Virtual Reality and Augmented Reality

VR Technology

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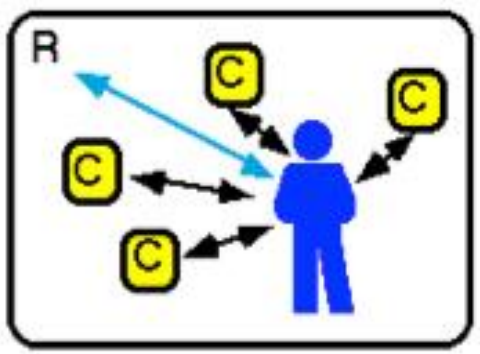
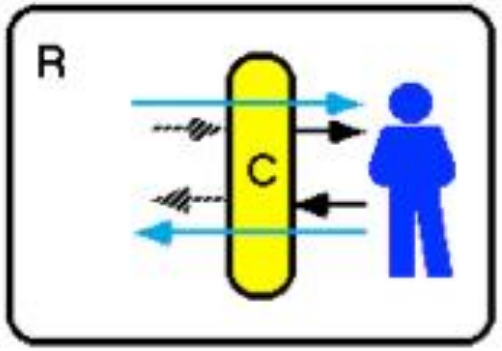
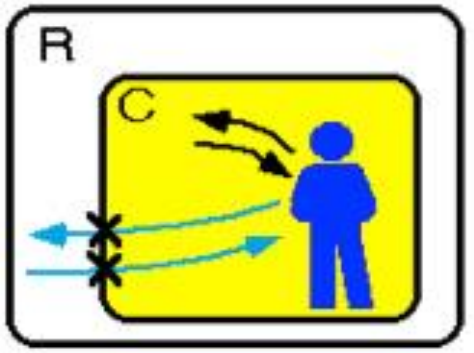
From Reality to Virtual Reality



Internet of Things



Augmented Reality

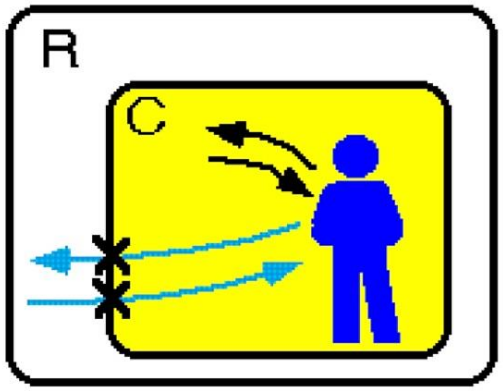


Virtual Reality

Real World

Virtual World

Virtual Reality (VR)



(b) Virtual Reality

- Users immersed in Computer Generated environment

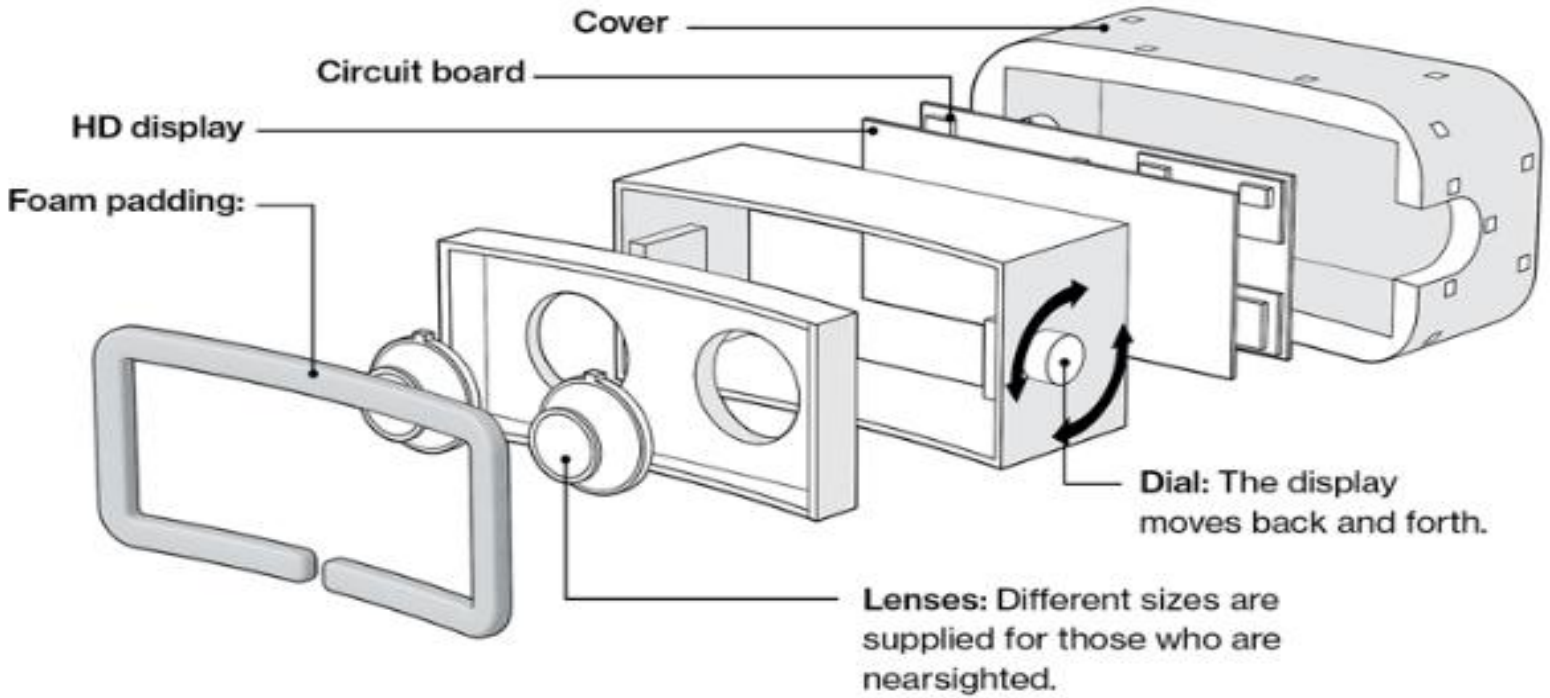
Goal of Virtual Reality

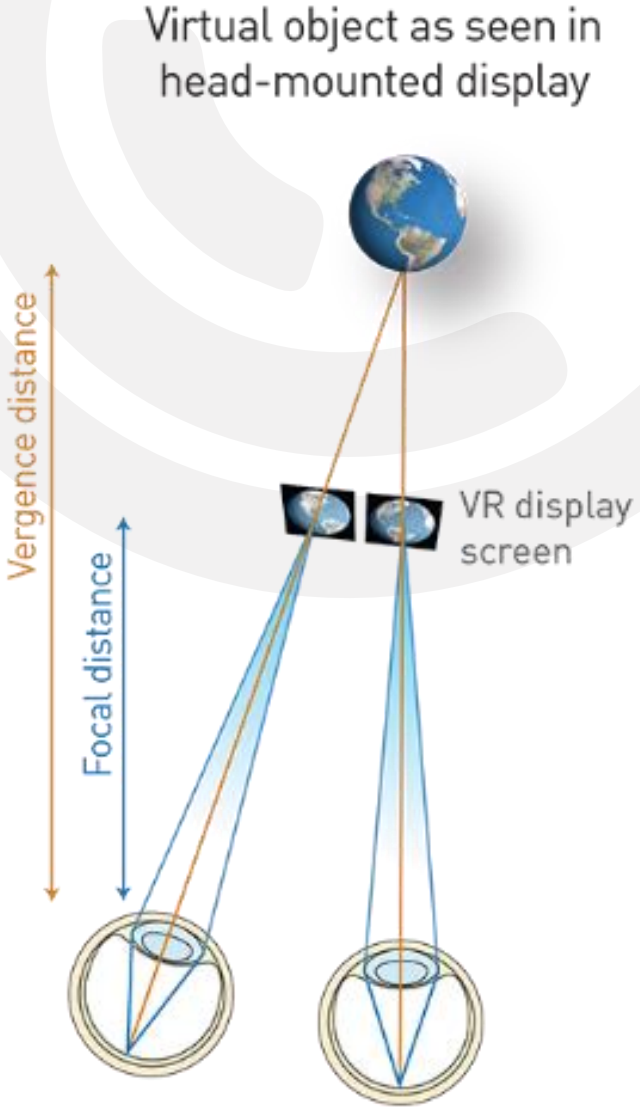
".. to make it feel like you're actually in a place that you are not."

Inside View

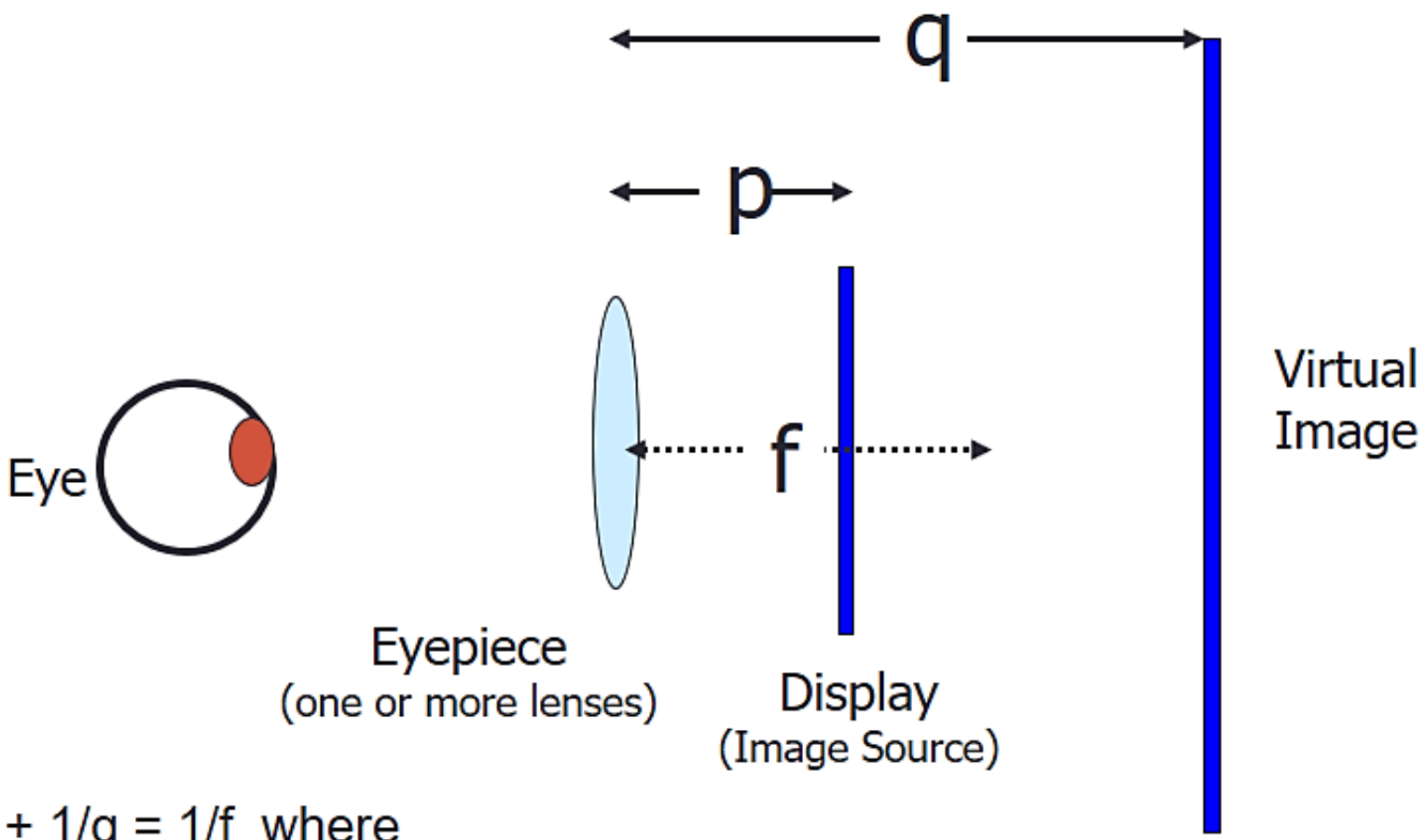
Oculus VR's first commercial headset was built using just a few components, including off-the-shelf electronics and simple lenses.

THE BUILD





Simple Magnifier HMD Design



1/p + 1/q = 1/f where

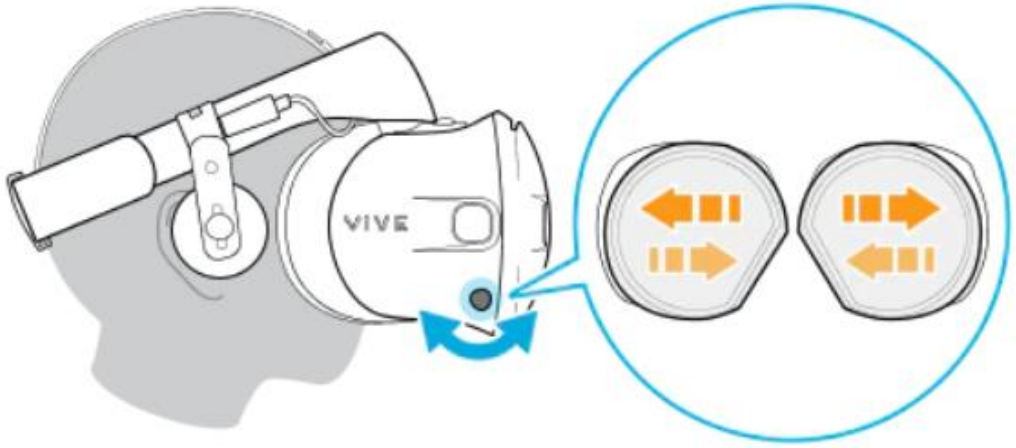
p = object distance (distance from image source to eyepiece)

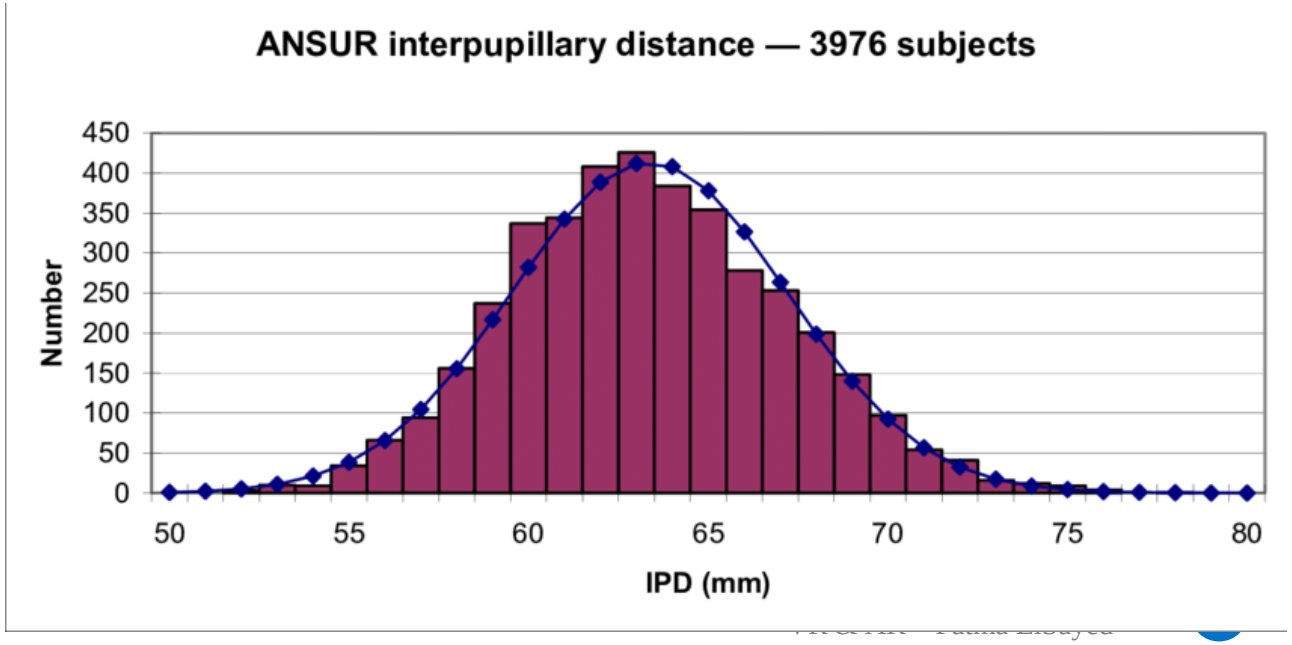
q = image distance (distance of image from the lens)

f = focal length of the lens

Interpupillary Distance (IPD)

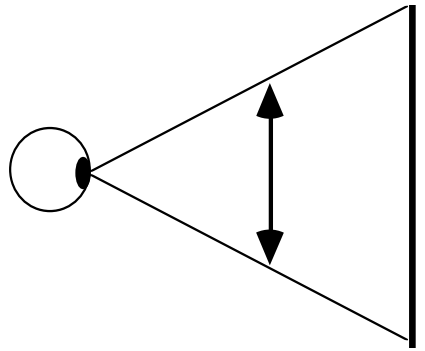
- Horizontal distance between a user's eyes
- Distance between the two optical axes in a HMD
- Typical IPD ~ 63mm



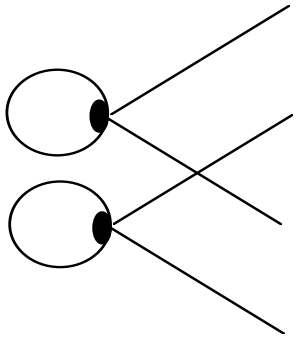


Field of View

Monocular FOV is the angular size of the displayed image as measured from the pupil of one eye.



Total FOV is the total angular size of the displayed image visible to both eyes.



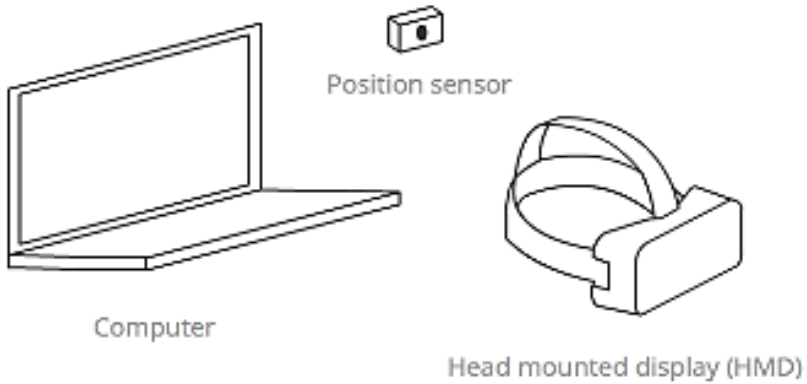
Binocular(or stereoscopic) FOV refers to the overlapping part of the displayed image that is visible to both eyes.

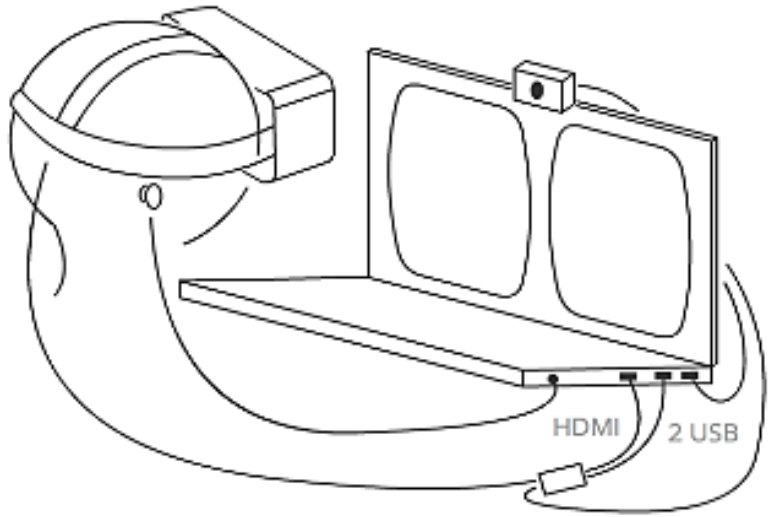
FOV may be measured horizontally, vertically or diagonally.

HMD Types

1

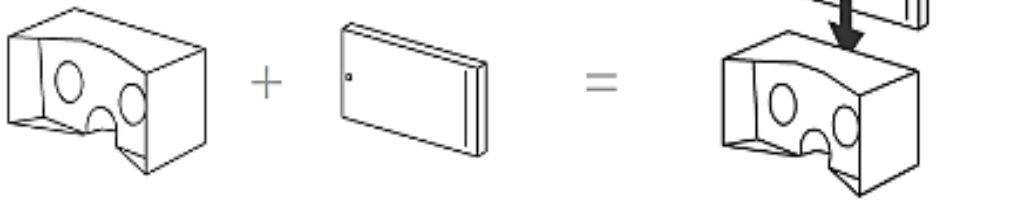
Computer based VR setup

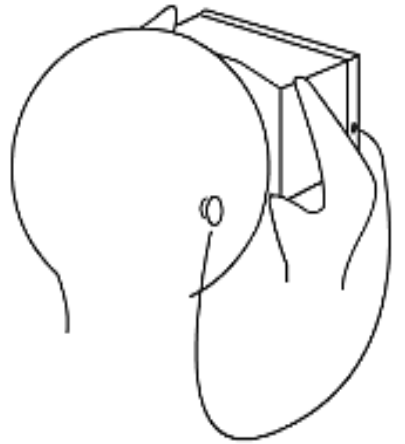




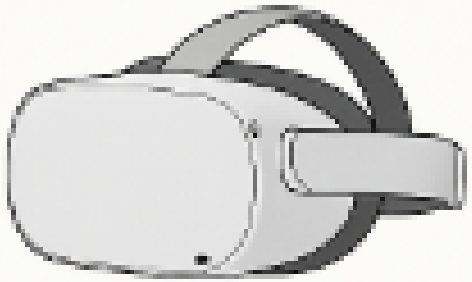
2

Mobile based VR setup





3



Standalone

HMD Types

Computer based (Tethered)

- Physically connected to a computer/console by cables.
- Offer high-end graphics and performance

Examples: include the Oculus Rift, HTC Vive, PlayStation VR, and the Pimax Crystal Light.

Mobile based

- Make use of the user's smartphone, the phone acts as the display and processor
- More affordable and portable

Examples: Samsung Gear VR, Google Cardboard, and Google Daydream View 2

Standalone

- All-in-one devices that do not require a PC or smartphone to operate.
- Easier to set up and use.

Examples: include the Oculus Quest and Pico Neo.

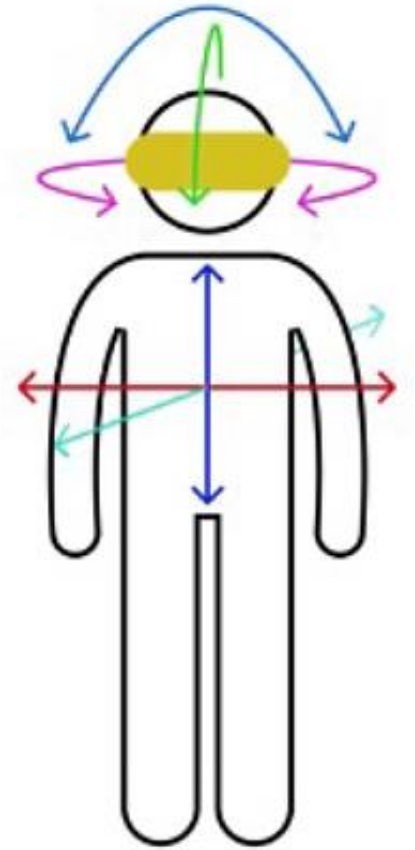
THE WILD
IMMERSIVE COLLABORATION FOR TEAMS

2021 Business VR Headset Comparison Chart (Q3)

	Oculus Quest 2	Pico Neo 2	HP Reverb G2	Valve Index	HTC Vive Pro
					
Support in The Wild	☑	☑	☑	☐	☑
Resolution / Eye	1832 x 1920	1920×2160	2160x2160	1440x1600	1440x1600
Refresh Rate (HZ)	90	75	90	144	90
Field of View	100°	101°	114°	130°	110°
Weight	503g	670g	544g	570g	563g
Tracking	Inside-out	Inside-out	Inside-out	Base Stations (more equipment = more precise hand tracking)	Base Stations (more equipment = more precise hand tracking)
Type	**Standalone** (no wires, less powerful processor) **+ option to tether** to a PC with a cable	**Standalone** (no wires, less powerful processor)	**Tethered** (wired to your PC, more powerful, can run larger models)	**Tethered** (wired to your PC, more powerful, can run larger models)	**Tethered** (wired to your PC, more powerful, can run larger models)
Price	**$299 / 💼$799**	**💼$699**	**$599**	**$999**	**$1,199**

Degrees of Freedom

3 Degree of freedom



6 Degree of freedom

Degrees of Freedom

Degree of Freedom = independent movement about an axis

- 3 DoF Orientation = roll, pitch, yaw

Axis: X-axis
Description: Looking up or down *(like shaking your head "yes")*

Axis: Y-axis
Description: Turning your head left or right *(like shaking your head "no")*

Axis: Z-axis
Description: Pivots your head left or right *(like when resting it on your shoulder)*

Tracking in VR

Different requirements

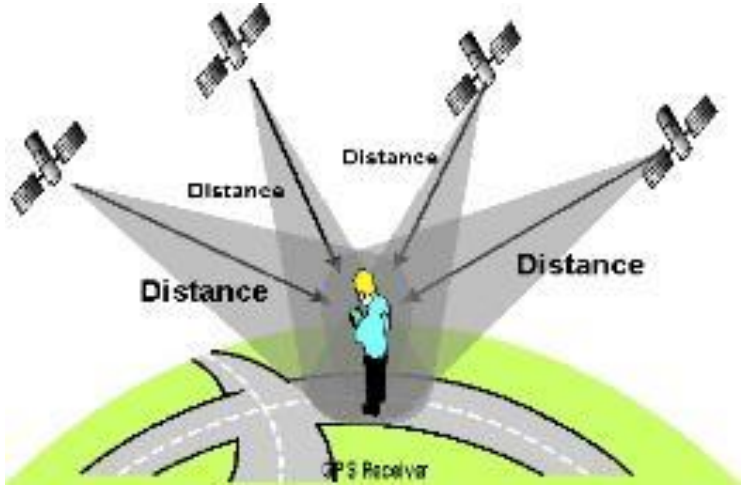
- User turns their head in VR → needs **3 DoF** orientation tracker
- Moving in VR → needs a **6 DoF** tracker (r,p,y) and (x, y, z)

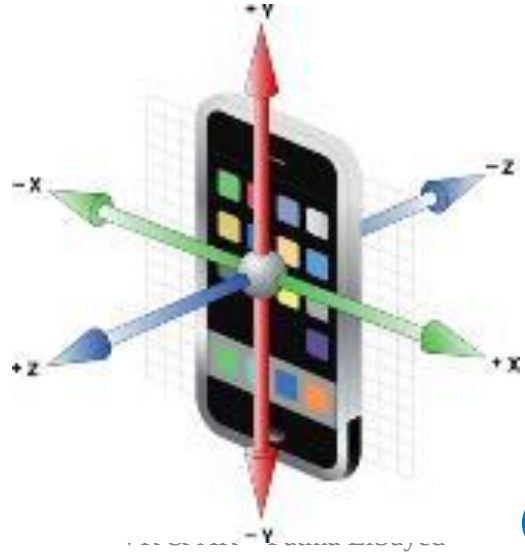
Need for Tracking

- User turns their head and the VR graphics scene changes
- User wants to walking through a virtual scene
- User reaches out and grab a virtual object
- The user wants to use a real-world object in VR

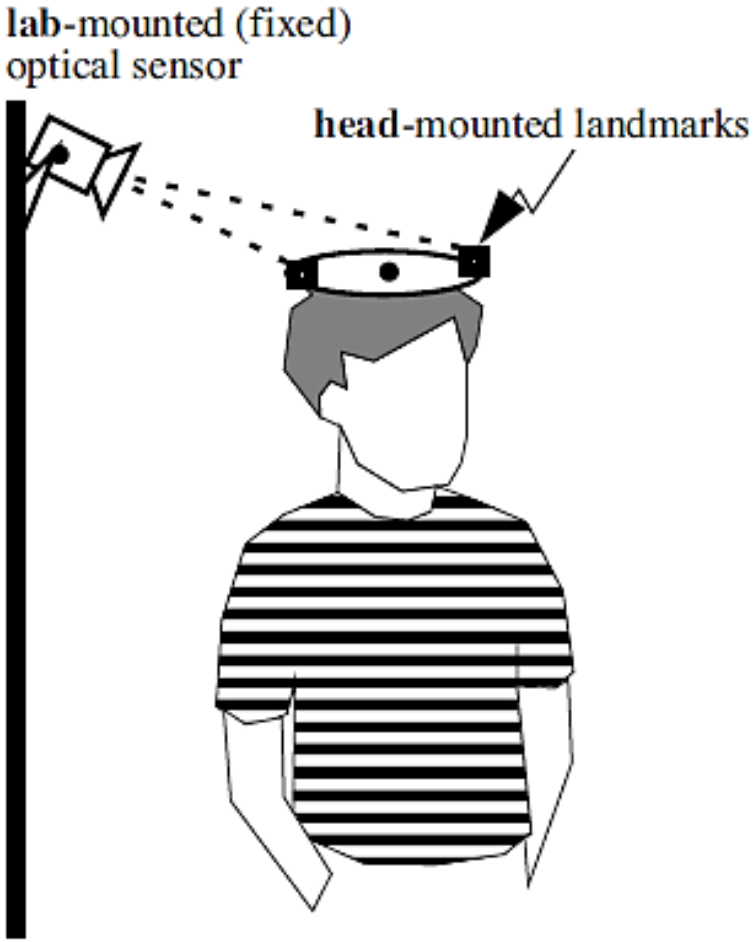
Tracking Technologies

1. **Active (device sends out signal)**
   - Mechanical, Magnetic, Ultrasonic
   - GPS, Wifi, cell location
2. **Passive (device senses world)**
   - Inertial sensors (Gyroscopes)
   - Computer Vision
3. **Hybrid Tracking**
   - Combined sensors (e.g. Vision + Inertial)

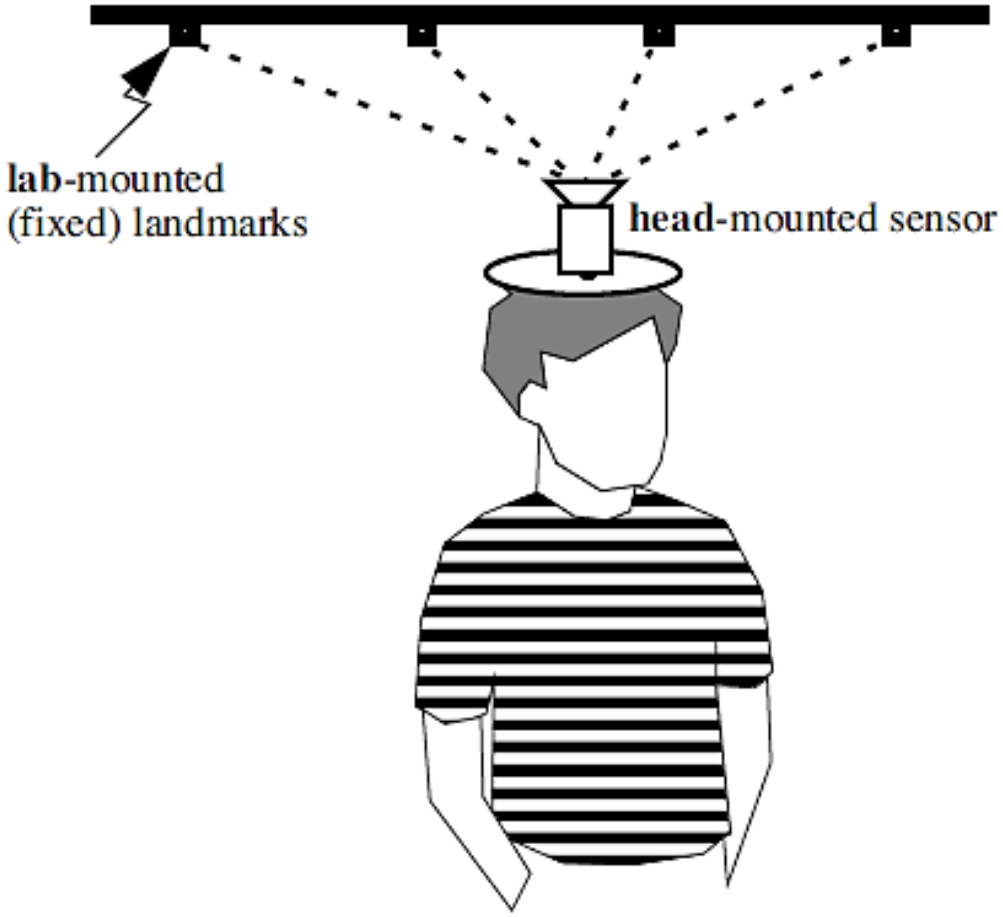




Outside-in vs. Inside-ut Tracking



Outside-Looking-In



Inside-Looking-Out

Outside-in vs. Inside-out Tracking

Outside-in

- Cameras/sensors are mounted in the room *(external)*.

How it works:

- The external cameras watch your movement and track your position and orientation.

Example: HTC Vive (Original & Vive Pro)

Inside-out

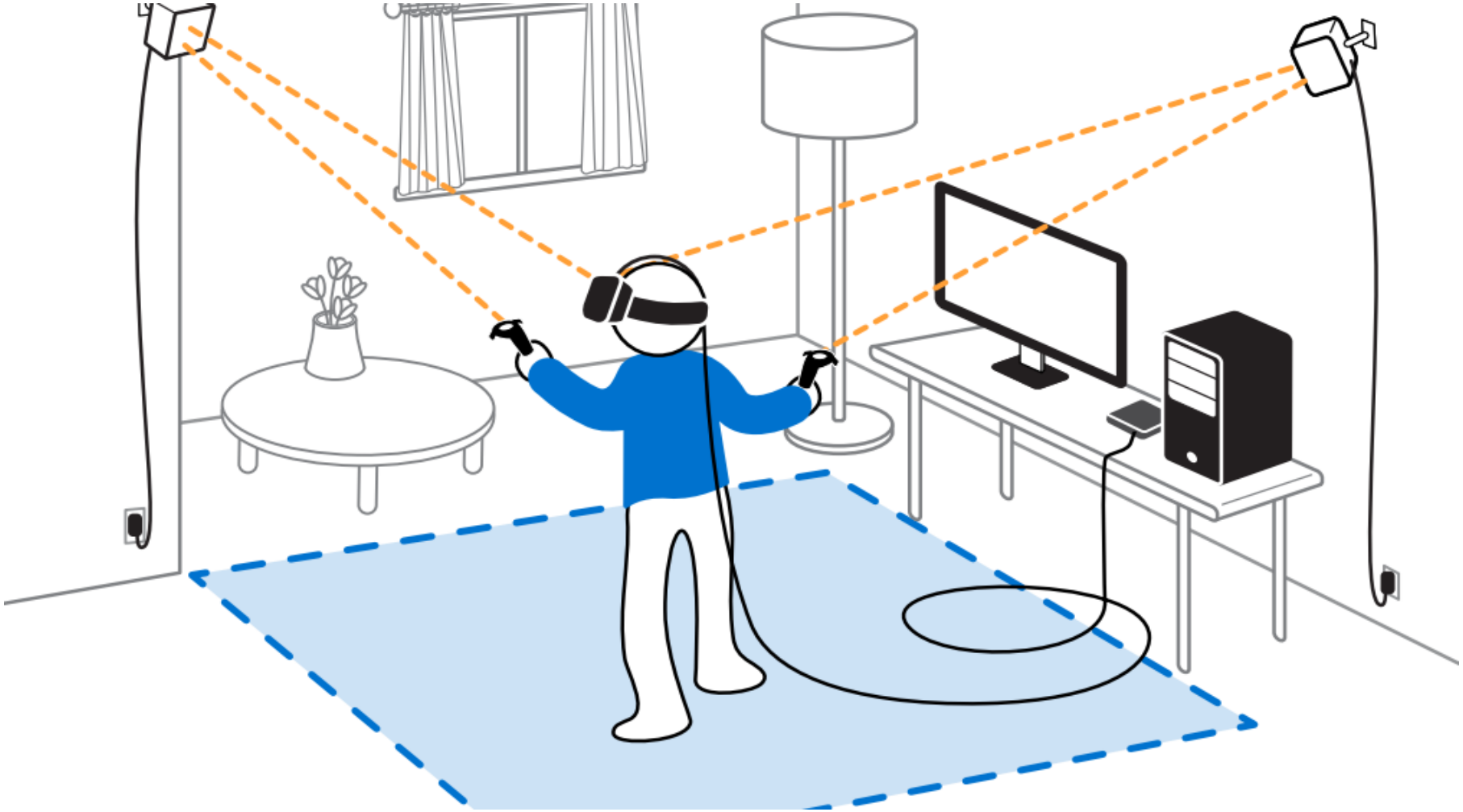
- Camera/sensors are on your headset *(internal)*.

How it works:

- Cameras or sensors on the headset look out and detect landmarks or surroundings to update your position and rotation in 3D space.

Examples: Oculus Quest

Example: Vive Lighthouse Tracking



https://www.youtube.com/watch?v=oqPaaMR4kY4

Example: Vive Lighthouse Tracking

Outside-in tracking system

- **2 base stations**
  - Each with 2 laser scanners, LED array
- **Headworn/handheld sensors**
  - 37 photo-sensors in HMD, 17 in hand
  - Additional Inertial Measurement Unit (IMU) sensors
    - IMU in the HMD tracks your **head movements**
    - In the Controllers tracks your hand movements

Example: Oculus Quest

Inside-out tracking system

- Four cameras on corner of display
- Searching for visual features
- On setup creates map of room

https://www.youtube.com/watch?v=2jY3B_F3GZk

THANK YOU