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Applications of Virtual Reality

Dhruv Pahuja, Dipti Bhardwaj, Manohar Kumar

***Abstract*— In this paper we present an overview of basic concepts of virtual reality (VR). We will describe important VR application when interacting with three dimensional computer generated worlds. In particular, we will discuss VR application in medical, engineering, primary education, etc. Finally we will focus on future advancement and application of VR to various section of society. It is a form of technology which generates a computer generated responsive environment from user point of view. Virtual reality has its advocates and opponents which are mainly due to a lack of understanding about this technology and its capabilities. Unrealistic expectations coupled with lack of awareness regarding technical limitations means that for many people, virtual reality is difficult to grasp or even take seriously**

***Index Terms*—Applications, Basic Introduction, Concepts used, History, Future Aspects**

I. INTRODUCTION

Virtual reality, well don't think of that as a screen, think of it as a window through which one looks into a virtual world. The challenging thing is that to make that virtual world look real, sound real, move and respond to interaction in real time, and even feel and smell real. It can be defined as a technology which takes us in a computer generated environment which is near to reality but actually not real. It is the term used to describe **a three-dimensional, computer generated environment** which can be explored and interacted with by a person. This can be achieved by using computer hardware and software. It was originally conceived as a digitally created space which humans could access by donning special computer equipment. It enables people to deal with information more easily. VR provides a different way to see and experience information, one that is dynamic and immediate. For example, in a computer game, user's joystick motions are tracked and the objects in the game are moved according to the joystick movements. In the same way a simulated, three-dimensional world is created around the user in which he/she could interact with objects, people, and environments. Typically three-dimensional life-sized images with support of audio devices are presented around the user and the perspective is modified in accordance with the user input (generally head or eye movements). Many devices along with the computers are used to create a virtual environment.

II. HISTORY

In mid 1950s visionary cinematographer Morton H Eilig built a single user console called **Sensorama** that included a stereoscopic display, fans, or emitters, stereo speakers and a moving chair. This enabled the user watch television in three dimensional ways. In 1961, Philco Corporation engineers developed the first HMD known as the **Headsight**. The helmet consisted of a video screen along with a tracking system. Then they linked to a closed circuit camera system. Then somewhat similar HMD was used for helicopter pilots. While flying in the dark these were of great help. In 1965, a computer scientist named Ivan Sutherland envisioned what he called the **"Ultimate Display."** After using this display a person imagines the virtual world very similar to the real world. During 1966, an HMD was built by Sutherland, which was tethered to a computer system Ivan Sutherland, with the help of his student Bob scrubll, created what is widely considered to be the first virtual reality and Augmented Reality (AR) head-mounted display (HMD) system. It was primitive both in terms of user interface and realism, and the HMD to be worn by the user was so heavy it had to be suspended from the ceiling. The graphics comprising the virtual environment were simple wire frame model rooms. The formidable appearance of the device inspired its name, The Sword of Damocles. **[6]**

III. CONCEPTS OF VIRTUAL REALITY

Nowadays new technological advancements researches and developments have reached the sensory outputs of the user to a different level.

It's however again not a true virtual environment as the element of interaction is missing. The element of interaction depends on a number of factors again. They are:-

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- Speed
- Range
- Mapping

Computer scientist Jonathan Steuer defines speed as the rate of an user's actions that a computer records in itself and the way it is reflected in a manner the user can realize it. Range is the number of possible results or reactions that can come out of any action made by the user. Mapping is the ability of the computer system to produce results as good as the natural world in response to the actions made by the user. Immersion is basically an unique experience that is connected with the world of virtual reality. Over here the user whole exploring the three dimensional world of virtual reality will simply immerse into this make believe world as the real world. It is basically feeling of involvement of the user in the virtual world intelligently designed by experts. Immersion is made up of two main components as stated by Jonathan Steuer. They are:-

- Depth of Information
- Breadth of Information

Depth of information can necessarily include anything and everything starting from the resolution of the display unit, the graphics quality, the effectiveness of the audio and video etc.Jonathan Steuer also defines breadth of information as a number of sensory dimensions presented simultaneously. Any virtual environment can be designated as having a wider breadth of information whenever it stimulates all the human senses. The audio and visual effects are the mostly researched area in creating a good virtual environment. These are considered as the main factors that can stimulate user's all sensory organs. The sense of touch is been given more and more priority as it has become the dominating factor to stimulate a human. Those systems that allow the users to interact through touch are known as Baptic Systems.

IV. APPLICATIONS

Virtual Reality has a very wide area of applications. Virtual reality has set up its roots in the area of Gaming, Engineering, Telecommunication, Business, Media, Military, etc.

A) ENGINEERING

Virtual reality in engineering helps greatly to visualize the projects of engineers in three-dimension view and helps in understanding the way it works. Virtual reality engineering includes the use of 3D modeling tools and visualization techniques as part of the design process. Also they can spot any flaws or potential risks in their projects before implementation. This also allows the design team to observe their project within a safe environment and make changes as and where necessary. This saves both time and money. What is important is the ability of virtual reality to depict fine grained details of an engineering product to maintain the illusion. This means high end graphics, video with a fast refresh rate and realistic sound and movement.

B) TELECOMMUNICATION

Virtual reality technology has also utilized in telecommunication, mainly in mobile communications which enables easy access to a variety of VR based projects. The main challenge is that of dealing with tone of voice, intonation, gesture and body language as compared to spoken words. In fact, spoken words only account for a very small percentage of the overall communication. But traditional forms of communication such as the telephone are being superseded by video conferencing, Skype and live chat. These communication mediums can be used on the internet and other similar systems and are seen as cheaper and more flexible. Telecommunications can be used to help virtual reality systems such as surgery simulation or telemedicine. An example of this is remote surgery in which images from that surgery can be transmitted to various locations around the world. It also enables surgery to be performed in remote locations using robotic technology and virtual reality.

C) PROGRAMMING LANGUAGE

For the effectiveness of virtual reality, it must have a good sense of realism. Virtual reality on its own is a technical challenge and, as such, virtual reality is highly demanding on many resources. It includes hardware performance, intellectual ability of the implementers of the system and their management is a massive issue. It requires good knowledge of in-depth computer science topics, usually requiring post-graduate education. Much like software development today, as time progresses and the field expands, these requirements must be dealt with effectively and the barrier of entry much be lowered. One such method is to employ a domain-specific programming language

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geared especially towards virtual reality. A DSL (domain-specific language) can be carefully applies to virtual reality. Carefully crafting the correct language(s) to virtual reality will allow developers to write less code which is optimized especially for the creation of a virtual environment.

D) CONSTRUCTION

Virtual reality can be extremely useful in the construction industry, which is often known as having a very high amount of inefficiency and low profit margins. Using a virtual environment, an organization can visualize resulting structure in 3D and can also experience them as they would in the real world. Building a construction project in a virtual environment offers many key benefits. One of the most obvious of these is having the ability to test a number of factors without the time and cost of building the structure, reducing the number of errors present in the completed building. Furthermore, the construction of a building can be simulated in virtual reality as it would in its normal environment. This allows an organization to fine-tune construction processes for maximum efficiency and a minimum amount of change. Although it's impossible to tell when exactly virtual reality in construction will become the norm, it's only a matter of time before it does. Virtual reality will allow us to make grander and more robust buildings in a shorter space of time - a very desirable property indeed.[1]

E) VIRTUAL REALITY IN FASHION

Fashion is not something that immediately comes to mind when thinking about virtual reality but nevertheless, it is used by the fashion industry in a variety of ways.
These include:

- VR software for building virtual fashion stores
- 3D avatars (virtual humans) to help with clothes design

The concepts behind virtual reality fashion are actually rather basic, focusing mainly on helping fashion move faster and more accurately. Computers have helped to keep the general public up to date with the current fashions as they happen. Fashion experts are looking for the next step. One new approach to fashion is the idea of Mass customization. Using 3-D technology and the internet, virtual reality models of specific customers can be created, sent across the country to a design studio where a CAD/CAM machine can make adjustments to a flat garment pattern for that specific customer. In the future, it will be possible for customers to choose fabrics and patterns for their garments as well. Another goal for this project is to eliminate the stresses of shopping. Through virtual reality, the 3-D customer model can be "dressed" in the chosen garment and moved around. In this way the customer can see how they in the garment and how it will move. This concept presents several problems. The first is how to accurately measure the human body quickly and to create a 3-D representation of that figure. Another problem is how to display clothing in 3-D so it looks and behaves like real fabric.[1]

F) VIRTUAL REALITY IN HEALTHCARE

Healthcare is one of the biggest adopters of virtual reality which encompasses surgery simulation, phobia treatment, robotic surgery and skills training.

One of the advantages of this technology is that it allows healthcare professionals to learn new skills as well as refreshing existing ones in a safe environment. Plus it allows this without causing any danger to the patients.
The use of virtual reality (VR) technologies in the U.S. healthcare industry has expanded tremendously due to extensive product development and the growing implementation of healthcare information technology (HIT) infrastructure. Virtual reality applications in the healthcare industry are associated with many leading areas of medical technology innovation including robot-assisted surgery, augmented reality (AR) surgery, computer-assisted surgery (CAS), image-guided surgery (IGS), surgical navigation, multi-modality image fusion, medical imaging 3D/4D reconstruction, pre-operative surgical planning, virtual colonoscopy, virtual surgical simulation, virtual reality exposure therapy (VRET), and VR physical rehabilitation and motor skills training. The clinical and enterprise benefits of healthcare VR technology are numerous and include improved patient outcomes, reduced medical errors, improved minimally-invasive surgical (MIS) technique, improved physician collaboration in diagnosis, and improved psychological and motor rehabilitation.

G) HUMAN SIMULATION SOFTWARE

One example of this is the Human Sim system which enables doctors, nurses and other medical personnel to interact with others in an interactive environment. They engage in training scenarios in which they have to interact

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with a patient but within a 3D environment only. This is an immersive experience which measures the participant's emotions via a series of sensors.

H) VIRTUAL REALITY DIAGNOSTICS

Virtual reality is often used as a diagnostic tool in that it enables doctors to arrive at a diagnosis in conjunction with other methods such as MRI scans. This removes the need for invasive procedures or surgery.

I) VIRTUAL ROBOTIC SURGERY

A popular use of this technology is in robotic surgery. This is where surgery is performed by means of a robotic device – controlled by a human surgeon, which reduces time and risk of complications. Virtual reality has been also been used for training purposes and, in the field of remote telesurgery in which surgery is performed by the surgeon at a separate location to the patient. The main feature of this system is force feedback as the surgeon needs to be able to gauge the amount of pressure to use when performing a delicate procedure. But there is an issue of time delay or latency which is a serious concern as any delay – even a fraction of a second – can interrupt the procedure. So there needs to be precise force feedback in place to prevent this. Robotic surgery and other issues relating to virtual reality and medicine can be found in the virtual reality and healthcare section. This section contains a list of individual articles which discuss virtual reality in surgery etc.

J) VIRTUAL REALITY IN GAMES

Virtual reality games are becoming very popular with many teenagers who love the graphics, animations and best of all, being able to talk to others. After all, what could be better than the chance to interact with top end technology and without any adults to get in the way?

These games are available for Xbox 360, PS2 and 3 as well as the Mac and PC so whatever console you use there is a VR game for that. This is pretty cool when you think about it.

This section talks about the different types of virtual reality games which also includes virtual worlds. You are probably familiar with Second Life but there are other virtual worlds such as Kaneva.

These games are mostly aimed at teenagers but there are few which are designed for adults. This ensures that they don't feel left out and is a good way of getting them used to technology.

V. FUTURE ASPECTS OF VIRTUAL REALITY

Today VR technology is still in its infancy, and there are damaging flaws. Graphics, no matter how impressive, are not lifelike. Time lags are far too long. Optic and auditory hardware are not 100% realistic. Users can walk into walls or pick up an object without feeling a thing. The equipment is still far too expensive for everyday use. But each and every one of these drawbacks is the subject of intense research and work; the problems are being overcome, and VR is poised for its major breakthrough. In the past, computing power has doubled approximately every 18 months, a trend that is known as Moore's Law. If this is the case then we should have a computer powerful enough to run immersive VR programs in our own homes by the year 2037. With the advancements in nanotechnology and quantum computing (where computers mimic the human brain's processes) this figure could be expected to grow exponentially.

VI. CONCLUSION

VR can be defined as a technology which takes us in a computer generated environment which is near to reality but actually not real. It is the term used to describe a three-dimensional, computer generated environment which can be explored and interacted with by a person. This can be achieved by using computer hardware and software. It was originally conceived as a digitally created space which humans could access by donning special computer equipment. It enables people to deal with information more easily. VR provides a different way to see and experience information, one that is dynamic and immediate. For example, in a computer game, user's joystick motions are tracked and the objects in the game are moved according to the joystick movements. In the same way a simulated, three-dimensional world is created around the user in which he/she could interact with objects, people, and environments. Typically three-dimensional life-sized images with support of audio devices are presented around the user and the perspective is modified in accordance with the user input (generally head or eye movements). Many devices along with the computers are used to create a virtual environment.

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AUTHOR BIOGRAPHY

He is pursuing his B.Tech in computer science & engineering from Dronacharya College of Engineering, Gurgaon which is affiliated to MDU Rohtak, one of the leading university in India. He is an Oracle Database SQL Certified Expert, Microsoft Technology Associate, Microsoft Certified Professional and Microsoft Student Associate. He is a member of various societies like Computer Society of India (CSI), Indian Society for Technical Education (ISTE), IAENG Society of Computer Science, IAENG Society of Internet Computing and Web Services, IAENG Society of Information System Engineering, IAENG Society of Software Engineering and Universal Association of Computer and Electronics Engineers (UACEE).

DHRUV PAHUJA

She is pursuing her B.Tech in computer science & engineering from Dronacharya College of Engineering, Gurgaon which is affiliated to MDU Rohtak, one of the leading university in India. She is an Oracle Database SQL Certified Expert, Microsoft Technology Associate and Microsoft Certified Professional. She has achieved her name in the Merit List of University for Dec-2013 Exam. She is a Sports Co-ordinator of her College. She has co-ordinated various technical events in her college. She is a member of various societies like Computer Society of India (CSI), Indian Society for Technical Education (ISTE), International Association of Engineers (IAENG), ISOC and Indian Engineer Association (IEA).

DIPTI BHARDWAJ

He is pursuing his B.Tech in computer science & engineering from Dronacharya College of Engineering, Gurgaon which is affiliated to MDU Rohtak, one of the leading university in India. He is Microsoft Technology Associate and Microsoft Certified Professional. He is the Placement Co-ordinator of his College. He has the membership of Computer Society of India (CSI) and Indian Society for Technical Education (ISTE).

MANOHAR KUMAR