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VR Stereo+Optics

Karan Singh

Inspired and adapted from Oliver Kreylos
Outline

- Real-world visual perception.
- How VR emulates it.
- Problems and consequences of the emulation in VR.
Vision
Vision
Vision in Room VR
Vision in Room VR
Vision in Room VR
Vision in Room VR
User Movement
Vision in Room VR
Vision in Room VR
Vision in Room VR
Vision in Room VR
Vision in Room VR
Head-Mounted Displays
Head-mounted Displays
Head-mounted Displays
Head-mounted Displays
Accommodation

...eye lens changes shape “accommodates” to focus at different depths.
HMD Optics
HMD Optics
HMD Optics
Head-mounted Displays
Head-mounted Displays
Lens Distortion
Lens Distortion
Lens Correction
Configuration
Configuration
Physiognomy
Configuration

Eye Relief
Configuration

Inter-pupillary Distance (IPD)
How to measure your IPD
Mis-configuration
Mis-configuration
Mis-configuration
Mis-configuration (depth inaccuracy)
What VR Needs

- Good screens and lenses
- Good internal calibration
- High-precision head tracking
- Good user calibration
- Ideally eye tracking
- Low end-to-end latency
End-to-end Latency
End-to-end Latency
End-to-end Latency
End-to-end Latency
What Else Can Go Wrong?

- Artificial locomotion
  - Mismatch between “seen” and “felt” motion
  - Vection-vestibular conflict
Accommodation and Vergence Conflict

Why do virtual objects close to my face appear blurry when wearing a VR headset? My vision is fine!

And why does the real world look strange immediately after a long VR session?
Vergence
Accommodation-Vergence Coupling

How do our eyes “accommodate” or determine lens focus?

• Blurriness reflex.
• We have two eyes, “vergence” and “accommodation” are coupled.

In VR the focal distance of the screen (accommodation) is typically fixed and different from the focal point of the virtual world (vergence).
A-V Conflict Effects

- Blurry objects
- Eye strain
- Accommodation-vergence *decoupling*.
- Vision feels “off” for a while after using VR
- Might interfere with vision development in very young children
- Potential solutions:
  - Lenses that allow different screen distances.
  - True Holographic displays.
A-V conflict mitigating UX design

- Use long viewing distances (out of reach): sensitivity of focus cues reduces with increasing distance.
- Define the depth of virtual objects around the distance of the simulated display screen.
- Change object depth slowly giving eyes time to adjust.
- Use other visual cues like perspective, shading and shadows to convey realistic depth.