VR

Unit-1

Virtual Reality and Virtual Environment.

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Virtual Reality : Immersive simulated experiences using headsets and other tech, creating the illusion of being physically present in virtual world.

Virtual Environment : Computer generated 3D spaces accessed through various interfaces, allowing interaction and exploration without physical immersion.

Q.1. Computer Graphics.

→ Computer graphics are the brushstrokes that paint the breathtaking ~~Worlds~~ worlds of Virtual Reality. They transform raw data and code into stunning visuals, realistic textures, and dynamic lighting that make VR feel so real.

Applications :-

- Movies & Games
- Prototyping
- Engineering Simulation
- Medical visualization
- Advertising & Marketing
- User Interface & design

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Q.2. Real time Computer Graphics

→ Real time computer graphics is the technology that generates and displays interactive, immersive 3D visuals in VR in real time, as you move and interact within the virtual world. It's essential for creating the sense of presence and realism that VR aims for

Advantages:

- Smooth and Responsive
- ~~Inte~~ Real time interaction
- flexibility and versatility
- cost efficiency
- efficient data utilization.

Q.3. Flight Simulation

→ - A flight simulator is a training system where pilots can acquire flying skills without involving a real aeroplane or airports.
- Simulators are used by professional pilots to practise flying strategies under emergency or hazardous conditions, or to train on new aircraft types. ~~Test~~

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Q.4. Virtual environment requirements.

→ - one of the primary requirements of any VR application is that ~~is~~ it is able to update images at high speed. Ideally this should be no slower than conventional video frame refresh rates which are 25 Hz for PAL and 30 Hz for NTSC

- To achieve this image update rate cells for specialist IGs as used in flight simulators, which is quiet expensive.
- other alternatives are found in graphics workstations and dedicated multiprocessor imaging system. this is cheap.

Q.5. The virtual world space

→ ~~So ba~~

There are two crucial steps for VR:

i) Build the world: Use X, Y, Z coordinates to place objects and create the virtual landscape.

ii) Explore the world: Move the virtual observer around to see different parts of virtual world and interact with it.

all this happens in real-time, making VR feel like you're actually there!

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Q.6. Positioning the virtual observer.

→

Location: You can be anywhere in the playground, like standing by a virtual tree.

Sight: you can look in any direction, up, down, left, right.

Two eyes: Just like in real life, your virtual observer has two "eyes" to see things in 3D.

To create this 3D view for each eye, the computer needs to understand your position and where you're looking.

Q.7. Perspective projection and Stereo perspective projection

- perspective projection: In VR perspective projection plays a crucial role in recreating the natural way we see the world. It's the magic behind transforming the 3D data of virtual environments into the 2D images displayed on your VR headset, creating a realistic sense of depth and dimension.

- stereo perspective projection: It's like giving your eyes superpowers. imagine looking at a virtual mountain, your left eye sees slightly more of left side and your right eye sees slightly more of right side. The brain combines these two views, creating a sense of depth and making the mountain feel like it's popping out of screen.

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Q.8. Human Vision.

→ - When it comes to VR, understanding human vision is crucial for creating immersive and believable experiences.
- Human vision refers to how we ~~perce~~ perceive the virtual world using our natural eyesight.
- It's about understanding how our brain interprets the visual information provided by the VR headset and creates a sense of presence within the virtual environment.

i) Monocular cues : Even with one eye, we can gauge depth.

ii) Binocular cues : Two eyes provide additional superpowers.

Q.9. 3D Clipping.

→ Imagine you're in VR. To show you what you see, the computer needs to "clip" out anything your eyes wouldn't naturally see, like things behind your head. It does this by imagining a pyramid around your viewpoint and only keeping objects inside. Think of it like trimming a bush to make it look neat — VR clips away the hidden parts of objects to only show you what matters!

~~This Clipping happens for each~~

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Q.10. Colour theory.

Q.11. Simple 3D modelling

→ Simple 3D modelling discusses how 3D models are represented in virtual environments. It starts with Euler's rule for polyhedrons and then introduces two common methods for storing 3D model data:

i) Edge table : Stores edges and their connected vertices, but cannot represent faces or shading.

ii) Face table : Stores faces and their vertex sequences, allowing for shaded views and objects with holes.

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Q.12. Illumination models.

→ An Illumination model is a set of mathematical equations and algorithms that simulate how light interacts with a surface, determining its brightness, color, and shadows.
They consider factors like:
- Light source properties: Intensity, colour, direction
- Material properties: Reflectivity, texture, transparency
- Geometric relationships: angle between light, surface and viewpoint.

Q.13. Reflection models

→ Reflection models are sets of algorithms and equations that calculate how light bouncing off a surface interacts with the environment.
They consider factors like:
- Surface properties: Reflectivity, roughness, transparency
- Light properties: Intensity, color, and direction.
- Geometry: angle between light surface.

Q.14. Shading algorithm.

→ shading algorithm are sets of mathematical equations and instructions that determine how light interacts with virtual surfaces.
They consider factors like:
- surface properties
- Light properties
- Geometry.

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Q.15. What is Radiosity ?

→ Radiosity is a computer graphics technique that simulates the way light is reflected and diffused between surfaces in a closed environment. It calculates the amount of light each surface emits and receives from other surfaces, creating a more realistic interplay of light and shadow compared to traditional single-bounce lighting models.

Q.16. Hidden surface removal.

→ Hidden surface removal plays an important role in virtual reality, ensuring you only see surfaces that should be visible, creating a seamless and immersive experience.

Q.17. Stereographic images.

→ Stereographic images are the type of images created by two slightly different photographs from two viewpoints, similar to how our eyes see the world. When presented to each eye separately, these create a sense of depth and prespective.

VR

Unit-2. Geometric Modeling.

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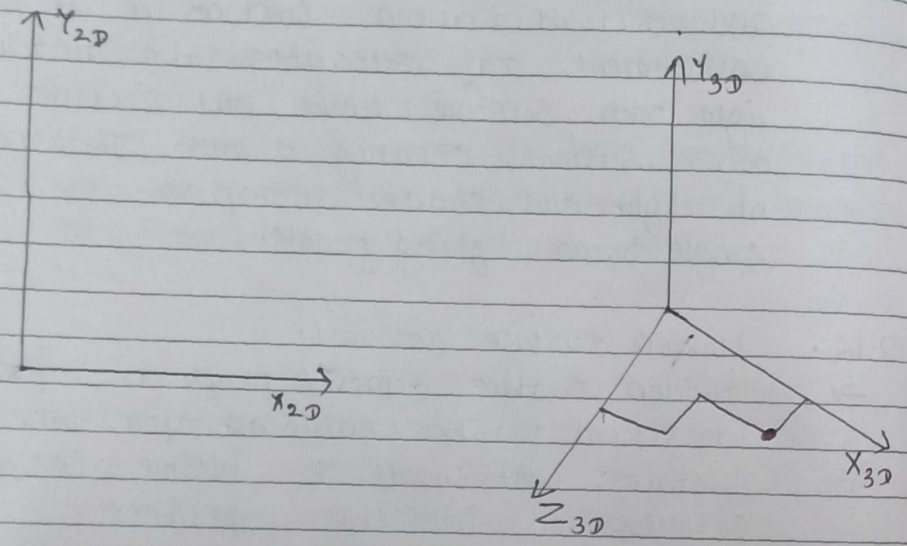
Q.1. From 2D to 3D.

→ Write about converting 2D object to 3D.



In this example, the 2D shape is converted into a 3D lamina by applying the following assignments:

$$X_{3D} = Y_{2D},\ Y_{3D} = 0.0,\ Z_{3D} = X_{2D}$$

Q.2 3D Space Curves

→ 3D space curves in VR refer to the creation and manipulation of curved in a virtual 3D environment. Imagine being able to draw or sculpt lines that twist and turn through the virtual space, not confined to the flat planes of traditional screens. This opens up a whole new world of possibilities for artistic expression, data visualization.

Q.3. Frame of reference.

→

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Q.4. Modelling transformation.

→ The process of manipulating the position, orientation, and scale of virtual objects within a 3D environment. These transformations are essential for creating immersive and interactive experiences, as they allow users to interact with virtual objects in a natural and intuitive way.

- Types of modelling transformation.

i) Translation : moving an object from one point to another in 3D space.

ii) Rotation : Turning an object around an axis

iii) Scaling : Resizing an object, making it larger or smaller.

Q.5. Instances.

→ Instances are copies of a single geometric entity that can be used multiple times in a CAD model.

Suppose, In CAD model you can create a single 3D model of say a table leg. Then you can create multiple instances of that leg and place them at different corners of table. Each leg instance will have the same geometry as the original model, but it will be positioned and oriented differently.

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Q.6. Picking.

→ the process of selecting and interacting with virtual objects within a virtual environment. It's how you grab, move, rotate, or otherwise manipulate objects to create a more immersive and interactive VR experience.

Q.7. Flying.

→ Flying in VR allows users to move through the virtual environment without physically walking. It's essentially like moving yourself around the virtual world by "swimming" through the air.

Key aspects of flying :

i) Direction : Choose direction of flying according to you.

ii) Distance : you can determine how far you move with each step in virtual space.

iii) Movement illusion : Instead of actually moving your physical body, the VR system manipulates the virtual environment.

Q.8. Collision detection.

→

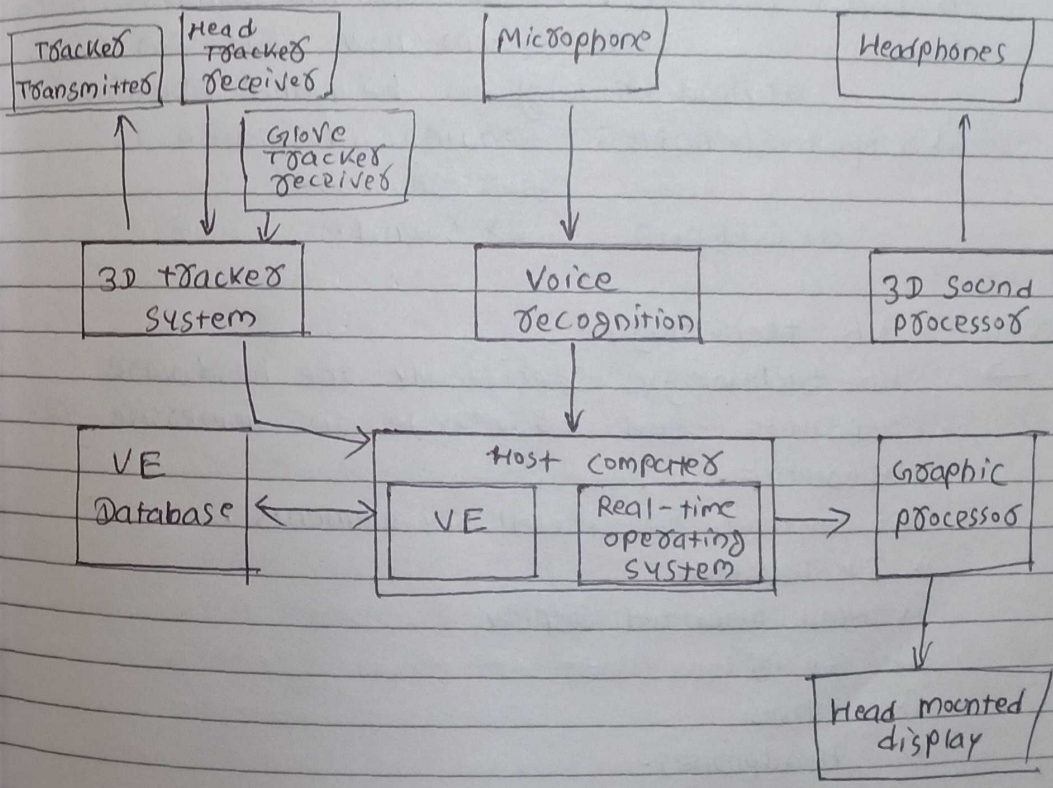
Collision detection in virtual reality (VR) is a crucial technology that ensures realistic interactions between the user and the virtual environment. It's what prevent your virtual hand from phasing through walls, objects, through each other and unexpected glitches interrupting your immersion.

Examples.

- Grabbing & manipulating object in a virtual scene
- Walking through a virtual world without clipping through walls.
- playing a VR game where you shoot at targets with objects that cause realistic impact interactions.

Q.9. Virtual environment.

→ It's the digital world constructed within the system that users step into and interact with. Imagine it as a 3D playground built with code and imagination, where anything is possible and only limits are you own creativity.



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Q.10. Computer environment.

→ The entire hardware and software setup that runs VR system is known as computer environment.

Its the brain behind the operation, processing your inputs, generating the virtual world, and sending it to your sensors.

i) Input channels: These are like windows, letting the system know what your doing.

a) Head tracking , b) Hand Tracking

ii) output channels: sending information to your senses.

a) Graphics , b) Sound.

Q.11. VR technology.

→ VR technology, specifically the hardware components used to create an immersive VR experience.

It focuses on several key elements:

i) 3D Trackers

ii) Head mounted Display

iii) 3D Mice

iv) Gloves

v) Headphones.

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Q.12. Model of interaction.

→ Model of interaction used to bridge the gap between users and ~~the~~ virtual world.

i) Immersive interaction: The ways user engage with the virtual environment in VR system, feeling a strong ~~of~~ scense of presence and physical interaction within the digital world.

ii) User Interface: it means how user interact with virtual world in VR system. It covers how they navigate, manipulate objects and perform actions within the VE.

iii) Non-immersive VR: It refers to virtual reality experiences that don't fully surround you into virtual world. Instead it presents the VE like a "window" on screen. You're aware you're using a computer and interacting with digital representation.

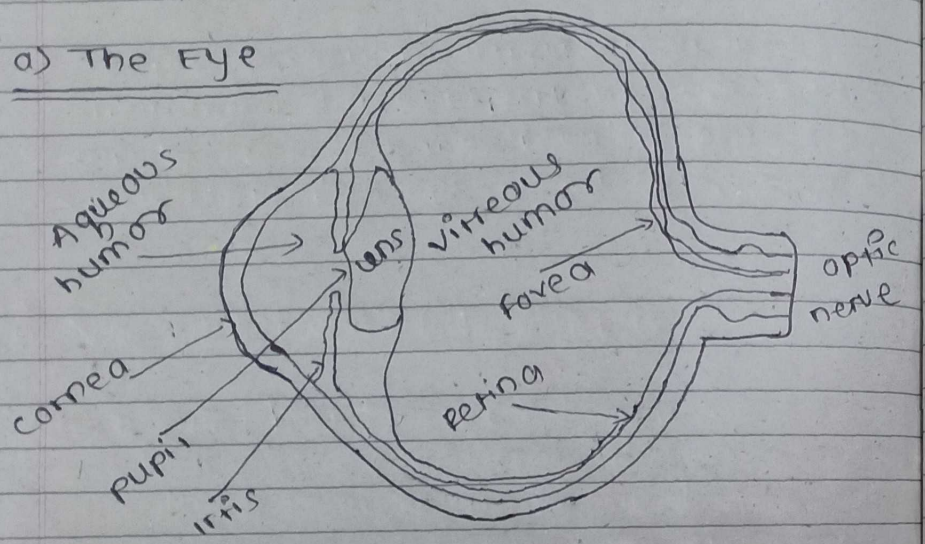
Q.13. VR System.

→ VR system is described as a technology enabling users to interact with a virtual database.

Unit - 05

① Human Factors

a) The Eye



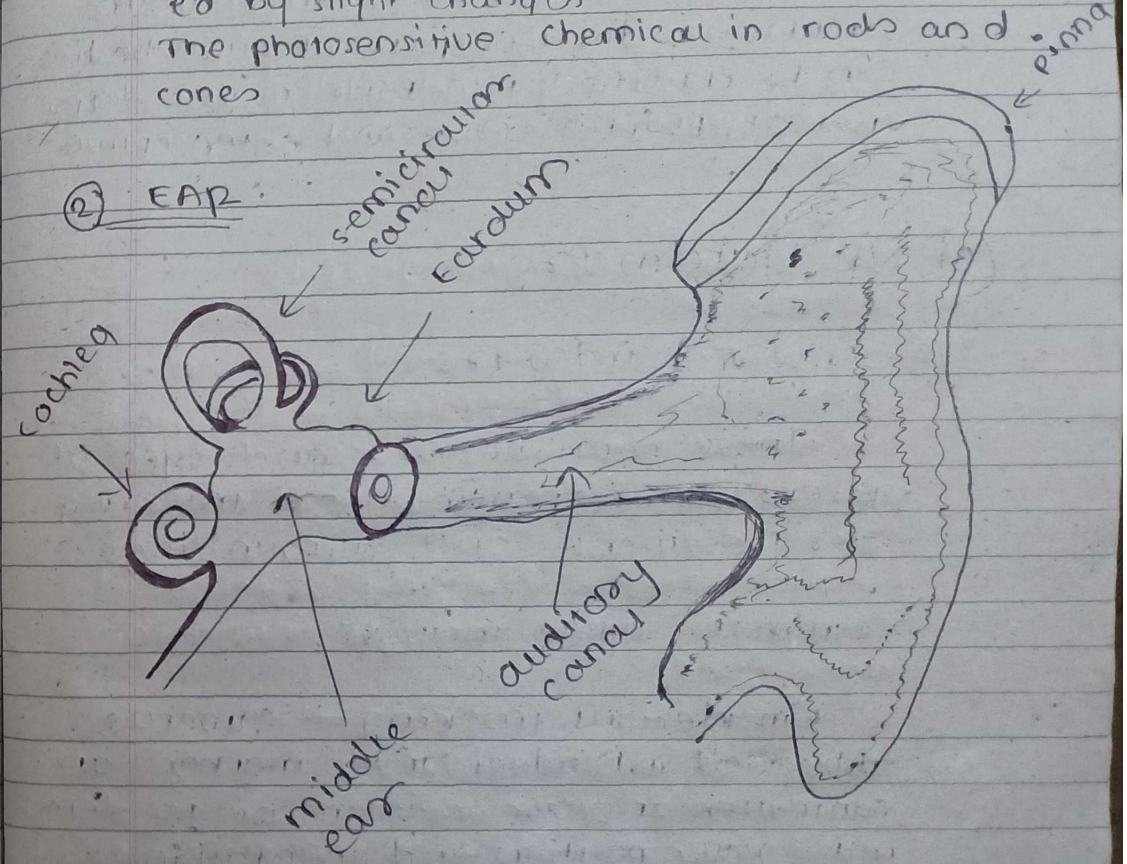
(i) pupil → increase depth of field for near vision by contracting and also maximize eye sensitivity by opening.

(ii) The retina → The retina is the light-sensitive surface attached to the rear of the eye and is several hundered microns thick.

(iii) visual acuity → like any other optical system the eye has limitations and one that is important to display systems concern visual acuity.

(iv) light and dark adaption → The luminous sensitivity of the eye is automatically adjusted by slight changes in concentration of the photosensitive chemical in rods and cones

② EAR



- Sound perception
- frequency range
- sound intensity
- sound direction
- sound stage.

(8.) Somatic senses

The sensations that arise from simulating different part of our bodies can be classified into four groups : deep, viscreal, proprioceptive and exteroceptive

(9) VR Hardware

(a) Sensor hardware

These are the ear and eyes of VR system responsible for tracking your movements and surroundings.

common types include

• inside-out tracking → cameras embedded in headset track markers on controllers or your environment to determine your position and orientation.

• outside-in tracking → external sensors positioned in the room capture your movements with greater precision and allow for large tracking areas.

• Haptic sensors → provide tactile feedback and simulate the sensation of touch.

(b) Head-coupled displays (HMDs) :

This is the screen you see through, presenting the virtual world to your eyes.

key factors -

• Resolution
• Refresh rate
• field of view
• display technology

(c) Acoustic Hardware :

This include anything that produces sound within the VR experience.

it include

• on-ear headphones → integrated into headset, providing spatial audio for immersive sound effects.

• off-ear headphones → offer more flexibility

• spatial audio system → use multiple speakers or virtualized sound techniques to create a realistic sense of directions and distance for in-game sound.

(d) Integrated VR system :

These are all-in-one solutions that combine the processing power, display, tracking, and audio into a single unit.

VR software

(5) Modeling virtual worlds :

(A)

- creating 3D objects and environment
- Texturing and materials → applying it to create realistic surface.
- Lighting → setting up light to create ambiance.
- Animations → Bringing object and characters to life through animation techniques.

(B) Physical simulation

- Realistic physics → incorporating physics engine to simulate real world physical interactions.

- Haptic feedback → integrating haptic devices to provide tactile world feedback

- constraints and interactions → shows how character interact with each other and the environment

(C) VR Toolkits

- Development platforms - software frameworks that provide tools and libaries for building VR applications, simplifying the development process.

examples

- unity → game platform with VR support
- unreal engine → powerful gameengine with advanced VR capabilities
- A-Frame → web framework for building VR experience in web browsers

(6) Introduction to VRML (virtual reality modeling language)

- standard for 3D scene description - A text-based file format for defining 3D world and objects, enabling sharing and distribution of VR content across platforms.

⑥ VR APPLICATIONS

- Engineering
- Entertainment
- science
- training

⑦ Future

- virtual environment
- modes or interaction.