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DEPARTMENT OF CIVIL ENGINEERING

19CET308- AR/VR in Civil Engineering

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UNIT - II AR/VR

VR Devices – Structure and working of Oculus Quest - Samsung Odyssey - Oculus Rift

Structure and Working of Oculus Quest

Oculus Quest is a standalone virtual reality (VR) headset developed by Oculus (now part of Meta). Unlike earlier VR headsets that required a PC or smartphone, the Oculus Quest is a self-contained device with built-in processing, tracking, and display. It offers a fully immersive VR experience with 6 Degrees of Freedom (6DoF) tracking, wireless freedom, and powerful built-in hardware.

Structure of Oculus Quest

The Oculus Quest consists of the following components:

1. Headset Frame
   - Made of lightweight plastic for comfort and durability.
   - Includes adjustable straps for a snug fit.
2. Display System
   - Uses OLED displays with a resolution of 1600 × 1440 per eye.
   - Refresh rate: 72Hz for smooth VR experiences.
   - Field of View (FoV): ~100° for an immersive view.
3. Lenses (Optics)
   - Uses Fresnel lenses to magnify the screen and provide a stereoscopic 3D effect.
   - Adjustable interpupillary distance (IPD) to align with the user's eyes.

Inside-Out Tracking System (6DoF)

- No external sensors required!
- Uses four ultra-wide-angle cameras on the headset for Positional Tracking.
- Provides 6 Degrees of Freedom (6DoF), meaning users can move in any direction within their play space.

5. Processing Unit (Standalone VR)

- Qualcomm Snapdragon 835 processor for running VR apps without needing a PC.
- 4GB RAM for smooth performance.
- Built-in storage (64GB or 128GB versions) for games and applications.

6. Oculus Touch Controllers

- Wireless controllers for interacting with virtual environments.
- Buttons, triggers, thumbsticks, and capacitive touch sensors for hand presence tracking.

7. Audio System

- Integrated 3D spatial audio speakers in the headset frame (no need for external headphones).
- 3.5mm headphone jack available for private listening.

8. Battery & Connectivity

- Built-in rechargeable battery (2-3 hours of playtime).
- Wi-Fi and Bluetooth for wireless connectivity.
- Supports Oculus Link for connecting to a PC (Oculus Quest can act as a PC VR headset).

Working of Oculus Quest

1. Setting Up the Headset

- **Power on the device and go through the initial setup (Wi-Fi, account login, guardian setup).**
- **The headset automatically detects the user's play area using its inside-out tracking system.**

2. Displaying the VR Environment

- **The OLED screen provides a clear, high-resolution image.**
- **The Fresnel lenses magnify the screen to create a 3D stereoscopic effect.**

3. 6DoF Positional Tracking

- **Inside-out tracking cameras on the headset map the environment in real-time.**
- **Tracks head movements (left-right, up-down, forward-backward).**
- **Allows real-world movement within a virtual space without needing external sensors.**

4. Hand and Controller Tracking

- **The Oculus Touch Controllers provide precise hand tracking.**
- **Each controller has buttons, thumbsticks, and capacitive sensors that detect finger placement.**
- **Supports hand tracking (without controllers) for gesture-based interaction.**

5. Interaction with VR Applications

- **Users can navigate menus, interact with objects, and play games using controllers or hand tracking.**
- **The Guardian System ensures users stay within a safe play area.**

6. Audio Experience

- Built-in 3D spatial audio creates realistic sound positioning.
- Users can also use headphones for enhanced audio.

7. Oculus Link (Optional PC VR Mode)

- Oculus Quest can connect to a PC via USB-C (Oculus Link).
- This allows it to run high-end PC VR games like those for Oculus Rift and SteamVR.

Key Features of Oculus Quest

✅ Standalone VR – No PC or external sensors required.
✅ 6DoF Tracking – Full movement in VR.
✅ Wireless Freedom – No cables, room-scale VR.
✅ Hand Tracking – Supports interaction without controllers.
✅ PC VR Compatibility – Can connect to a PC via Oculus Link.
✅ Oculus Store Access – Large selection of VR games and apps.

Limitations of Oculus Quest

❌ Limited Battery Life – Lasts around 2-3 hours per charge.
❌ Lower Graphics Compared to PC VR – Mobile chipset limits graphical power.
❌ Requires Guardian Setup – Needs a play area to avoid collisions.
❌ Refresh Rate – 72Hz is lower than high-end PC VR headsets (like Valve Index at 120Hz).

Comparison: Oculus Quest vs. HTC Vive vs. Samsung Gear VR

Feature	Oculus Quest	HTC Vive	Samsung Gear VR
Tracking	6DoF (Inside-Out)	6DoF (External Sensors)	3DoF (Phone Sensors)
Display	OLED (1600×1440/eye)	OLED (1080×1200/eye)	Smartphone Display
Interaction	Touch Controllers, Hand Tracking	Motion Controllers	Touchpad, Bluetooth Controller
Wireless	✅ Fully Wireless	❌ Requires PC, Cables	✅ Fully Wireless
PC VR Support	✅ (Oculus Link)	✅ Yes (High-End)	❌ No
Price	~$300 - $400	~$600+	~$50 - $100

Structure and Working of Samsung Odyssey

The Samsung HMD Odyssey is a Windows Mixed Reality (WMR) headset designed for virtual reality (VR) experiences. Unlike standalone headsets (like Oculus Quest), the Odyssey requires a PC connection and runs on the Windows Mixed Reality platform. It features inside-out tracking, a high-resolution AMOLED display, and built-in AKG headphones for immersive VR experiences.

Structure of Samsung Odyssey

The Samsung Odyssey consists of several key components:

1. Headset Frame
   - Made of lightweight plastic for comfort.
   - Adjustable headband with a dial-based tightening system for a secure fit.
2. Display System
   - Dual AMOLED displays with a resolution of 1440 × 1600 per eye.
   - Refresh rate: 60Hz – 90Hz (adjustable based on the PC's capability).
   - Field of View (FoV): ~110° for a wide viewing area.
3. Lenses (Optics)
   - Uses Fresnel lenses for sharp visuals and reduced distortion.
   - Fixed interpupillary distance (IPD) at 63mm (not adjustable).

4. Inside-Out Tracking System (6DoF)
   - No external sensors required.
   - Uses two front-facing cameras for positional tracking.
   - Provides 6 Degrees of Freedom (6DoF), allowing full movement within a VR space.
5. Controllers (Samsung Odyssey Controllers)
   - Two motion controllers with built-in tracking sensors.
   - Features joysticks, buttons, triggers, and a touchpad for interaction.
   - Uses Bluetooth connectivity to sync with the PC.
6. Audio System (Built-in AKG Headphones & Microphone)
   - Integrated AKG headphones for 3D spatial audio.
   - Built-in microphone for voice communication.
   - 3.5mm headphone jack available for external headphones.
7. Connectivity & Power
   - HDMI & USB 3.0 cables connect the headset to a PC.
   - Requires a Windows Mixed Reality-compatible PC to function.

Working of Samsung Odyssey

1. **Connecting the Headset to a PC**
   - Plug in the HDMI cable (for video/audio output) and USB 3.0 cable (for power and tracking data).
   - Install Windows Mixed Reality (WMR) software and follow the setup instructions.
2. **Displaying the VR Environment**
   - The AMOLED display provides high-resolution visuals with vibrant colors and deep blacks.
   - The Fresnel lenses magnify the display and create a stereoscopic 3D effect.
3. **Inside-Out Tracking (6DoF Motion Tracking)**
   - The built-in cameras track the headset's position in real-time.
   - Tracks head movement (left-right, up-down, forward-backward) without external sensors.
4. **Hand and Controller Tracking**
   - The Samsung Odyssey controllers provide motion tracking using Bluetooth.
   - Each controller has buttons, a touchpad, and triggers for interaction.

5. Audio Experience
   - AKG headphones deliver 3D spatial sound, making audio feel like it's coming from different directions.
   - The built-in microphone allows for voice communication.
6. Interacting with VR Applications
   - The headset is compatible with Windows Mixed Reality, SteamVR, and Microsoft Store apps.
   - Users can play games, explore virtual environments, and interact with objects using controllers.
7. Adjusting Settings & Exiting VR
   - Users can adjust the IPD, brightness, and sound through Windows Mixed Reality settings.
   - Removing the headset automatically pauses the VR experience.

Key Features of Samsung Odyssey

- ✅ High-resolution AMOLED display – 1440 × 1600 per eye.
- ✅ Inside-out tracking (6DoF) – No external sensors needed.
- ✅ Comfortable headband with dial adjustment.
- ✅ Built-in AKG headphones & microphone.
- ✅ Compatible with SteamVR & Windows Mixed Reality.

Limitations of Samsung Odyssey

- ✗ **Requires a high-end PC – Needs a Windows Mixed Reality-compatible PC.**
- ✗ **Fixed IPD – Might not fit all users perfectly.**
- ✗ **Limited tracking range – Inside-out tracking can struggle in low-light conditions.**
- ✗ **Wired connection – Requires an HDMI and USB 3.0 connection to a PC.**

Comparison: Samsung Odyssey vs. Oculus Quest vs. HTC Vive

Feature	Samsung Odyssey	Oculus Quest	HTC Vive
Tracking	6DoF (Inside-Out)	6DoF (Inside-Out)	6DoF (External Sensors)
Display	AMOLED (1440×1600/eye)	OLED (1600×1440/eye)	OLED (1080×1200/eye)
Interaction	Motion Controllers	Touch Controllers, Hand Tracking	Motion Controllers
Wireless	❌ No (Wired PC VR)	✅ Yes (Standalone)	❌ No (Wired PC VR)
PC VR Support	✅ Yes (Windows Mixed Reality)	✅ Yes (Oculus Link)	✅ Yes (High-End)
Audio	Built-in AKG headphones	Built-in speakers	External headphones
Price	~$400 - $500	~$300 - $400	~$600+

Structure and Working of Oculus Rift

The Oculus Rift is one of the first consumer-grade VR headsets developed by Oculus VR, a subsidiary of Meta (formerly Facebook). It was released in 2016 and is a PC-powered VR headset designed for gaming and immersive experiences. The Oculus Rift requires an external PC connection and uses external sensors for precise motion tracking.

Structure of Oculus Rift

The Oculus Rift consists of several key components:

1. Headset Frame

- **Made of lightweight plastic with an adjustable head strap.**
- **Foam padding around the lenses for comfort.**

2. Display System

- **Dual OLED displays with a resolution of 1080 × 1200 per eye.**
- **Refresh rate: 90Hz for smooth visuals.**
- **Field of View (FoV): ~110° for an immersive experience.**

3. Lenses (Optics)

- **Uses Fresnel lenses to focus light from the display to the user's eyes.**
- **Adjustable interpupillary distance (IPD) to match different eye distances.**

4. External Tracking System (Outside-In Tracking with Constellation Sensors)
   - Requires external infrared sensors (Oculus Constellation cameras) to track movement.
   - Provides 6 Degrees of Freedom (6DoF) tracking for head and body movement.
5. Controllers (Oculus Touch Controllers)
   - Two ergonomic controllers with joysticks, buttons, triggers, and capacitive touch sensors.
   - Enables hand presence and natural gestures in VR.
6. Audio System (Integrated Headphones & 3D Sound)
   - Built-in over-ear headphones for spatial 3D audio.
   - 3.5mm audio jack for external headphones.
7. Connectivity & Power
   - HDMI & USB 3.0 cables connect the headset to a PC.
   - Requires high-performance GPU and CPU for VR rendering.

Working of Oculus Rift

1. Connecting the Headset to a PC
   - The Rift connects to a PC via HDMI and USB 3.0.
   - The Oculus software detects the headset and external sensors.

2. Displaying the VR Environment
   - The OLED display provides sharp, stereoscopic 3D visuals.
   - The Fresnel lenses magnify and focus the images for each eye.
3. Motion Tracking (Outside-In Tracking with External Sensors)
   - The Oculus Constellation sensors track the headset's position and rotation.
   - Movement is translated into the virtual environment in real time.
4. Hand Tracking (Oculus Touch Controllers)
   - The controllers have built-in motion sensors and are tracked by the external cameras.
   - Users can interact with objects, grab items, and use gestures.
5. Audio Experience
   - The integrated 3D spatial audio enhances immersion.
   - Sound positioning matches the virtual environment (e.g., hearing footsteps behind you).
6. Playing VR Games & Applications
   - The Oculus Rift supports Oculus Store, SteamVR, and other VR platforms.
   - Users can play games, explore virtual worlds, and watch immersive videos.

Key Features of Oculus Rift

- ✓ High-quality OLED display with 90Hz refresh rate.
- ✓ External tracking (Constellation sensors) for precise movement detection.
- ✓ Ergonomic Oculus Touch controllers for natural interactions.
- ✓ Integrated spatial 3D audio.
- ✓ Compatible with SteamVR and Oculus Store applications.

Limitations of Oculus Rift

- ✗ Requires a powerful PC with a dedicated GPU.
- ✗ External sensors need proper setup (more cables, limited range).
- ✗ Wired connection may limit mobility.
- ✗ No built-in hand tracking (relies on controllers).

Comparison: Oculus Rift vs. Oculus Quest vs. HTC Vive

Feature	Oculus Rift	Oculus Quest	HTC Vive
Tracking	6DoF (External Sensors)	6DoF (Inside-Out)	6DoF (External Sensors)
Display	OLED (1080×1200/eye)	OLED (1600×1440/eye)	OLED (1080×1200/eye)
Interaction	Touch Controllers	Hand + Touch Controllers	Motion Controllers
Wireless	❌ No (Wired PC VR)	✅ Yes (Standalone)	❌ No (Wired PC VR)
PC VR Support	✅ Yes (High-End PC Required)	✅ Yes (Oculus Link)	✅ Yes (High-End)
Audio	Built-in 3D spatial sound	Built-in speakers	External headphones
Price	~$400 - $500	~$300 - $400	~$600+

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