

CHAPTER 1

INTRODUCTION TO VIRTUAL REALITY

1.1 INTRODUCTION

Virtual reality is a term that applies to computer simulated environment that can simulate physical presence of a person in places in the real world as well as in the imaginary world. Virtual Reality can be defined as an environment which is simulated by a computer system. The environment can mimic the “real” world, or it can be a simulation of a completely imaginary world. The term Virtual (or Artificial) Reality is attributed to Myron Krueger, an American computer artist in the 1970s. It has been recorded as far back as 1938 however, by the French artist Antonin Arnaud, who coined the phrase while discussing his theatre shows.

The first virtual reality equipment, which attempted to physically realise the concept was developed by Morton Heilig in the 1950s. He created the Sensorama machine, which contained a moving seat, along with 3-D moving images, smell, sound, and even wind. This is demonstrated in the image below.



Fig 1.1: Morton Heiligs Sensorama Machine

In the 1960s, further work in the field was done by Ivan Sutherland. In 1968, he developed a headset which allowed the wearer to “interact” with virtual objects, using wire frame graphics. Virtual Reality entered the public consciousness in the 1980s and 90s. It was featured in popular culture, including films such as Tron, The Lawnmower Man, The Matrix, and the Holodeck in Star Trek, The Next Generation. The Holodeck is a fictional example of True Immersive Virtual Reality, which is one of the levels or methods of Virtual Reality.

1.2 TYPES OF VIRTUAL REALITY

There are five main types of Virtual Reality classified on the basis of Display Technology. These are as follows:

- **Adventure games, MUD/MOO**

Textually described virtual worlds where the user perceives the virtual environment through mental images based on the words read (like reading a novel).

- **Desktop**

3D virtual environment graphically displayed on a desktop computer monitor.

- **Projected**

3D environment projected onto a screen. It enables a single user to demonstrate concepts to a group of people. A CAVE(tm), where several screens are used to surround the user with images, is the most advanced form of projected VR in use today.

- **Semi-immersive**

Most advanced flight, ship and vehicle simulators are semi-immersive. The cockpit, bridge, or driving seat is a physical model, whereas the view of the world outside is computer-generated (typically projected).

- **Immersive**

It is the 3D environment seen through a head-mounted display (HMD). In a completely immersive system the user feels part of the environment (experiences a feeling of 'presence'). The user has no visual contact with the physical world.

1.3 TECHNICAL REQUIREMENTS

The following are the technical requirements for the virtual reality systems:

- Hardware capable of rendering real-time 3D graphics and high-quality stereo sound.
- Input devices to sense user interaction and motion.
- Output devices to replace user's sensory input from the physical world with computer-generated input.
- Software that handles real-time input/output processing, rendering, simulation, and access to the world database in which the environment is defined.

CHAPTER 2

CONCEPTS OF VIRTUAL REALITY

2.1 BASIC PRINCIPLE

Virtual Reality (VR) is a fully-immersive, absorbing, interactive experience of an alternate reality through the use of a computer structure in which a person perceives a synthetic environment by means of special human-computer interface equipment and interacts with simulated objects in that environment as if they were real.

VR represents computer interface technology that is designed to leverage our natural human capabilities. Today's familiar interfaces - the keyboard, mouse, monitor, and GUI - force us to adapt to working within tight, unnatural, two-dimensional constraints. VR changes that. VR technologies let you interact with real-time 3D graphics in a more intuitive, natural manner. This approach enhances your ability to understand, analyze, create and communicate.

A VR system lets you experience data directly. For example, today's advanced interfaces let you look and move around inside a virtual model or environment, drive through it, lift items, hear things, feel things, and in other ways experience graphical objects and scenes much as you might experience objects and places in the physical world.

As a result, VR serves as a problem-solving tool that lets us accomplish what was previously impossible. It's also a communications medium, and, ultimately, an artistic tool/medium.

2.2 VIRTUAL REALITY DEVICES

The virtual reality devices include:

- Head-Mounted Displays
- Data Gloves

- Head Tracking
- I Smeller
- Motion Trackers

2.2.1 Head-Mounted Displays

- Can display either stereo or mono images.
- May be totally immersive or see-through.
- May include a built-in head-tracker.
- May have built-in stereo headphones.



Fig 2.1: Head-Mounted Displays

2.2.2 Data Gloves

- This peripheral interacts with objects in a virtual world.
- It uses trackers and some form of bending sensors on each finger.



Fig 2.2: Data Glove

2.2.3 Head Tracker

- Head tracker detects movement in all three axes.
- It also detects rotation on all three axes.
- Head tracker can detect the movement of your head and translate that to computer control.



Fig 2.3: Head Tracker

2.2.4 I Smeller

- It can generate thousands of everyday scents with a small cartridge that contains 128 odors.
- These primary odors are mixed together to generate other smells that closely replicate common natural and manmade odors.



Fig 2.4: I Smeller

2.2.5 Motion Tracker

- They track the user's movement.
- They can be mechanical, electromagnetic, optical or acoustic.



Fig 2.5: Motion Trackers

CHAPTER 3

VRML

3.1 INTRODUCTION

VRML stands for Virtual Reality Modeling Language. It is a specification for displaying 3 dimensional objects on the World Wide Web. It can be considered as a 3-D equivalent of HTML (i.e. Hyper Text Markup Language). Files written in VRML language have a .wrl extension. To view these type of files we need a VRML browser or a VRML plug-in to a web browser.

VRML produces a hyperspace, a 3-dimensional space that appears on your display screen and we can figuratively move within this space. That is, as we press keys to turn left, right, up or down, or go forwards or backwards, the images on the screen will change to give the impression that we are moving through a real space.

VRML, the Virtual Reality Modeling Language, is a file format for describing interactive three-dimensional objects and *worlds*. Here a world is a model of a 3D space, which can contain 3D objects, lights, and backgrounds; in other 3D systems this is often called a *scene*. Objects can be built from solid shapes, from text, or from primitive points, lines, and faces. Objects have optical material properties which affects how they interact with the lights in the world; they can also have textures (2-D patterns) applied to them.

Objects can be grouped into more complex objects, used multiple times, translated, and rotated. Objects can trigger events which can be routed to other events or to scripts written in JavaScript or Java. Within VRML you can trigger sounds, move objects along paths, and link to HTML or VRML targets. In JavaScript or Java you can manipulate VRML object properties programmatically and even generate new objects.

The experience for someone browsing a VRML world can be active or passive, depending on how you've scripted the world. VRML can be used to create interactive 3D games, simulations of real or imagined devices and buildings or even cities for walk-throughs, interactive visualizations of scientific data, advertising banners, and much more. VRML is a system- and device-independent language, so one VRML world can be viewed on any VRML viewer of the correct vintage.

The current VRML specification is VRML97, which is an ISO and IEC standard. VRML97 is essentially the same as VRML 2.0, which in turn is essentially the SGI "Moving Worlds" proposal. VRML 1.0 is pretty much obsolete at this point, although most VRML 2.0 browsers will automatically convert VRML 1.0 worlds.

It's entirely possible to create VRML worlds with nothing more than the VRML specification, a text editor, and a VRML-enabled browser (all of which are free), if you're a programmer with a good grasp of 3D computer graphics concepts. On the other hand, a VRML modeling program can take a lot of the pain out of the process, and make 3D world creation accessible to non-technical designers.

CHAPTER 4

HEAD MOUNTED DISPLAY

4.1 INTRODUCTION

A Head Mounted Display is just what it sounds like -- a computer display you wear on your head. Most HMDs are mounted in a helmet or a set of goggles. Engineers designed head-mounted displays to ensure that no matter in what direction a user might look, a monitor would stay in front of his eyes. Most HMDs have a screen for each eye, which gives the user the sense that the images he's looking at have depth.

The monitors in an HMD are most often Liquid Crystal Displays (LCD), though you might come across older models that use Cathode Ray Tube (CRT) displays. LCD monitors are more compact, lightweight, efficient and inexpensive than CRT displays. The two major advantages CRT displays have over LCDs are screen resolution and brightness. Unfortunately, CRT displays are usually bulky and heavy. Almost every HMD using them is either uncomfortable to wear or requires a suspension mechanism to help offset the weight. Suspension mechanisms limit a user's movement, which in turn can impact his sense of immersion.

4.2 WORKING PRINCIPLE

HMD is an acronym for Head Mounted Display, which is a set of goggles or a helmet with tiny monitors in front of each eye that generates images seen by the wearer as being three dimensional. A true HMD includes a device for tracking the users head movements and orientation. In other words, it tracks what direction the user is looking. Most HMDs will track yaw, roll, and pitch and some will even track the users head translations, a full six degrees of freedom (6 DOF).

Many HMDs also have 3D sound headsets as part of the unit. Unconstrained objects have six different directions or rotations they are able to move within including forward or backwards, up or down, and left or right; these are called translations. Objects can also rotate around the principal axes.



Fig 4.1: Head Mounted Display Working

CHAPTER 5

DATA GLOVES

5.1 INTRODUCTION

A glove equipped with sensors that sense the movements of the hand and interfaces those movements with a computer. Data gloves are commonly used in virtual reality environments where the user sees an image of the data glove and can manipulate the movements of the virtual environment using the glove. It uses trackers and some form of bending sensors on each finger.

A data glove is an interactive device, resembling a glove worn on the hand, which facilitates tactile sensing and fine-motion control in robotics and virtual reality. Data gloves are one of several types of electromechanical devices used in haptic applications. Tactile sensing involves simulation of the sense of human touch and includes the ability to perceive pressure, linear force, torque, temperature, and surface texture. Fine-motion control involves the use of sensors to detect the movements of the user's hand and fingers, and the translation of these motions into signals that can be used by a virtual hand.

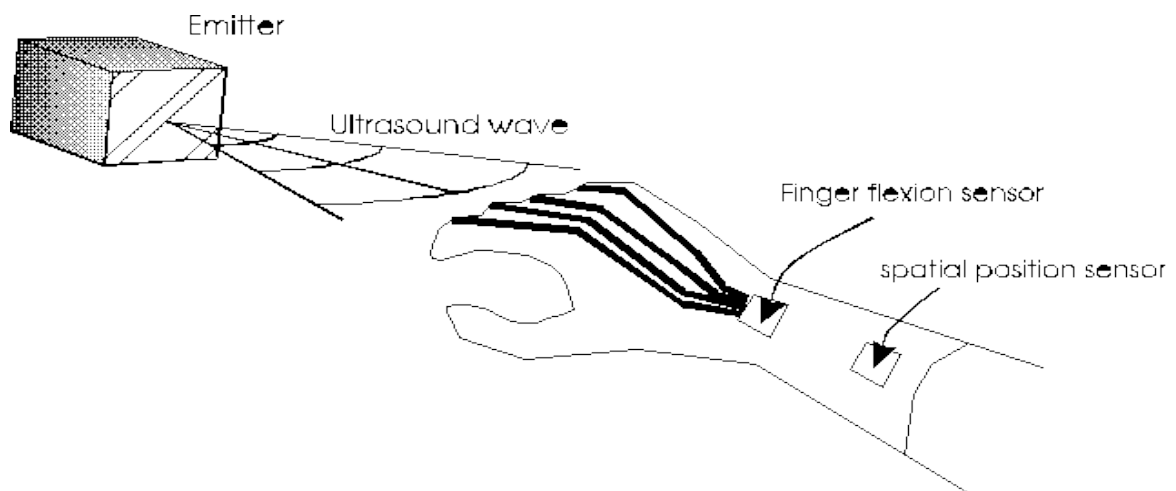


Fig 5.1: Data Glove Working(i)

5.2 WORKING PRINCIPLE

A data glove is a glove-like input device for human-computer interaction, often in virtual reality environments. Various sensor technologies are used to capture physical data such as bending of fingers. Often a motion tracker, such as a magnetic tracking device or inertial tracking device, is attached to capture the global position/rotation data of the glove. These movements are then interpreted by the software that accompanies the glove, so any one movement can mean any number of things. Gestures can then be categorized into useful information, such as to recognize Sign Language or other symbolic functions. They use trackers and some form of bending sensors on each fingers. There are various methods of determining the position and the spatial orientation of an object.

This method makes use of a stereoscopic analysis, correlating pixels common to two images, seen by two offset cameras. As with ultrasounds, this technique requires an unobstructed line-of-sight so that the cameras can "see" the dots to be triangulated into 3D spatial positions. The triangulation consists of correlating given points on two images.

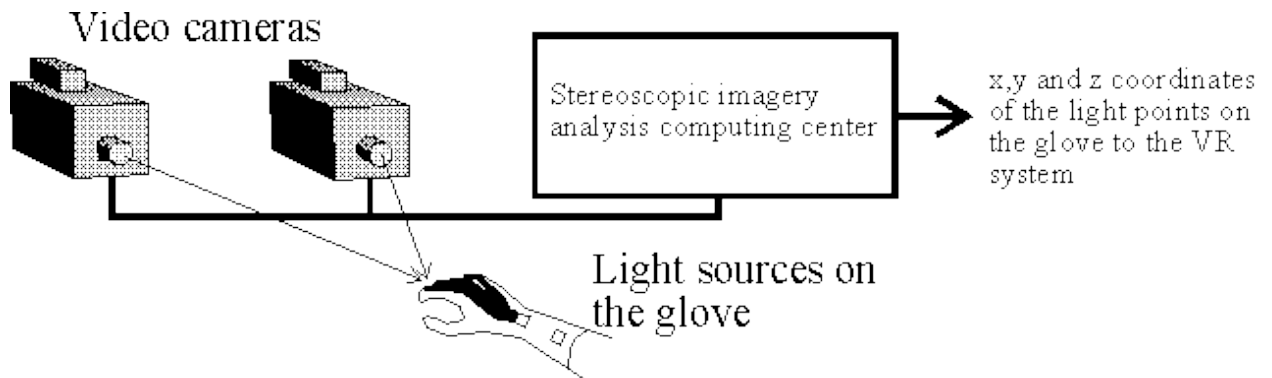


Fig 5.2: Data Glove Working (ii)

CHAPTER 6

HEAD TRACKER

6.1 WORKING PRINCIPLE

Head tracking is a precision, six degree-of-freedom positional and angular head tracking device. The first three "degrees of freedom" are coordinate movements along the X, Y, and Z axes. A mouse is a 2-D peripheral, detecting movement along two of the three axes previously mentioned. Head tracker detects movement in all three, as well as rotation on those axes.

Head tracker can detect the movement of your head and translate that to computer control. For example "looking up, down, left, right" emulates the cursor control of your desktop mouse. Moving your head "toward the monitor or away from the monitor" is also detected and can be programmed to be computer control functions. Moving your head "up", "down", "left", or "right" are also detected and can become computer control functions.



Fig 6.1: Head Tracker Working

CHAPTER 7

I SMELLER

7.1 Working Principle

DigiScents has indexed thousands of smells based on their chemical structure and their place on the scent spectrum. Each scent is then coded and digitized into a small file. The digital file is embedded in Web content or e-mail. A user requests or triggers the file by clicking a mouse or opening an e-mail. A small amount of the aroma is emitted by the device in the direct vicinity of the user. The iSmell can create thousands of everyday scents with a small cartridge that contains 128 primary odors. These primary odors are mixed together to generate other smells that closely replicate common natural and manmade odors. The scent cartridge, like a printer's toner cartridge, will have to be replaced periodically to maintain the scent accuracy.

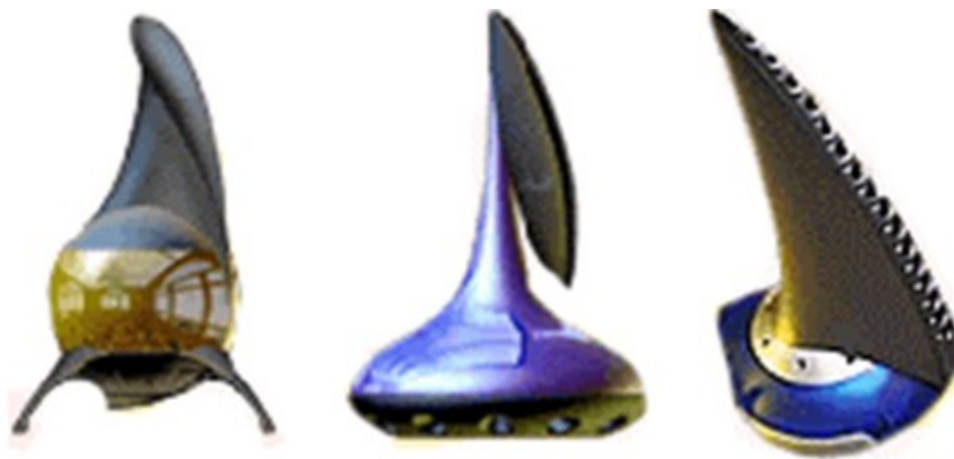


Fig 7.1: I Smeller Working

CHAPTER 8

MOTION TRACKER

8.1 WORKING PRINCIPLE

- **Mechanical**

Usually a mechanical arm attached to the tracked object

Very accurate, short lag, but restrict movement

- **Electromagnetic**

Measures strength of magnetic fields in coils attached to objects

Fast, short lag, but often prone to interference

Limited range

- **Optical**

Typically, pulsating LEDs monitored by a camera at a fixed position

Fast, reasonably short lag, but often prone to interference caused by ambient lighting conditions

Line of sight problems

- **Acoustic**

Use ultrasound waves to measure position and orientation

Slow and often imprecise

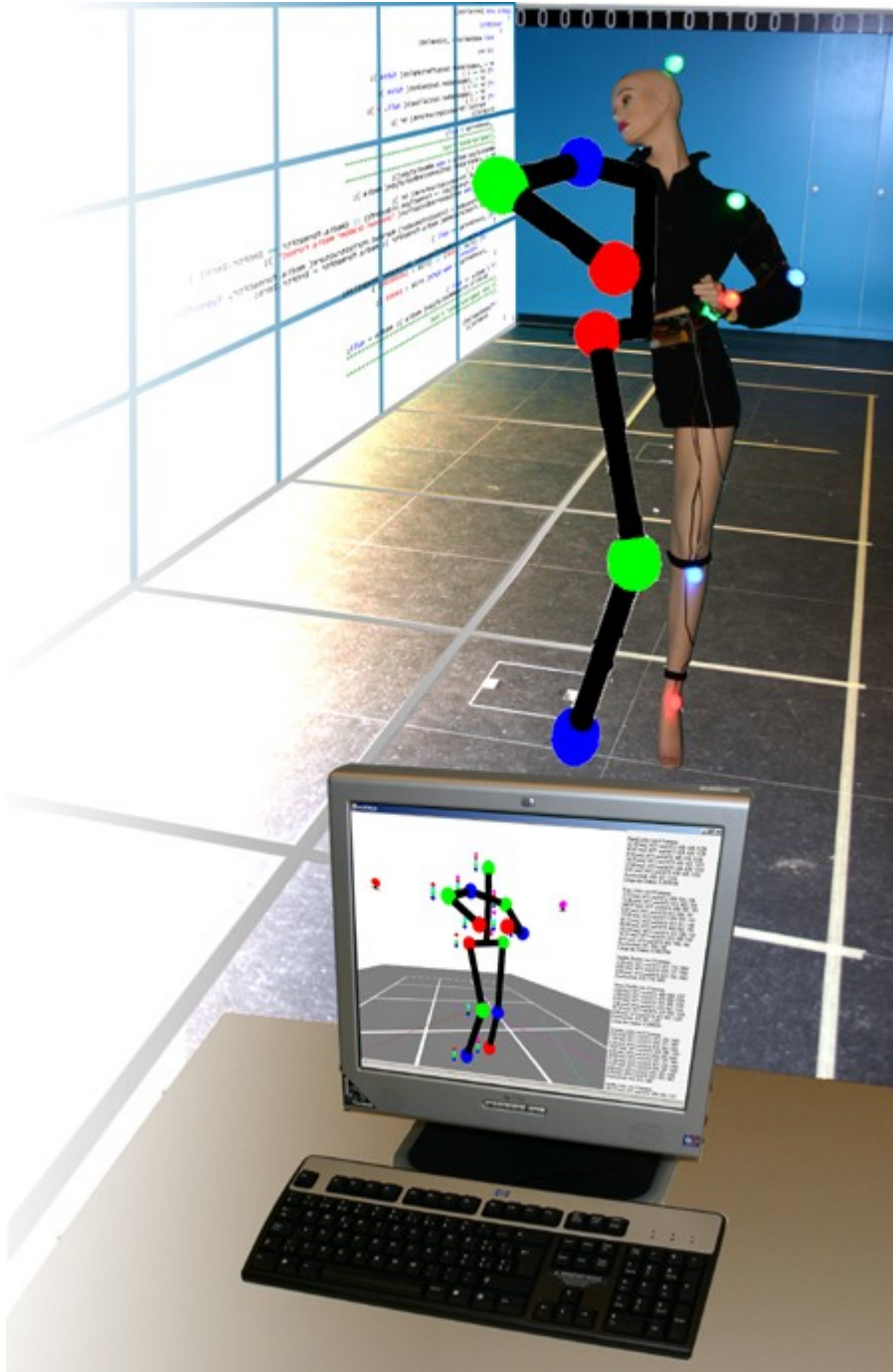


Fig8.1: Motion Tracker Working

CHAPTER 9

APPLICATIONS

9.1 INTRODUCTION

As the technologies of virtual reality evolve; the applications of VR become literally unlimited. It is assumed that VR will reshape the interface between people and information technology by offering new ways for the communication of information, the visualization of processes, and the creative expression of ideas.

Note that a virtual environment can represent any three-dimensional world that is either real or abstract. This includes real systems like buildings, landscapes, underwater shipwrecks, spacecrafts, archaeological excavation sites, human anatomy, sculptures, crime scene reconstructions, solar systems, and so on. Of special interest is the visual and sensual representation of abstract systems like magnetic fields, turbulent flow structures, molecular models, mathematical systems, auditorium acoustics, stock market behavior, population densities, information flows, and any other conceivable system including artistic and creative work of abstract nature. These virtual worlds can be animated, interactive, shared, and can expose behavior and functionality.

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

9.2 MEDICAL APPLICATIONS

In the past decade medical applications of virtual reality technology have been rapidly developing, and the technology has changed from a research curiosity to a commercially and clinically important area of medical informatics technology. Research and development activity is well summarized by the yearly "Medicine Meets Virtual Reality" meetings, and the commercialization of the technology is already at an advanced stage.

1. Diagnostics

Initially, algorithms for graphical rendering of anatomy have been used to provide support for three dimensional organ reconstructions from radiological cross sections. For the clinician this method of visualizations provided a more natural view of a patient's anatomy without losing the see through capability of the radiologist.

Virtual endoscopy techniques (such as virtual colonoscopy or bronchoscopy) based on the virtual reconstruction and visualizations of individual patient anatomy are rapidly developing. Owing to the potential benefits of patient comfort and cost effectiveness virtual endoscopic procedures could replace real endoscopic investigations in the foreseeable future in some areas of diagnosis. The most impressive development has been demonstrated in virtual colonoscopy as a screening tool for colon polyps and cancer and which is currently in the clinical validation phase.



Fig 9.1: Virtual Reality Diagnosis

2. Preoperative Planning

In many areas today the use of computer models to plan and optimise surgical interventions preoperatively is part of daily clinical practice. In some areas, such as conformal radiotherapy and stereotactic neurosurgery, treatment is not possible without preoperative planning with the aid of a computer. In other areas, such as craniofacial neurosurgery and open neurosurgery, the possibility of planning surgery on a computer screen, trying out different surgical approaches with realistic prediction of the outcome and planning individualised custom made implants have substantial impact on the success and safety of the intervention.

9.3 EDUCATION AND TRAINING SYSTEM

Education and training is one of the most promising application areas for virtual reality technologies. Computerized three dimensional atlases presenting different aspects of the anatomy, physiology, and pathology as a unified teaching atlas are about to revolutionize the teaching of anatomy to medical students and the general public.

Systems based on virtual reality offer a unique opportunity for the training of professional surgical skills on a wide scale and in a repeatable manner, in a way similar to the routine training of pilots. Contrary to the preoperative planning systems, which require an extreme level of accurate registration and alignment of tissue (data fusion), medical and surgical education and training rely more on high fidelity visualization and realistic immersion into the virtual scene than on the precise data fusion of the applied models with the specific anatomy of a patient.



Fig 9.2: Car Learning Simulator

9.4 OTHER APPLICATION AREAS

Virtual reality offers promising solutions in many other areas of medical care, where the immersion into a virtual world can help the patient, the physician, and the developer of the technology. Several systems have been developed and tested for physical or mental rehabilitation and for supporting mental health therapy by exposing the patient to appropriate experience or illusion. Finally, virtual reality based technology plays a major role in telemedicine, ranging from remote diagnosis to complex teleinterventions.

Virtual reality based technology is a new but rapidly growing area in medicine, which will revolutionise health care in the foreseeable future. The impact of this technology is just beginning to be recognised owing to methodological, technical, and manufacturing breakthroughs in the past few years. It must, however, be emphasised that the technology

is simply a tool and that the other critical areas of content development and physician-patient relationship must be incorporated into the new systems.

9.5 COMMERCIAL APPLICATIONS

- Usage of Virtual Reality in medical field

Virtual reality based technology is a new but rapidly growing area in medicine, which will revolutionize health care in the foreseeable future. In the past decade medical applications of virtual reality technology had been rapidly developing, and the technology has changed from a research to a commercial.

- Doctors getting trained in Virtual Hospitals

Education and training is one of the most promising application areas for virtual reality technologies. Medical students will be able to learn real world practical problem in VR world. For example Medical students can operate a patient who will be dieing due to a certain disease in a VR world and even medical students can get knowledge about emergencies an accident.

- Image guided Diagnosis

Virtual Reality system will allow physicians to view data such as MRI(magnetic resonance imaging) scans during a surgery to aid in the proper positioning of medical instrumentation.

- Aeronautical Training Programs

Virtual Reality is playing an important role in Aeronautics which is very helpful for Army, Air force, Navy etc.

- Flight Stimulators

With the help of flight stimulators which are based on virtual reality we can train the pilots.

- Virtual Reality Parachute Training

Virtual Reality Programs are also used in parachute training and it is only due this technology that life risk can be totally avoided.

- Aircraft Designing Programs

Virtual Reality has done the job easy for the aircraft designers. They can easily check angle and the flow of air on the body of the aircraft.

- World Tour

You can explore the every corner of the world with the help of virtual reality technology. Just imagine for a moment that you are sitting in your house located in Lahore and you are enjoying visit to New York and if you do not like it then in less than a second approximately with a speed of light you can go to Dubai and if in Dubai there is a hot sunny day of June then you can enjoy snow fall just with a click of a button.

- Virtual Teaching Programs

A student can get education from the professors at Howard University and can enjoy the campus and environment of Howard University. A teacher can improve their teaching skills by presenting lectures in a virtual reality classroom of Howard University which provides the same environment like real classrooms.

CHAPTER 10

IMPACT OF VIRTUAL REALITY

10.1 IMPACTS

There has been increasing interest in the potential social impact of new technologies, such as virtual reality. Perhaps most notably, Mychilo Stephenson Cline, argues that virtual reality will lead to a number of important changes in human life and activity. He argues that:

- Virtual reality will be integrated into daily life and activity and will be used in very human ways.
- Techniques will be developed to influence human behavior, interpersonal communication, and cognition (i.e., virtual genetics).
- As we spend more and more time in virtual space, there will be an gradual “migration to virtual space,” resulting in important changes in economics, worldview, and culture.
- The design of virtual environments may be used to extend basic human rights into virtual space, to promote human freedom and well-being, and to promote social stability as we move from one stage in socio-political development to the next.

Whether virtual reality will have positive or negative implications on the social structure is debatable, but one thing is certain – VR will play an increasingly important role in public and private life as we move towards the future.

The idea of virtual reality faces humankind with a completely new phenomenon, what are the practical consequences of inhabiting a different reality?

10.2 PROS AND CONS

The chart below briefly outlines some of the major arguments for and against societies inevitable submission to a virtual reality culture.

| S. No | PROS | CONS |
|-------|--|--|
| 1 | VR is imaginably more personal than electronic mail or instant messaging, or even a letter or a telephone call. | An inescapable aspect of social life is the formation and maintenance of interpersonal relationships. |
| 2 | VR is a great social leveler, it may find a common ground across differences in age, culture. And linguistic orientation | Interaction ought not be substituted for community. |
| 3 | People will be drawn together by similar interests instead of purely by geographic location. | Separates the 'haves' from the 'have-nots', a technology of Information Age Industrialized nations. |
| 4 | Communication will be both challenging and rewarding, more effective and productive, and thus more enjoyable. | VR will provide a communication environment in which the dangers of deception and the benefits of creativity are amplified beyond the levels that humans currently experience in their interpersonal interactions. |
| 5 | A tremendous opportunity for every 'connected' person to find his or her field and/or | Could lead to low self-esteem, feelings of worthlessness and insignificance, even self- |

| | | |
|--|-------------|-------------------|
| | discipline. | destructive acts. |
|--|-------------|-------------------|

Table 10.1 Pros and Cons of Virtual Reality

CHAPTER 11

PUBLIC PERCEPTION

11.1 PERCEPTION

The general public's fascination and expectations of the Virtual Reality field and applications have been greatly influenced by the coverage it has received in the mass media. The high expectations raised from the coverage, and from movies such as *The Lawnmower Man*, have led to disappointment and ambivalence concerning VR and its value to the individual. VR's success in the entertainment marketplace has been uneven at best, in part driven by disappointment with the reality of virtual reality versus the mass media notions and because the cost still after decades is nearly prohibitive for immersive equipment owners, forcing them to pass the cost onto the users of the equipment—and the experience using contemporary VR equipment still has not demonstrated it is superior to satisfaction gained from other entertainment alternatives of similar or lesser cost.

To date, the exceptions in the public sector have been theme parks and similar venues and video gaming (with a population willing to engage with the imaginary environments on the developers' terms). However, the public seems more than willing to embrace VR as a common media, provided the experience provided matches up to tremendously high expectations created by illusions of what VR could be provided by movies and television alongside actual news coverage. For the technology to work well enough to support a business model, it must break through the "novelty barrier" with a killer application to commoditize the industry. With the goal of ideal simulated reality itself possibly unattainable, virtual reality technologies have found their best success in industry where they line up with pre-existing business needs.

CHAPTER 12

DRAWBACKS

12.1 DRAWBACKS

The drawbacks of virtual reality are:

- Personal isolation.
- Lack of interaction with real world and other people.
- Live in virtual world.
- Increases unemployment.

CHAPTER 13

FUTURE PERSPECTIVES

13.1 FUTURE PERSPECTIVES:

- More extensive uses in hospitals, including surgery applications.
- Entertainment--"Glasstron audio/video glasses".
- Flying simulations.
- More widespread uses in all fields.
- Movies like Robot and Matrix.

- Virtual Life

Virtual life is the computer simulation of life. Instead of flesh and bones, the creatures are made up of algorithms and bytes. Many different aspects of virtual life exist. Some of these include virtual pets, virtual people, and artificial life ecosystems. Depending on the particular simulation, these virtual life creatures are capable of learning, eating, reproducing, evolving, and even carrying on a dialogue with you.

- Virtual Pets

Virtual pets are one aspect of virtual life. These virtual pets can learn, and often times even simulate emotions such as hunger, anger, fear, happiness, and love. The Tamagotchi keychain is an example of a virtual pet. It requires food and nurturing - lack of can kill it.

- Virtual People

Virtual people are another aspect of virtual life. These virtual people also simulate emotions. The Sims is an example of virtual people; these virtual people require food and rest, and develop emotional bonds with each other. Sometimes, as in The Sims Online, these virtual people can even have virtual pets of their own.

CHAPTER 14

CONCLUSIONS

14.1 CONCLUSIONS:

- After 30 years, we're still at beginning of VR.
- Every year, new, lighter, cheaper and more powerful devices get into market.
- Sound and specially speech recognition and synthesis reinforce symbiosis between human and the machine.
- Computers are advancing on gestures recognition.
- Exoskeletons are being introduced to the market and used on simulation of complex force feedback.
- Improvements on touch simulation thanks to use of new materials on datagloves.
- Use of artificial noses and odor generators are being developed.
- Introduction of cheap VR systems for video games world.

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