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DEPARTMENT OF CIVIL ENGINEERING

19CET308- AR/VR in Civil Engineering

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AP/CIVIL

UNIT - II AR/VR

VR Devices – Structure and working of HTC Vive - Google Cardboard - Samsung gear VR

Structure and Working of HTC Vive

HTC Vive is a high-end VR headset designed for immersive virtual reality experiences. It was developed by HTC and Valve and is known for its room-scale VR and precise motion tracking.

Structure of HTC Vive

HTC Vive consists of the following key components:

1. Head-Mounted Display (HMD)

- Dual AMOLED screens with a resolution of 1080×1200 per eye.
- 90 Hz refresh rate for smooth visuals.
- Field of View (FOV) of 110°, providing an immersive experience.
- Integrated front-facing camera for mixed-reality applications.
- Adjustable lens distance and head straps for comfort.

2. Base Stations (Lighthouse Tracking System)

- Uses infrared laser tracking to detect the position of the headset and controllers.
- Two base stations are placed in opposite corners of the room for 360-degree tracking.
- Emits infrared pulses that reflect off sensors on the headset and controllers.

3. Vive Controllers

- **Motion controllers equipped with buttons, trackpads, and triggers.**
- **Uses infrared sensors to detect hand position in real time.**
- **Features haptic feedback for realistic interactions.**

4. Motion Tracking Sensors

- **HMD and controllers are embedded with 37 infrared sensors.**
- **Uses SteamVR tracking for precise positional tracking (6DoF – Six Degrees of Freedom).**

5. Connectivity and Processing Unit

- **Connects to a PC via HDMI, USB, and power cables.**
- **Requires a high-end graphics card (NVIDIA GTX 1060 or better).**

Working of HTC Vive

1. **Setup and Calibration**
    - **Place the base stations at opposite corners of the room.**
    - **Connect the HMD to a powerful PC with SteamVR software.**
    - **Define the play area using boundary setup.**

2. Head and Hand Tracking

- **Base stations emit infrared laser pulses across the room.**
- **Sensors on the HMD and controllers detect these pulses.**
- **The system calculates position and orientation in real-time.**

3. Rendering and Display

- **PC processes VR content and sends it to the HMD.**
- **The dual AMOLED screens display the 3D scene with a 90 Hz refresh rate.**
- **The lens system adjusts images for a stereoscopic 3D effect.**

4. Interactivity

- **Users interact using controllers, gaze, and gestures.**
- **The tracking system ensures movement is reflected inside the VR world.**
- **Haptic feedback enhances immersion.**

5. Room-Scale Movement

- HTC Vive supports room-scale VR where users can physically walk in a defined play area.
- If a user nears a boundary, the Chaperone System displays a virtual grid for safety

6. Audio and Mixed Reality

- External headphones provide 3D spatial audio.
- The front-facing camera allows for mixed-reality experiences.

Key Features of HTC Vive

- ✅ Accurate 6DoF tracking for full movement detection.
- ✅ High-resolution displays with a 90 Hz refresh rate.
- ✅ Room-scale VR for real-world movement.
- ✅ SteamVR integration with thousands of VR applications.
- ✅ Wireless adapter available for tether-free VR.

Structure and Working of Google Cardboard

Google Cardboard is a low-cost virtual reality (VR) headset developed by Google. It is designed to work with smartphones to provide an immersive VR experience. Unlike high-end VR headsets like HTC Vive and Oculus Rift, Google Cardboard relies on the phone's display, sensors, and processing power to create virtual reality experiences.

Structure of Google Cardboard

Google Cardboard is a simple and lightweight VR headset made from inexpensive materials. Its key components include:

1. Cardboard Frame
   - The headset is primarily made of foldable cardboard, making it lightweight and cost-effective.
   - It has cutouts and slots to hold a smartphone securely.
2. Lenses
   - Uses biconvex lenses (convex on both sides) to focus and magnify the smartphone screen.
   - These lenses create a stereoscopic 3D effect, enhancing depth perceptio

3. Smartphone Slot
   - The headset has a slot to hold a smartphone (typically 4 to 6 inches in size).
   - The phone's screen is divided into two sections (one for each eye) to create a 3D view.
4. NFC Tag (Optional)
   - Some versions of Google Cardboard include an NFC tag that automatically launches the Google Cardboard app when a phone is inserted.
5. Magnetic Button (or Capacitive Touch Button)
   - Earlier versions had a magnetic trigger that interacted with the smartphone's magnetometer to act as a button.
   - Newer versions use a capacitive touch button, which touches the phone's screen to trigger interactions.
6. Velcro Straps (Optional)
   - Some versions include Velcro straps to secure the headset on the user's head

Working of Google Cardboard

1. Setting Up the Smartphone
   - The user installs the Google Cardboard app (or any VR-compatible app) on their smartphone.
   - The smartphone is placed inside the headset with the screen facing the lenses.
2. Displaying the VR Content
   - The app splits the screen into two images (one for each eye) to create a stereoscopic effect.
   - The phone's gyroscope and accelerometer track head movements.
3. Image Projection and Depth Perception
   - The biconvex lenses magnify the smartphone display, making the images appear larger and more immersive.
   - The lenses create a 3D depth effect, making objects in the virtual world appear closer or farther.
4. Interaction and Navigation
   - Users interact with VR content using the capacitive touch button or by moving their head.
   - Some apps allow users to select options by gazing at objects for a few seconds.
5. Motion Tracking
   - The gyroscope and accelerometer in the smartphone detect head movements.
   - The VR app adjusts the display in real time, changing the perspective as the user moves their head.

Key Features of Google Cardboard

✅ **Affordable – Made from cardboard, making it one of the cheapest VR headsets.**

✅ **Easy to Use – Works with most smartphones without additional hardware.**

✅ **Portable & Lightweight – Can be folded and carried easily.**

✅ **Wide Compatibility – Supports iOS and Android devices.**

✅ **VR Gaming & Experiences – Can be used for 360° videos, VR apps, and basic interactive games.**

Limitations of Google Cardboard

❌ **Limited Immersion – No external sensors, limited tracking, and no room-scale movement.**

❌ **Smartphone Dependent – The experience depends on phone resolution, processing power, and sensors.**

❌ **No Built-in Audio – Unlike high-end VR headsets, it lacks built-in speakers.**

❌ **Basic Interaction – Lacks motion controllers, relying on head tracking and a simple button.**

Comparison: Google Cardboard vs. HTC Vive

Feature	Google Cardboard	HTC Vive
Tracking	Smartphone sensors (basic)	Lighthouse tracking (precise 6DoF)
Display	Smartphone screen	High-resolution OLED (1080x1200 per eye)
Interaction	Button or gaze-based	Motion controllers, hand tracking
Price	~$10-$30	$600+
Immersion	Limited	Full-room VR experience

Structure and Working of Samsung Gear VR

Samsung Gear VR is a mobile-based virtual reality (VR) headset developed by Samsung in collaboration with Oculus. It was designed to work with Samsung Galaxy smartphones, using them as the display and processing unit for VR experiences. Unlike Google Cardboard, Gear VR includes additional sensors and a dedicated touchpad for improved interaction

Structure of Samsung Gear VR

The Samsung Gear VR consists of the following components:

1. Headset Frame
   - Made of lightweight plastic for durability and comfort.
   - Includes an adjustable head strap to fit different head sizes.
2. Smartphone Slot
   - The front panel holds a Samsung Galaxy smartphone (compatible models like Galaxy S8, S9, Note 8, etc.).
   - The phone acts as both the display and processor for VR content.
   - USB-C or Micro USB connector links the phone to the headset for power and data transfer.

3. Lenses (Optical System)
- Uses biconvex lenses to magnify the smartphone screen.
- Creates a stereoscopic 3D effect for immersive visuals.
- The interpupillary distance (IPD) adjustment dial helps align the lenses with the user's eyes.

4. Sensors
- Unlike Google Cardboard, Gear VR has built-in motion sensors for better tracking:
  - Gyroscope – Tracks head rotation.
  - Accelerometer – Detects speed and direction of movement.
  - Magnetometer – Helps with orientation and calibration.

5. Touchpad and Control Buttons
- Located on the right side of the headset, includes:
  - Touchpad – For navigation and selection in VR.
  - Back Button – To return to the previous menu.
  - Volume Controls – Adjusts audio levels.

6. Ventilation System
- Prevents the smartphone from overheating during prolonged VR sessions.

7. Audio Support
- Works with external headphones or the smartphone's built-in speakers for 3D spatial audio.

Working of Samsung Gear VR

1. Setup and Calibration

- **Insert a Samsung Galaxy smartphone into the headset.**
- **The USB-C/Micro USB port connects the phone to Gear VR.**
- **The Oculus software automatically launches when the phone is docked.**

2. Display and Image Processing

- **The smartphone screen splits into two sections (one for each eye).**
- **The biconvex lenses magnify the screen and create a stereoscopic 3D effect.**
- **The OLED display of Samsung phones provides high resolution and a smooth 60 Hz refresh rate.**

3. Motion Tracking and Navigation

- **The built-in gyroscope and accelerometer track head movements in 3 Degrees of Freedom (3DoF).**
- **Users can look around in VR, but not move physically (unlike HTC Vive, which supports full 6DoF tracking).**

4. Interaction with the VR Environment

- **The touchpad and buttons allow users to navigate through menus and interact with virtual objects.**
- **Some apps support external Bluetooth controllers for more advanced interactions.**

5. Audio Experience

- **Supports 3D spatial audio through headphones or the smartphone's speakers.**

6. VR Applications and Content

- Compatible with Oculus Store and Samsung VR apps.
- Users can experience VR gaming, 360° videos, and virtual tourism.

Key Features of Samsung Gear VR

✅ Wireless VR – No need for external cables like HTC Vive.
✅ Built-in sensors – Provides better tracking than Google Cardboard.
✅ High-quality display – Uses Samsung's OLED screens for superior visuals.
✅ Comfortable Design – Lightweight with adjustable straps.
✅ Oculus Software Integration – Access to a wide range of VR apps.

Limitations of Samsung Gear VR

❌ Limited Tracking (3DoF only) – Users can rotate their head but cannot move physically in VR.
❌ Samsung Phone Dependent – Works only with specific Samsung Galaxy models.
❌ No Built-in Controllers – Relies on touchpad or optional Bluetooth controllers.

Comparison: Samsung Gear VR vs. Google Cardboard vs. HTC Vive

Feature	Samsung Gear VR	Google Cardboard	HTC Vive
Tracking	3DoF (Head Rotation)	Basic (Phone Sensors)	6DoF (Full Tracking)
Display	Samsung OLED (Phone)	Phone Screen	Dual OLED (1080x1200 per eye)
Interaction	Touchpad, Bluetooth Controllers	Simple Button	Motion Controllers
Price	~$50 - $100	~$10 - $30	$600+
Immersion	Moderate	Basic	High
External Sensors	No	No	Yes (Base Stations)

Thankyou