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 1st image evolves smoothly into the second image.
    -   In-betweens are the drawing between the key frames which help to create the illusion of motion.