

## Unit 9

### Introduction to Virtual Reality

- Virtual reality is a system for providing an interactive exploration of a three dimensional virtual environment.
- Virtual reality is an environment that is simulated by a computer, trying to imitate the real thing.
- Virtual reality refers to a high-end user interface that involves real-time simulation and interactions through multiple sensorial channels.

A typical **VR system** consists of **six main components** grouped into two:

*a. Internal Components:*

- i. Virtual world    ii. Graphics Engine    iii. Simulation Engine    iv. User interface

*b. External Components:*

- i. User inputs    ii. User outputs

#### **Virtual world:**

A scene database containing the geometric representations and attributes for all objects within the environment.

#### **Graphics Engine:**

- Responsible for actually generating the image or scene, which a viewer will see.
- Usually the scene database and the viewer's current position and orientation is taken into account.
- It also includes other information from the scene database e.g. sound, special effects textures etc.

#### **Simulation Engine:**

- Does most of the work required to maintain virtual environment.
- Concerned purely with the dynamics of the environment
  - How it changes over time
  - How it responds to the user's actions
- This includes handling interactions, physical simulations (gravity, inertia)

#### **User interface:**

Controls how the user navigates and interacts with this virtual environment.

### Types of VR System

#### **1. Desktop VR**

- Based on the concept that the potential user interacts with the computer screen without being fully immersed and surrounded by the computer generated environment.
  - Applications domains involve architecture, industrial design, data visualization
  - Less cost and involves less use of interacting technology
-

## 2. Immersive VR

- Completely immerse the user's personal viewpoint inside the virtual 3D world.
- The user has no visual contact with the physical world.
- Often equipped with a Head Mounted Display (HMD).

## 3. Telepresence

- A variation of visualizing complete computer generated worlds.
- Links remote sensors in the real world with the senses of a human operator. The remote sensors might be located on a robot. Useful for performing operations in dangerous environments.

## 4. Augmented Reality (Mixed reality)

- The seamless merging of real space and virtual space.
- Integrate the computer-generated virtual objects into the physical world which become in a sense an equal part of our natural environment.
- E.g. Head Up Displays (HUD)
  - Used in modern military aircraft
  - These superimpose flight data such as altitude, air speed upon the pilots field of view
  - This can be on a cockpit mounted display or upon the pilot's helmet visor

## 5. Distributed VR

- A simulated world runs on several computers which are connected over network and the people are able to interact in real time, sharing the same virtual world.

## Technologies of VR – Hardware

### ▪ Head-Mounted Display (HMD)

- A Helmet or a face mask providing the visual and auditory displays.
- Use LCD or CRT to display stereo images.
- May include built-in head-tracker and stereo headphones.

### ▪ Binocular Omini-Orientation Monitor (BOOM)

- Head-coupled stereoscopic display device.
- Uses CRT to provide high-resolution display.
- Conventional to use.
- Fast and accurate built-in tracking.

### ▪ Cave Automatic Virtual Environment (CAVE)

- Provides the illusion of immersion by projecting stereo images on the walls and floor of a room-sized cube.
  - A head tracking system continuously adjust the stereo projection to the current position of the leading viewer.
-

- **Data Glove**
  - Outfitted with sensors on the fingers as well as an overall position/orientation tracking equipment.
  - Enables natural interaction with virtual objects by hand gesture recognition.
  
- **Control devices**
  - Control virtual objects in 3 dimensions.

### **Technologies of VR – Software**

- **Toolkits**
  - Programming libraries.
  - Provide function libraries (C & C++)
  
- **Authoring system**
  - Complete programs with graphical interfaces for creating worlds without resorting to detailed programming.
  
- **Virtual Reality Modeling Language (VRML)**
  - Standard language for interactive simulation within the World Wide Web.
  - Allows to create “virtual words” networked via the internet and hyperlinked with the World Wide Web.
  - Aspects of virtual world display, interaction and internetworking can be specified using VRML without being dependent on special gear like HMD.

### **Applications of VR**

- a) Flight simulation
    - For pilot training
    - Safe and realistic
    - Risk free
  
  - b) Medicine
    - Practice performing surgery.
    - Perform surgery on a remote patient.
    - Teach new skills in a safe, controlled environment.
  
  - c) Education and training
    - Driving simulators.
    - Ship simulator
    - Flight simulator
  
  - d) Engineering and design
    - CAD and CAM
    - View products as it would be seen when manufactured
-

- e) Human factor modeling
  - Used to model human behavior in the design of new products or buildings  
E.g. simulation of fire in a building and a user can view how the virtual occupants react to the emergency
- f) Visualization
  - Data visualization
- g) Military

## **Computer Animation**

- Computer Animation generally refers to any time sequences of visual changes in a scene.
- Computer animation is the process used for generating animated images (moving images) using computer graphics.

Applications:

1. Entertainment (Motion picture and cartoons)
2. Advertising
3. Scientific and Engineering studies
4. Training and Education

### **Steps for designing animation sequence:**

#### **1. Storyboard Layout:**

- It is the outline of the action. It defines the motion sequences as a set of basic that are to take place.
- Depending upon the type of animation to be produced, the storyboard could be consist of a set of rough sketches or it could be a list of basis ideas for motion.

#### **2. Object Definitions:**

- Each object participating in the action is given object definition, such as polygons or splines.

#### **3. Key Frame Specifications:**

- *Frames:* It is one of the many single photographic images in a motion picture. The individual frames are separated by frame lines. Normally, are needed for one second of film.
- A key frame in animation and filmmaking is a drawing that defines the starting and ending points of any smooth transition.
- A sequence of key frames which movement the spectator will see.

#### **4. Generation of in-between frames:**

- It is the process of generating intermediate frames between two images to give appearance that the 1<sup>st</sup> image evolves smoothly into the second image.
  - In-betweens are the drawing between the key frames which help to create the illusion of motion.
-