as a teleoperating and collaborative medium, and of course in the entertainment area.

4.2 Data and architectural visualization

For a long time people have been gathering a great amount of various data. The management of megabytes or even gigabytes of information is no easy task. In order to make the full use of it, special visualization techniques were developed. Their goal is to make the data perceptible and easily accessible for humans. Desktop computers equipped with visualization packages and simple interface devices are far from being an optimal solution for data presentation and manipulation. Virtual reality promises a more intuitive way of interaction.

The first attempts to apply VR as a visualization tool were architectural walkthrough systems. Many other research groups created impressive applications as well –just to mention the visualization of St. Peter Basilica at the Vatican presented at the Virtual Reality World'95 congress in Stuttgart or commercial Virtual Kitchen design tool. VR makes it superior to a standard computer graphics. The feeling of presence and the sense of space in a virtual building, which cannot be reached even by the most realistic still pictures or animations. One can watch it and perceive it under different lighting conditions just like real facilities.

Another discipline where VR is also very useful is scientific visualization.[5] The navigation through the huge amount of data visualized in three-dimensional space is almost as easy as walking. An impressive example of such an application is the Virtual Wind Tunnel developed at the NASA Ames Research Center.[4]

The advantages of such a visualization system are convincing – it is clear that using this technology, the design process of complicated shapes of e.g., an aircraft, does not require the building of expensive wooden models any more. It makes the design phase much shorter and cheaper.

5. Virtual Reality technology

VR requires more resources than standard desktop systems do. Additional input and output hardware devices and special drivers for them are needed for enhanced user interaction. In general: input devices are responsible for interaction, output devices for the feeling of immersion and software for a proper control and synchronization of the whole environment.[1]

All modern VR displays are based on technology developed for smart phones including: gyroscopes and motion sensors for tracking head, hand, and body positions; small HD screens for stereoscopic displays; and small, lightweight and fast processors. These components led to relative affordability for independent VR developers, and lead to the 2012 Oculus Rift kick starter offering the first independently developed VR headset.

Independent production of VR images and video has increased by the development of Omni directional cameras, also known as 360-degree cameras or VR cameras that have the ability to record in all directions, although at low-resolutions or in highly compressed formats for online streaming. In contrast, photogrammetric is increasingly used to combine several high-resolution photographs for the creation of detailed 3D objects and environments in VR applications.

6. Concerns and challenges

Virtual reality technology faces a number of challenges, including health and safety, privacy and technical issues. Long-term effects of virtual reality on vision and neurological development are unknown; users might become disoriented in a purely virtual environment, causing balance issues; computer latency might affect the simulation, providing a less-than-satisfactory end-user experience; navigating the non-virtual environment (if the user is not confined to a limited area) might prove dangerous without external sensory information. There have been rising concerns that with the advent of virtual reality, some users may experience virtual reality addiction. From an economic and financial perspective, early entrants to the virtual reality market may spend significant amount of time and money on the technology. If it is not adopted by enough customers, the investment will not pay off.

7. Conclusion

VR is a conceptual idea, not some products with the specified definition. There are many people who have no idea about what is VR; this is so this is VR technology. The concept of VR appeared a long time ago; however, it is until now when it comes into people's sight. In this paper, we introduced VR from every aspect.

VR has found already an enormous number of applications in different areas of science It became a perfect tool for architects, designers, physicists, chemists, doctors, surgeons etc. All these disciplines, however, are closed for average people and therefore virtual reality is becoming some kind of myth – something extremely wonderful and at the same time something inaccessible.

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