Virtual Reality

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Abstract—**"Virtual Reality (VR)" was proposed by Jaron Lanier, founder of VPL Research (1989). Alternate names for VR are virtual environment (VE), cyberspace (proposed by William Gibson), artificial reality, augmented reality. VR simulates the virtual world around you that makes user think of being in a real world (virtually created). A true virtual environment must include immersion and interactivity. Virtual reality uses HMD (Head Mounted Devices), PCs and graphics software to perform immersion and input devices such as joystick, datagloves and different kind of sensors for user interaction.**

Virtual Reality is an emerging technology that has application areas such as Real estate, manufacturing of vehicles, training program for the military, in medicine doctors can train for surgical procedure and diagnosing the patient with fear and other conditions, virtual games. This paper also includes innovative ideas that can be implemented using any of three (Virtual Reality, Augmented Reality as well as Holograms).

Index Terms— **Holographic Books, HoloBag, Virtual Reality, Virtual Environment, Hologram**

I. INTRODUCTION

Virtual Reality (VR) can be seen as an artificial environment which is created using hardware and software presented to the user in such a way that they come to believe that it's a real environment. VR can be experienced through senses like sight, sound and touch. Virtual Reality (VR) is stimulating the human senses in such a way that a virtually created world is experienced as real world. In order to get a true immersion of reality in virtual environment, it is necessary for the user to have influence on this.

Fig. 1 An example of virtual reality device

All that should be done in order to increase the illusion of being in or acting upon a virtual environment or virtual world, is providing *the interaction* between the user and the actual environment. Generally, a VR interface stimulates one of the human senses. This should not be as complex as it sounds, e.g. a headphone stimulates the auditory sense; a display monitor stimulates the visual sense. Consequently, visual and auditory senses are most widely used as Virtual Reality interfaces.

A technology inherited from VR which connects the virtual objects with real world object is Augmented Reality (AR). Purpose of both technologies is the same but they are different in terms of their use and expandability. VR is used to simulate the computer images within a room area whereas AR connects the virtual world with the real world by using some wearable devices like "Google Glass" from Google Inc. and "Holo Lence" from Microsoft Inc.

Augmented Reality is more complex than virtual Reality as it deals (interact) with real world objects. Virtual Reality has become more popular in the last decade as whole world started using it in simulation of real object, Virtual Training, Education, business etc.

II. HOW "VIRTUAL REALITY" WORKS

There are different opinions on what forms a true virtual experience, but basic goal for VR is to:

- Simulating 3D images that appears to life-sized in user's perception.
- Track user's motion generally Head, Hand etc.

In virtual environment, user feels *immersion* i.e. being part of the virtual world. Tracking user's motion is like giving him ability to *interact* with the virtual world. The combination of both Interaction and Immersion is known as *Telepresence*. According to Jonathan Steuer Telepresence can be defined as "the extent to which one feels present in the mediated environment, rather than in the immediate physical environment." In other terms, a successful VR experience let you become oblivious of real environment and giving attention to presence of user in the virtual environment.

Jonathan Steuer also There are two main part of immersion: *Depth of information* **and** *Breadth of information*. Depth of information concerns about data in signal that user gets as the response of interaction in VR. For the user, graphic density of system, resolution of the display device, the clarity of audio

output and input, etc can be considered in it. Breadth of information considers "the count of sensory dimensions presented at the same time".

A VR has a good breadth of information if it provides support to all your senses. Most VR experience gives more priority on components like visual and audio over other factors that stimulates sensors, but an increasing number of engineers and computer scientists are looking forward into ways to incorporate touch sense of a user. A system that supports a physical reaction and interactivity are called **Haptic Systems**.

Generally all displays must render at least 20 - 30 FPS to create a real user experience. Delay between user's action and VE's reflection for that action is known *latency*. It generally focuses on the time gap between the time a user takes to move his sensory body parts and the variation in the position of vision, this term also applies for time gaps in other sensory dimensions. A study says humans are able to sense a time lag of more than 50 milliseconds. After a user finds the time lagging he becomes aware of being in virtual environment that ultimately destroys the sense of immersion.

Above we discussed about *immersion* next we'll look other aspect of telepresence i.e. *interactivity*. Immersion and Interaction both must be present for true experience of virtual environment. Consider, DisneyQuest in orlando, florida is not an example of VE whereas the Head-mounted display (HMDs) devices such as Oculus rift, samsung gear and project morpheus are true examples of VE.

It depends upon number of factors but Steuer proposes three of them:

- *Speed*

  It is a rate at which a user's inputs are taken into the computer and rendered in a way that a user can see it properly.

- *Range*

  Range can be determined as all possible outcomes from any particular input given by the user as an action.

- *Mapping*

  It is the capability of the system that how fast it can generate output according the user's input.

Navigation is also one kind of input i.e. interactivity in a virtual environment. If a user can control his movement within the virtual world, then it is a good interactive experience. Ability of modifying the virtual environment makes the interactivity truly powerful. A true virtual reality will work on user's actions that should make sense, though it only makes sense within the area of virtual world. If there is any unwanted change in virtual world, it causes disturbing the user's sense of immersion.

To achieve above two goals i.e. true immersion and interaction we require some hardware and software. Now a day,

the general VR systems are developed by simple computers. PCs are capable enough to develop and execute the software needed to generate the whole virtual world. Graphics are generally managed by complex graphics cards initially designed with the video gaming society keeping in mind. The same VRAM which allows you play Dragon Ball Z is perhaps being used for the graphics to create sophisticated virtual environment.

For the sake of immersion, a VR system must show the 3D images to user. Most of VR systems use Head Mounted Displays, headsets that is made with two displays, one for left and another for right eye. Old HMDs used huge cathode ray tube (CRT) monitors but delivered a good resolution and clarity, or cheaper liquid crystal displays (LCDs), which didn't stand a chance against the clarity of CRT monitors. Today, LCD displays have got more complex features, with great resolution and fine saturation, and are generally used in place of CRT monitors. Automatic Virtual Environments (CAVE) is kind of virtual system that projects the contents on the walls, floor and ceiling of a room. CAVE monitors are very costly and need larger are of projection than other VE systems. Basic hardware requirements for immersion are HMDs, CAVE, GraphicCard, HDMI cables, Computer System, LCDs, and CRTs etc.

Devices for giving inputs are also important part in VR systems. Presently, input devices can be controllers with two or three simple buttons to complex voice identification software. There is still no standard control system that can be used in VE. VR scientists are constantly finding ways to make the input methods very natural so that it can increase the telepresence. Some more common forms of input devices are, ***Joysticks, Force balls/tracking balls, Controller wands, Datagloves, Voice recognition, Motion trackers/bodysuits, Treadmills.***

Scientists and engineers are also working behind developing of biosensors for virtual systems. This sensor can sense and understand nerve and muscle movements. Using perfect working biosensor, a system can get user's movement in physical environment and transform that into the same motions in virtual environment. Biosensors may be connected directly to the skin of a user, or may be incorporated into gloves or suits. One drawback to biosensor suits is that they must be made custom for different users otherwise the biosensors won't work properly for that user's body.

Some programmers visualize the development of web into a 3D virtual environment, where you walk all the way in virtual land to access the data and entertainment. Websites could appear as a 3D area, permitting users to explore in better ways than before. There are many programming languages languages and Web browsers to full fill this vision. They are:

- *Virtual Reality Modeling Language (VRML)* – the very first language for the Websites that runs in web browser and create 3D models.

- *3DML* – using this language a user can install some pulg-ins and visit a Websites from most Internet browsers.

- *X3D* – the programming language that works in place of VRML as one of the way for developing virtual world on the web.

- *Collaborative Design Activity (COLLADA)* **-** a format to interchange the files inside the 3D programs.

III. VR APPLICATIONS

Architects develop virtual simulations for their building plans so that clients can walk through the structure before the foundation is actually built. Clients can inspect exteriors and interiors and ask questions, or even give suggestion for the design. Virtual models provide you a much more precise idea of how moving in a building will feel than in a tiny model.

Car companies have used VR technology to make virtual model of new vehicles and test them systematically before producing any physical part. Car designers can easily alter the design that is not easy with physical ones. As a result the manufacturing process becomes more efficient and less expensive.

Virtual environments are used in military training programs, the space programs and even for medical students. The military division has been big followers of VR technology and development. Training programs can incorporate everything from the simulations of vehicle, tanks to war. Soldiers who have trained through extensive VR training have proven to be more effective than others.

Fig. 2　　Using virtual therapy to treat a patient's fear of flying.

In medicine, doctors can be trained for surgical procedures and to diagnosing a patient. Surgeons have not used VR technology only for training and education, but also for performing surgery remotely by using some robotic devices. In 1998 The first robotic surgery was performed at a hospital in Paris. The biggest challenge in using VR technology for performing robotic surgery is latency, because any delay in such kind of delicate procedure leads to big threat to life of a patient. It also needs to provide responsive sensory feedback to the surgeon.

Another use of VR technology in medical is psychological therapy. Dr. Barbara Rothbaum of Emory University and Dr. Larry Hodges of the Georgia Institute of Technology initiated the use of virtual reality in treating patient with phobias and other mental conditions. Their research resulted to the origin of the company Virtually Better, which sells VR therapy systems to doctors in 14 countries.

IV. VR CHALLENGES AND CONCERNS

The big challenges in the area of virtual reality are developing enhanced tracking systems, finding more usual ways to let users to interact within a virtual environment and reducing the time it takes to generate virtual spaces. While there are a few tracking system companies that were existed around since the initial days of virtual reality, most companies were small and didn't last very long. Similarly, there aren't many companies that are working behind input devices particularly for VR applications. Most VR developers have to depend on and adapt technology originally develop for other disciplines, and they have to expect that the company producing technology stays in business.

Another concern for VE system developers is creating a system that evades bad ergonomics. Many systems depend on hardware that limits his options through physical tethers. Without elegant hardware, a user could experience cybersickness. Not all users appear to be at risk for cybersickness -- some people can discover a virtual environment for hours with no ill effects, while others may feel sick after just a few minutes.

Some psychologists are concerned that being in virtual environments could sensitively affect a user. They suggest that VR systems that leave a user in violent situations could cause in the user becoming desensitized. Others are not as concerned about desensitization, but warn about that convincing VR experiences could cause a kind of cyber addiction.

Another rising concern involves criminal acts. In the virtual environment, crucial acts such as murder or sex crimes have been challenging. Can authorities accuse a person with an actual crime for his actions within a virtual environment? Should the attacker be punished for causing real-life distress? We don't yet know the answers for these questions.

V. SOME INNOVATIVE APPLICATIONS IN EDUCATIONAL AREAS

As we discussed some other technologies related to VR i.e. *Hologram* and *augmented reality* we can have several specific application for Education purpose. Here I proposed an innovative futuristic application of Hologram technology. At present the concept is all based on the Theory but in future there would be the implementation for the same. Al- though all three technologies have different definition but they are much related and can be combined into one device; Microsoft *HoloLence* is the example of this kind of devices. Although we have discussed more about virtual reality my concept will be totally related to *Hologram technology*.

Hologram technology enables generating of three-dimensional images (holograms). It involves the use of a laser, light intensity recording, interference, diffraction, and suitable

illumination of the recording. The image adjusts as the position and direction of the viewing system changes in precisely the same way as if the thing were still present, hence making the image appear three-dimensional.

VI. HOLOBAG, THE CONCEPT

A. Introduction

The ***HOLOBAG,*** a futuristic concept in educational area that makes uses of hologram technology and other ongoing technologies like StylusPen, TouchPad etc. today, we carry heavy school bags on our shoulders that weight more than 5 Kg. In this paper I have proposed the concept behind a holographic device. *HoloBag* will be as small as possible in size to fit your pocket. It can contain educational material like books, notes, and other digital media in a holographic form. HoloBag will project things in 3-dimensional view so you can feel it close like real. HoloBag can be made in any shape like a tennis ball shape or a rectangular one. In the following image a man is seating on chair having the HoloBag on the table that projects a 3D holographic book in the air. It will also enable you to give inputs i.e. writing on a touchpad will instantly reflect in hologram projection. In the next section we will see some important features and working of HoloBag. Later we will see some other related applications and also some challenges and concerns.
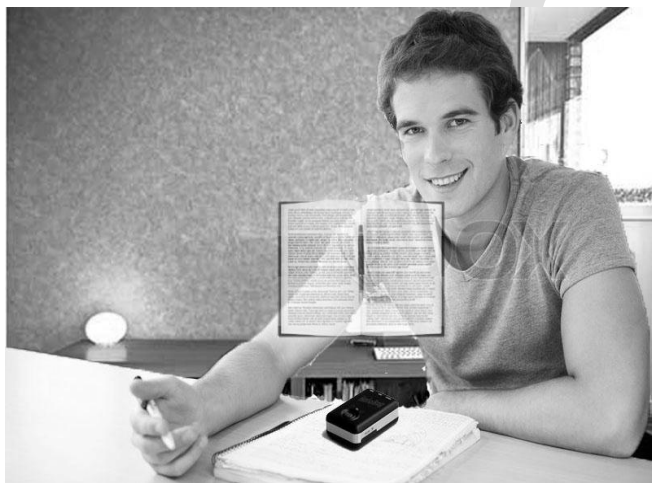

Fig. 3 The concept of "HoloBag"

B. Features and Working

Here are some important features of **HoloBag**:-

- It can projects all the images in 3D format that will look life sized.
- It can have input devices like touchpad and a stylus pen through which you can write something to hologram projection screen.
- It will be having enough memory to store all your documents and related books.

- There will be motion sensors through which we can simply move to the next image.
- It will also feature Bluetooth connectivity to control it with some devices like Smartphone.

These features are on the specs some more features also can be added based on user requirements and environmental conditions.

Before discussing the working of Holobag first we will discuss little about the Holograms. Holography is science of creating holograms. It is a method of recording pattern of light to produce 3-D objects. If you see these holograms from different angles, you see holographic objects from different point of view, just like you were looking at an actual object. Some holograms even seem to move as you walk past them and see them from different perspective. If you make a hologram of a magnifying glass, the holographic version will magnify the other objects in the hologram, just like a real one.

C. Hardware and Software Requirements

After discussing all these things now we will see what software and hardware will make it to work. Software and hardware requirements are lot more similar to any hologram projector but some hardware are not ordinary. All hardware and software required are listed below.

Tools (hardware) used in making of holograms: -

- *Laser* – generally Helium neon (HeNe) lasers are commonly used. They are the red lasers but some holograms uses different colors of light.
- *Lenses* – actually holography is lensless photography but it uses lenses to make beams spread out.
- *A Beam Splitter* – it is a kind of device which split one beam into two.
- *Mirrors* – this is used to direct the beam to the correct location. It should be properly clean as like lenses and beam splitters.
- *Holographic Film* – it does the recording of light at higher resolution that is important for creating holograms.

Some other hardware that is required for the HoloBag-

- *TouchPad* – a Touch pad that will be used to take input from user or a kind of control as well.
- *TouchPen* – a kind of pen to write on the Touch pad for text input from user.

There are number of software that can be used to create holograms. Any featured image editing software can be useful. Some free and useful software are –

- **Red Giant Holomatrix**
- **Sound Editor Deluxe**
- **Cortical Cafe CGH Creator**

D. Challenges in Implementation

Some challenges and concerns are there –

- Making this device work and to fit in your pocket sophisticated and small hardware parts are required.
- Tracking pen's movement and mapping it instantly to hologram projections can be another challenge.
- As this device is portable and should work anywhere, the projection should be visible also in daylight.
- Acceptability of this device in present educational environment may become the concern.

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