

Introduction To Virtual Reality

Unit- 9

What is Simulation?

- A representation of a problem, situation, etc. in mathematical terms, using a computer is called simulation.
- Mapping the real-world scenarios into mathematical model using computer graphics.
- Example: Robot Operation Simulation, Training

What is Virtual Reality (VR) ?

- Virtual Reality (VR) is the use of computer graphics and other technologies to create a simulated environment in which the user interacts.
- A realistic simulation of an environment, including three-dimensional graphics, by a computer system using interactive software and hardware.
- A computer simulation of a real or imaginary world or scenario, in which a user may interact with simulated objects in real time. Computer simulations that use 3D graphics and devices such as the data glove to allow the user to interact with the simulation.
- The definition of “virtual” is near and “reality” is what we experience as human beings.

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More about VR

- You can view virtual reality through a special VR viewer, such as the *Oculus Rift*. Other virtual reality viewers use your phone and VR apps, such as *Google Cardboard* or *Daydream View*.
- With *virtual reality apps*, you can explore places you have never been, such as the surface of Mars, the top of Mt. Everest, or areas deep under the sea. The New York Times has a virtual reality app that lets you experience virtual environments on Earth and other planets.
- *Google Earth* also has a virtual reality app.

The Three I's of VR

1. **Immersion**

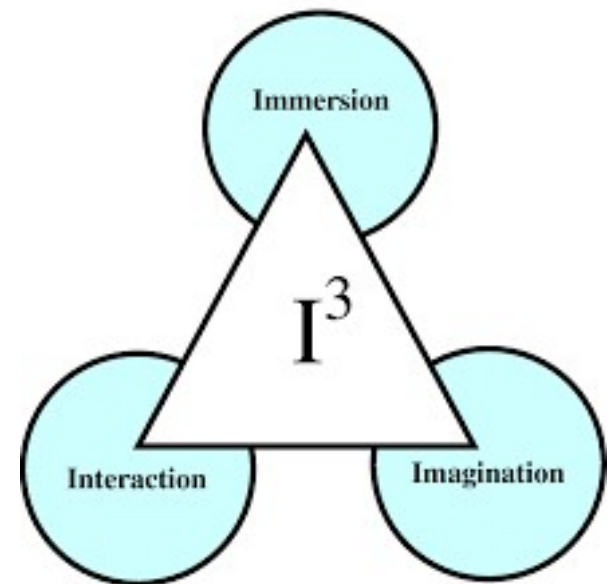
- The feeling of presence, being there
- The amount and quality of stimuli and sensation
- Real time: very little latency accepted
- Around 50ms is a threshold of visual noticeability, but varies for all senses

2. **Interaction**

- Not just passive watching
- Moving in the virtual world
- Doing all kind of things there

3. **Imagination**

- The applications
- The ideas
- The virtual worlds



Properties of Virtual Reality

1. Synthetically generated environment

- Computers, 3D, real-time

2. Sensory feedback

- I/O devices

3. Interaction, moving

- In time
- In space
- In scale

4. Immersion

- Being there

- 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

Components of Virtual Reality

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. sounds, special effects, textures etc.

Components of Virtual Reality

Simulation Engine :

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

User Interface :

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

Components of Virtual Reality

Input Devices : transfer information from the user to the computer

- Mouse, keyboard
- Trackball, Joystick
- Position Tracking
- Orientation Tracking
- Data gloves
- Data suit
- Motion Capture
- Eye Tracking
- Brainwaves (EEG), EMG, EOG

Output Devices: transfer data from the computer to senses of the user

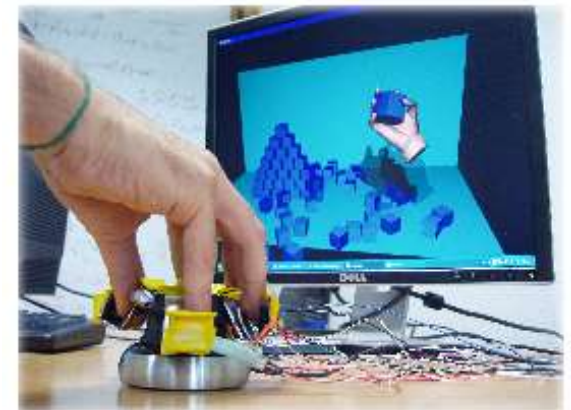
- Displays: monitors, projectors
- Localized audio: loudspeakers, headphones
- Tactile and Haptic : force feedback
- Smell, balance , etc.

Types of VR

- Desktop (Non-Immersive) VR
- Projected VR
- Immersive VR

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.



Non- Immersive / Projected VR

- Based on overlapping of the image of the real user on the computer generated world.
- A special movement tracking device can capture the movements of the user and enter them so they can cause actions and reactions in the virtual world.
- Often used in VR Art Shows

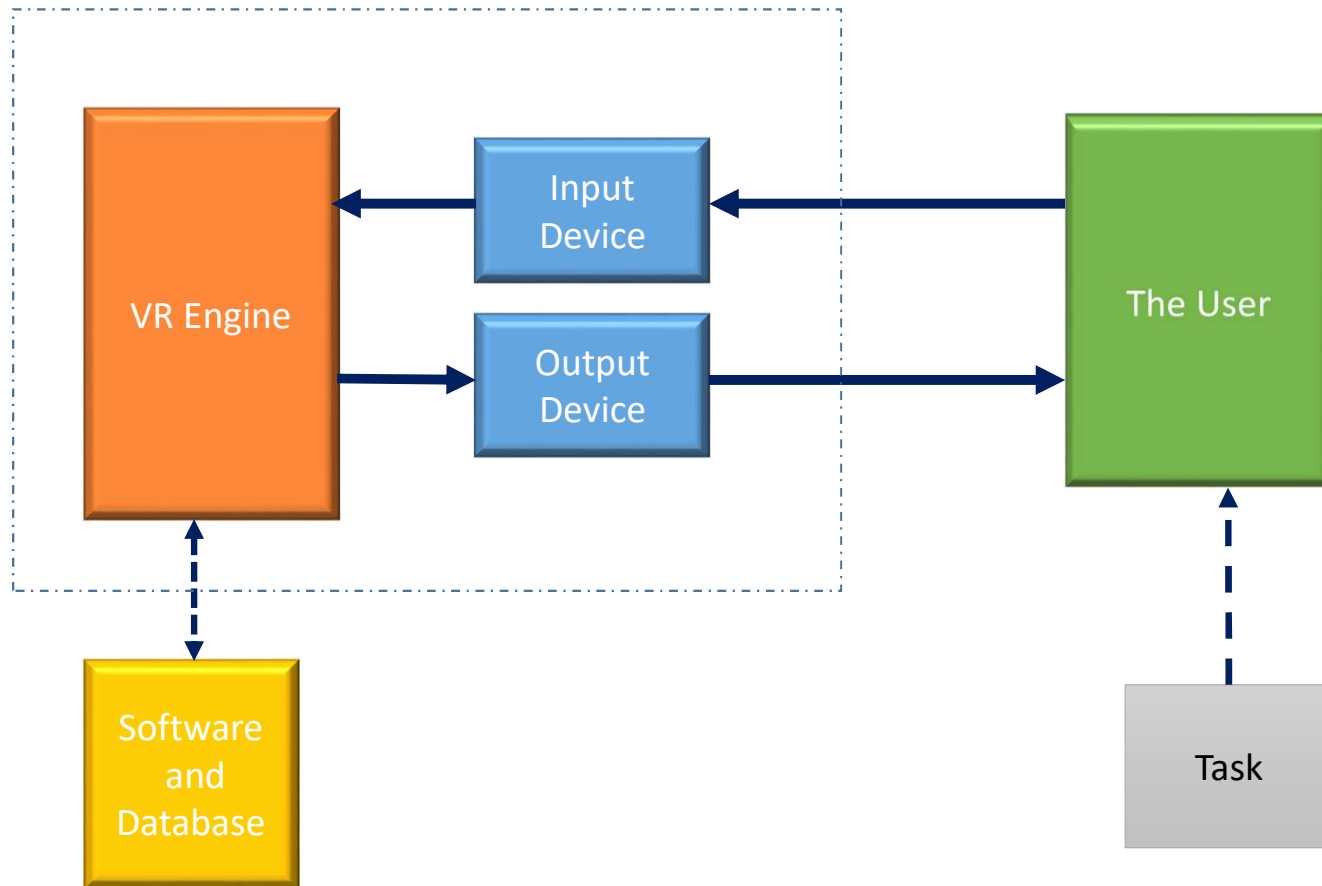


Immersive VR

- The user appears to be fully inserted in the computer generated environment.
- Illusion rendered by providing HMD (Head Mounted Device) with 3D viewing and a system of head tracking that gives the exact correspondence and coordination of the user's movements with the feed-back of the environment.
- The goal is to completely immerse the user within a synthetic environment or make them feel a part of that environment.



The VR System Architecture



Application of VR

- Flight simulation
 - For pilot training
- Engineering and Design
 - CAD and CAM
 - View products as it would be seen when manufactured
- 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.
- Data Visualization

Augmented Reality (AR)

- AR is a field of computer research which deals with the combination of real-world and computer generated data.
- It is a combination of a real scene viewed by a user and a virtual scene generated by a computer that augments the scene with additional information.
- An AR system adds virtual computer-generated objects, audio and other sense enhancement to a real-world environment in real time.
- Examples of augmented reality experiences include Snapchat lenses and the game Pokemon Go.

Goal of AR

- To enhance a person's performance and perception of the world
- Ultimate goal?????
- Create a system such that a user CANNOT tell the difference between the real world and the virtual augmentation of it.

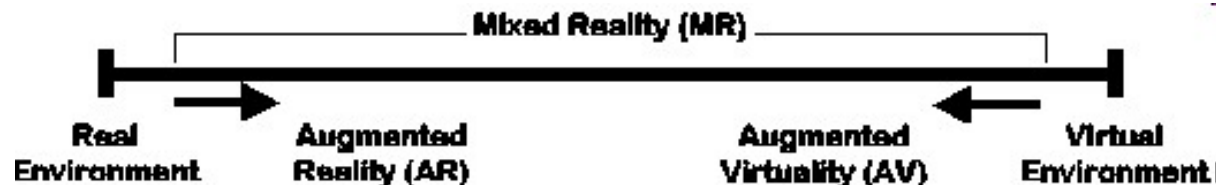
Characteristic of AR

- AR systems have the following three characteristics:
 1. Combines real and virtual objects in a real environment
 2. Is interactive in real-time
 3. Registers (aligns) real and virtual objects with each other.

Augmented Vs. Virtual Reality

1. Immersion :

- The main difference between these two technologies is the immersion they provide.
- Virtual Reality generates a completely computer-generated world, everything the user sees is an artificial recreation, so the user loses contact with the real environment.
- On the other hand, Augmented Reality enhances reality by adding digital information to it, so the user is still in contact with the real environment during the **AR experience**. This allows the user to interact with the “augmented” objects while being in contact with the real world.



Augmented Vs. Virtual Reality

2. Devices :

- VR uses headsets that immerse the user's vision and hearing into the virtual world. AR is provided from a wider variety of devices: AR headsets, laptops, **tablets, smartphones...** Don't forget that AR keeps the user in contact with the real world, that's what makes the biggest difference between the devices used.

3. Edtech Application

- VR can be used to immerse students into historical worlds for example, making it a good solution for theoretical lessons. However, the main feature of AR is the ability to interact with the “augmented” world, that's why it can provide students more practical lessons

How does AR work?

- The basic idea of augmented reality is to superimpose graphics, audio and other sense enhancements over a real-world environment in real-time.
- The graphics will then change to accommodate the user's eye or head movements.



Simulated augmented reality medical image

What is needed?

- Laptop or computer
- Handheld like Smartphone or Tablets
- Head-Mounted Device (HMDs) often employ sensors for six degree of freedom monitoring that allow the system to align virtual information to the physical world and adjust accordingly with the user's head movements
- Smart Glasses
- Gesture based solution (Kinect, Leapmotion)



HMD



Google Cardboard

Current Uses of AR

- Yellow first down line used on TV broadcasts of football games:
 - Real world elements: football field and players
 - Virtual element: the yellow line drawn over the image by computers in real-time



Current Uses of AR

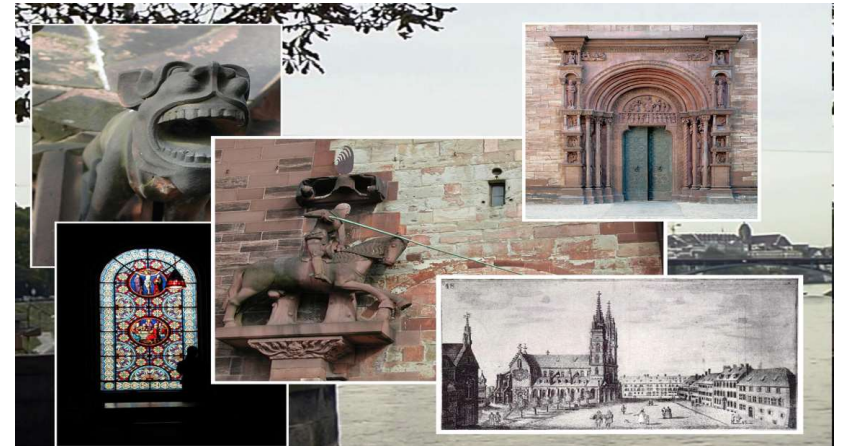
- HUD (Head Up Display):
 - Used in commercial aircraft, automobiles, and other applications
 - Presents data without requiring the user to look away from his or her usual viewpoint



Current Uses of AR

LifeClipper

- LifeClipper is a wearable AR system being used in Switzerland.
- When walking around a chosen culturally interesting area, the user will feel as though they are watching a film.



Current Uses of AR : Wikitude – AR Travel Guide

- Mobile travel guide for the Android platform (open source OS for cell phones).
- Plan a trip or find about current surroundings in real-time.



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