CSC 2524, Fall 2019
VR Stereo+Optics

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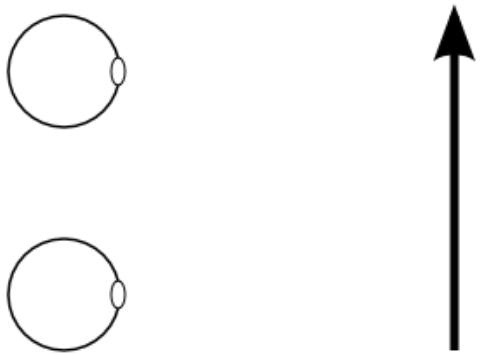
Inspired and adapted from Oliver Kreylos

Outline

- Real-world visual perception.
- How VR emulates it.
- Problems and consequences of the emulation in VR.

Vision



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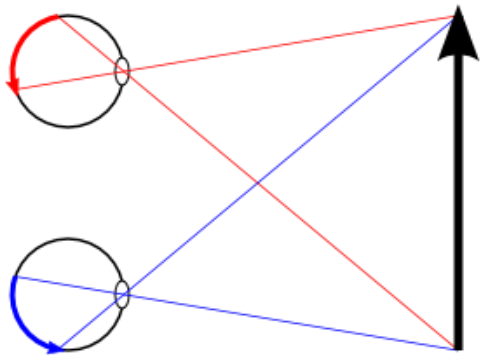
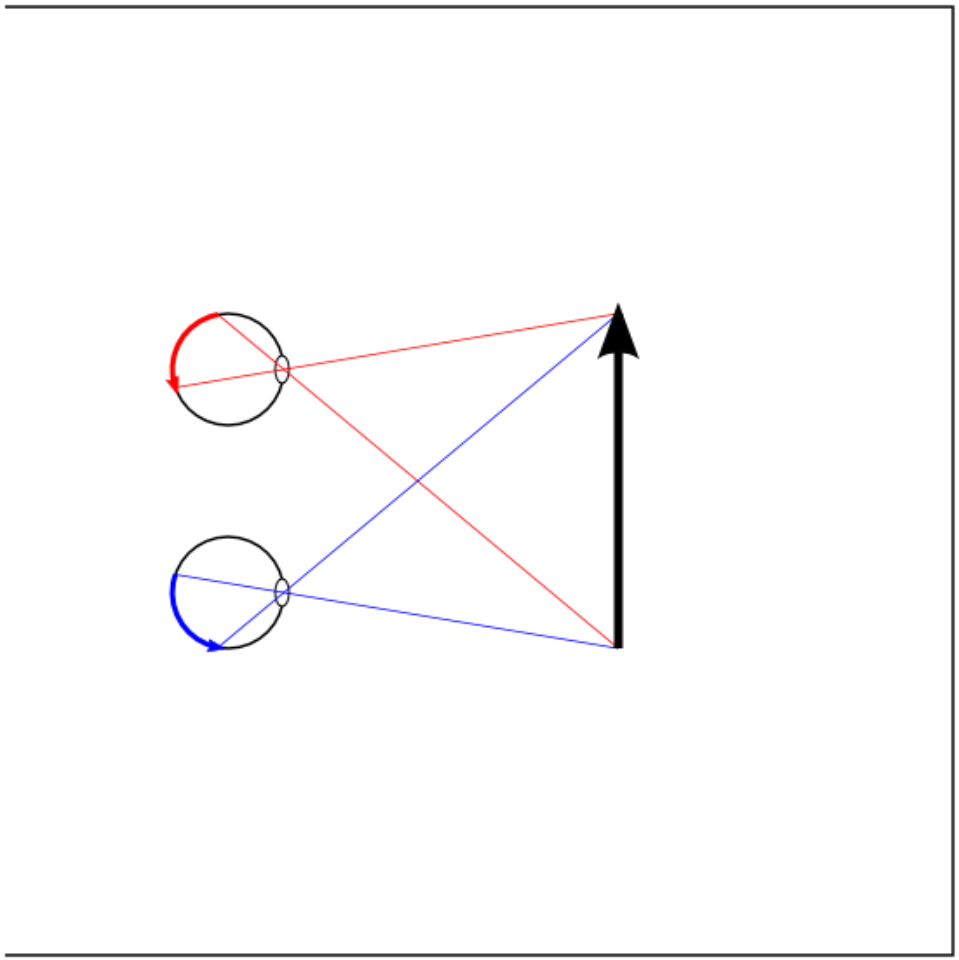


Vision in Room VR



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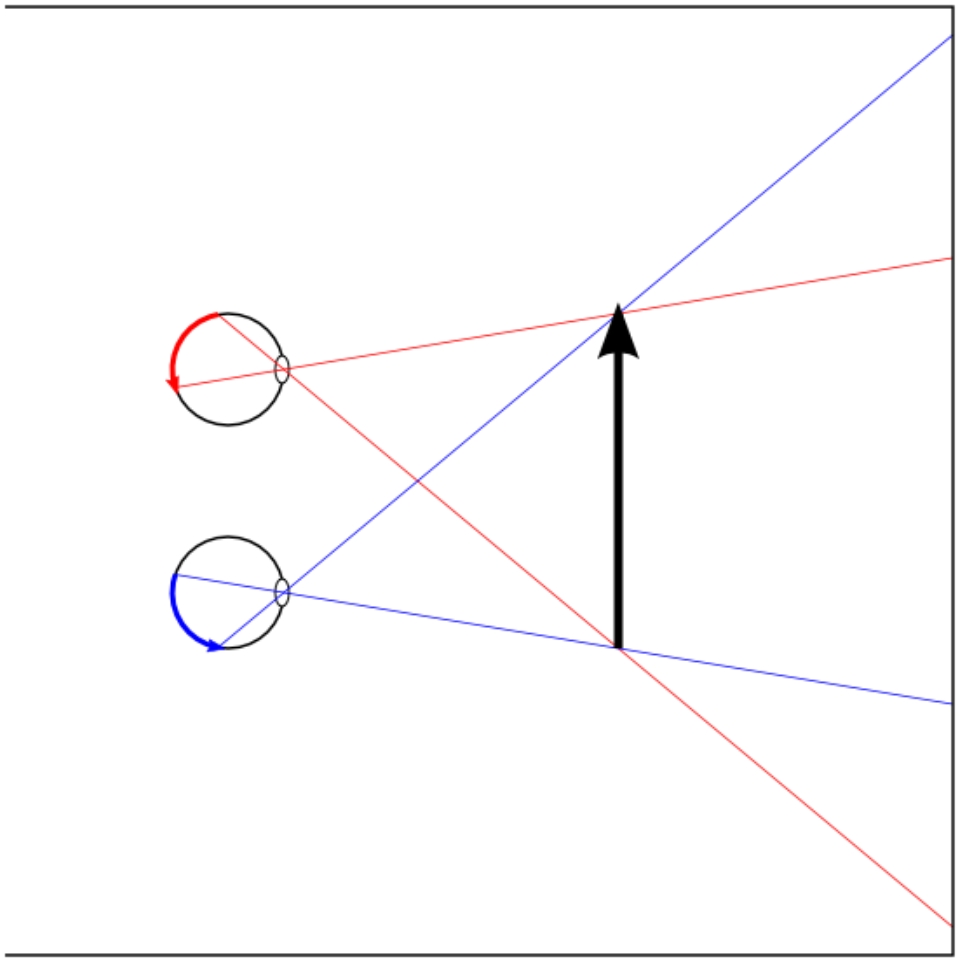

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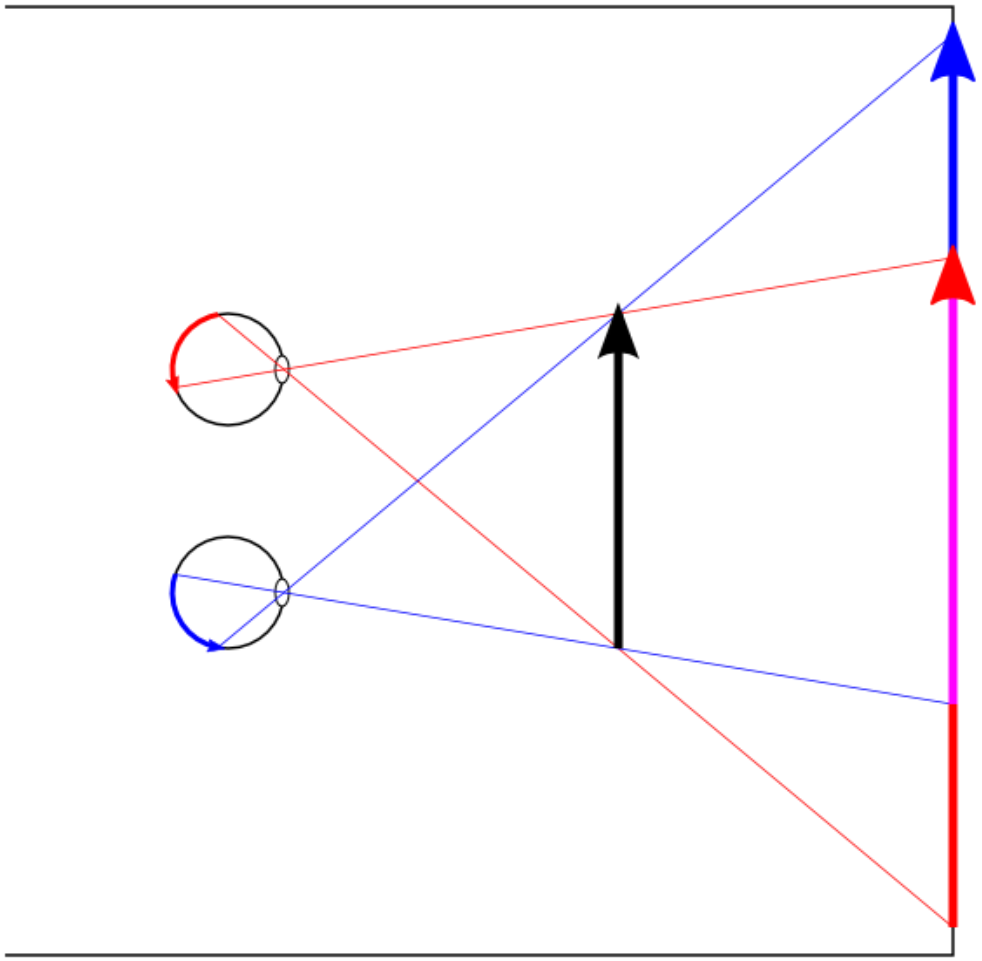

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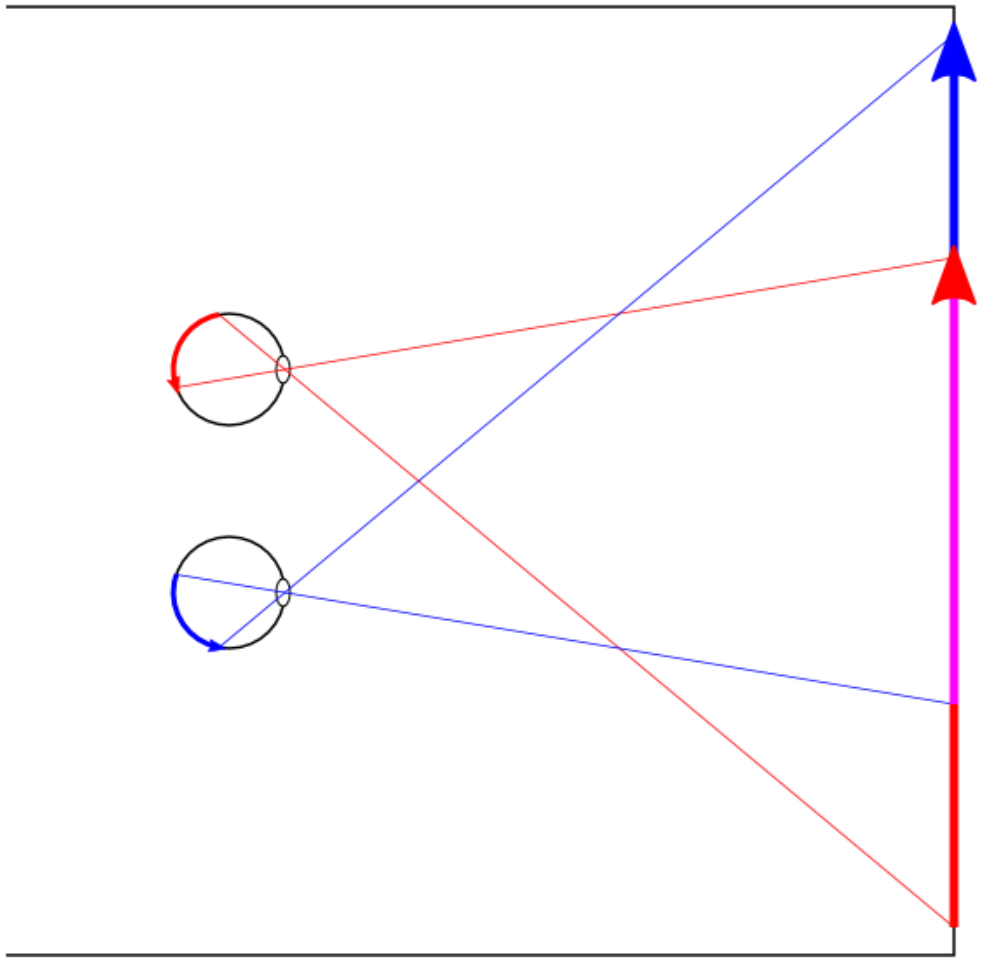

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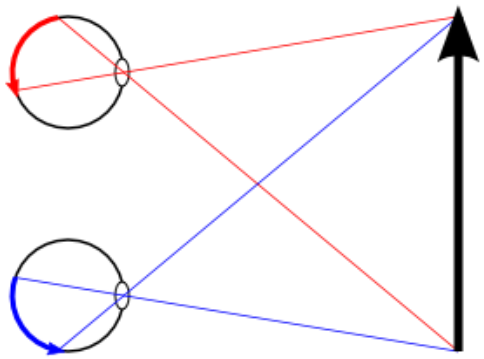
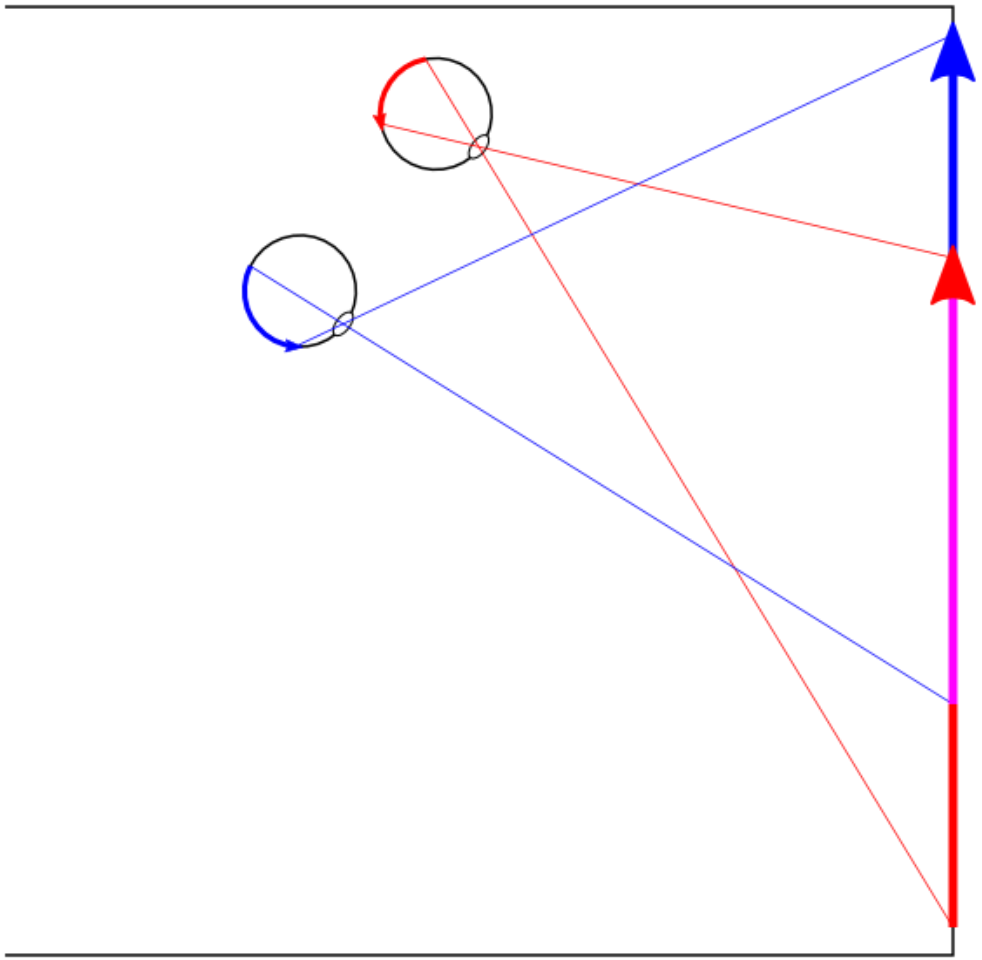


User Movement

Vision in Room VR



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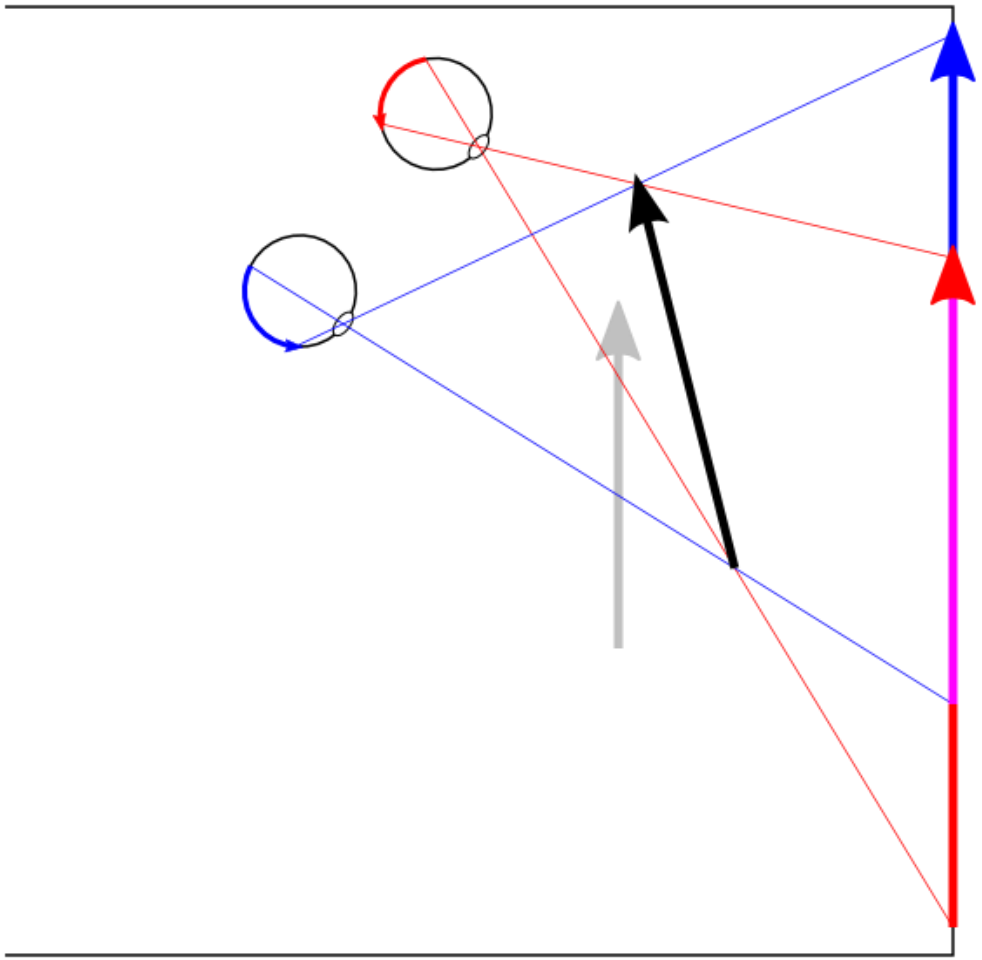

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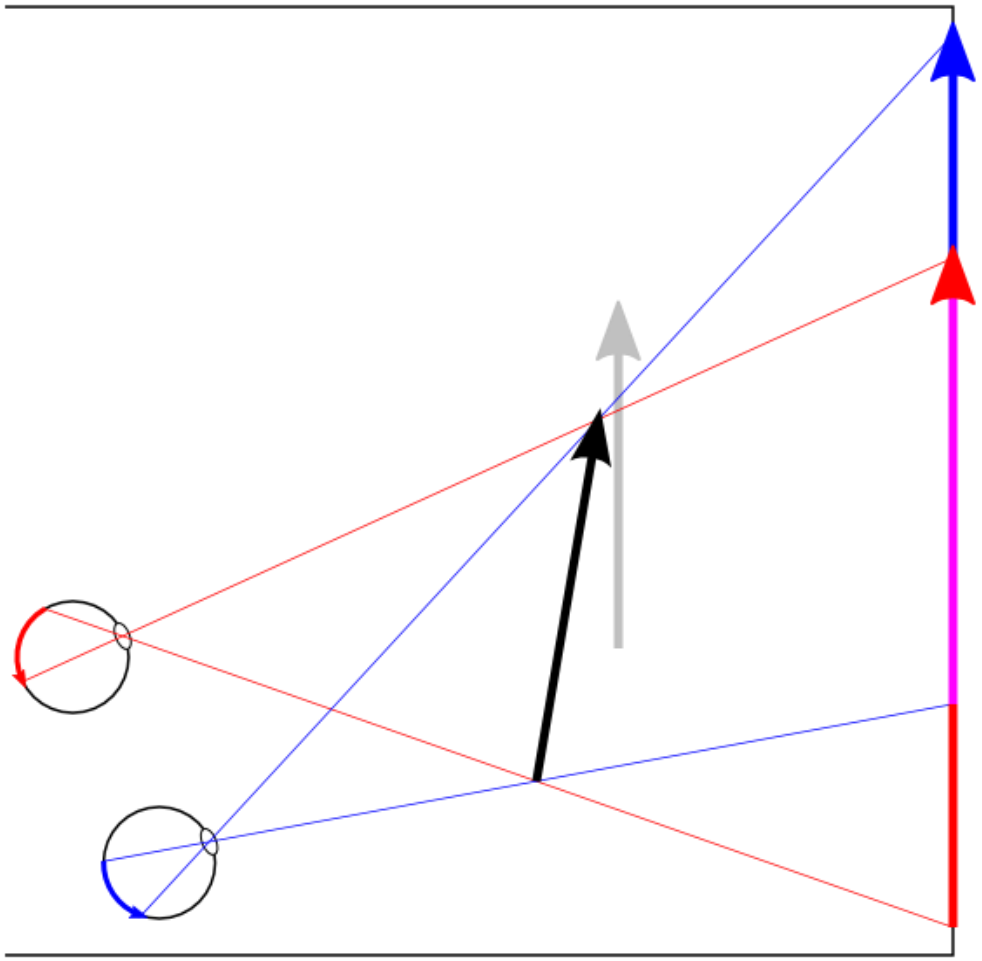

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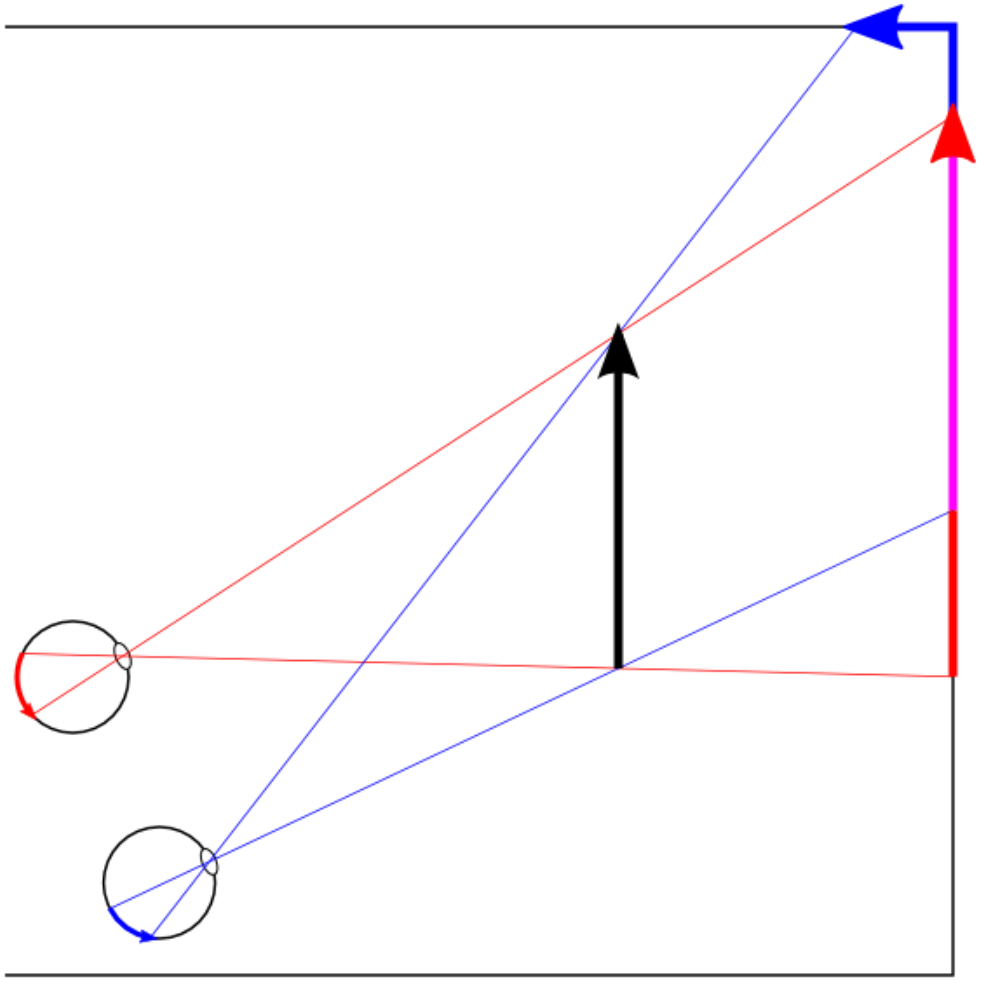

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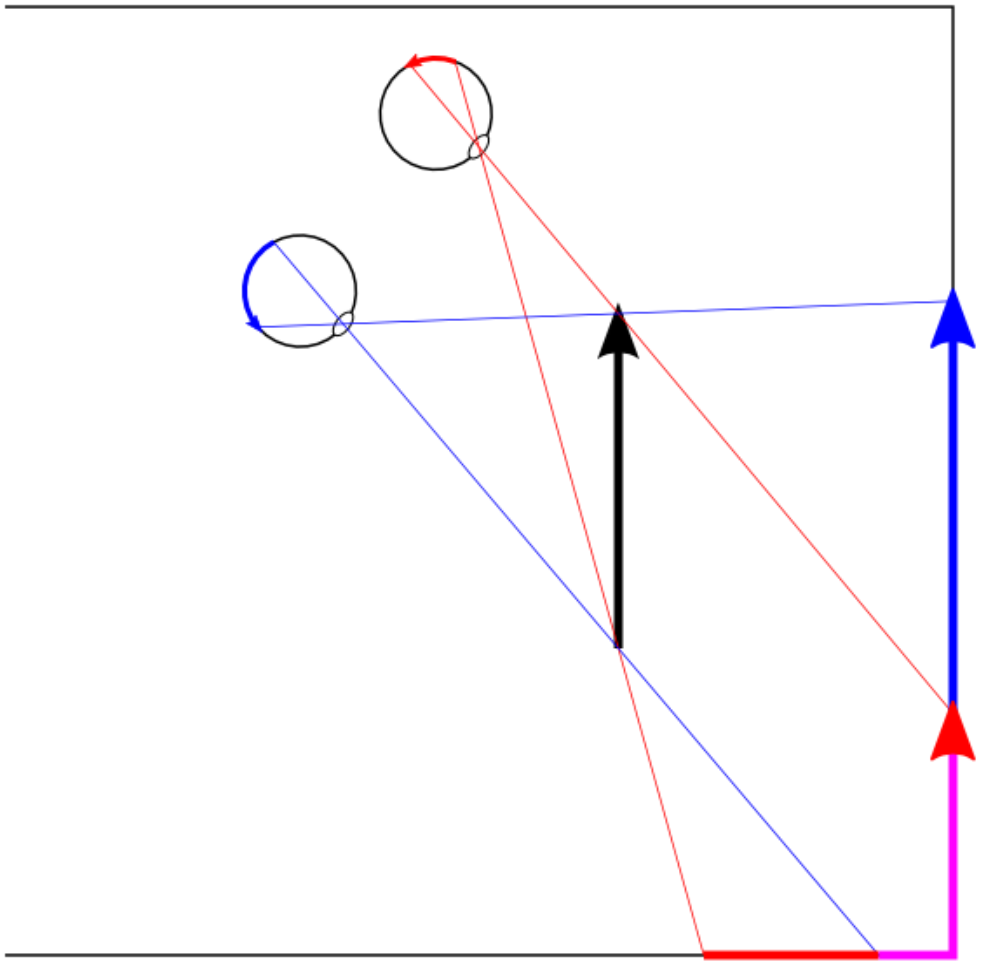
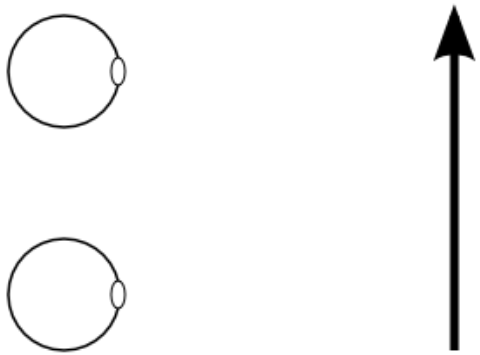


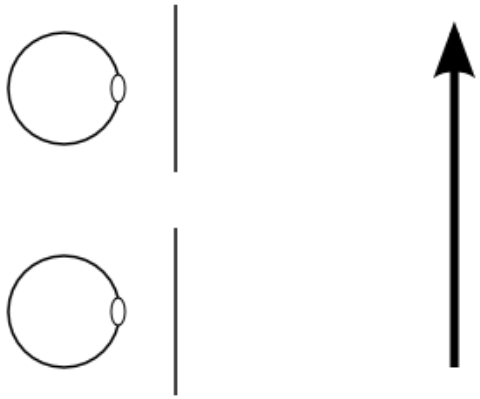
Vision in Room VR

Head-Mounted Displays

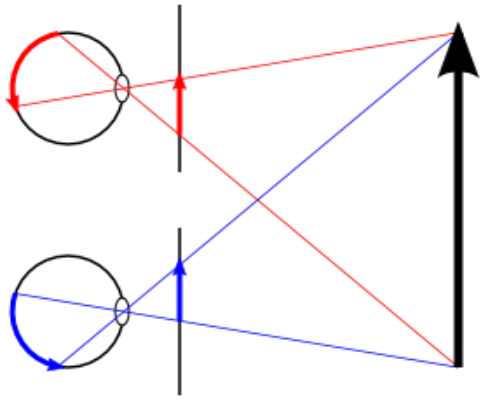
Head-mounted Displays



Head-mounted Displays



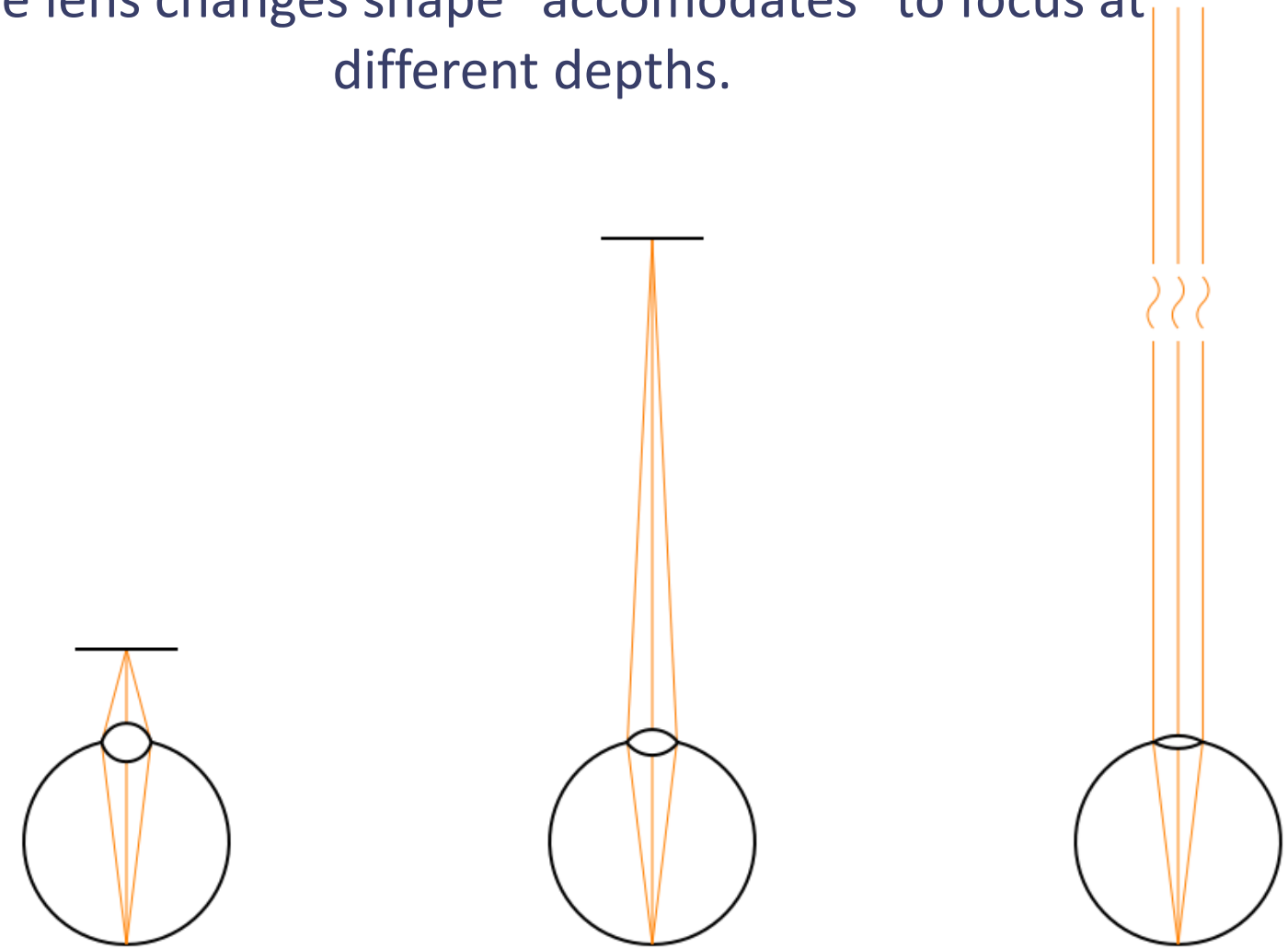
Head-mounted Displays



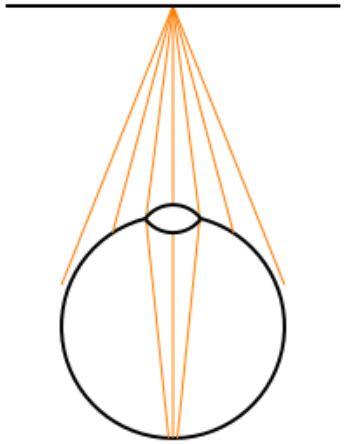
Optics

Accommodation

…eye lens changes shape “accomodates” to focus at different depths.



HMD Optics



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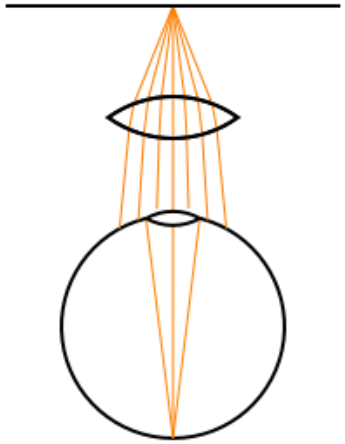

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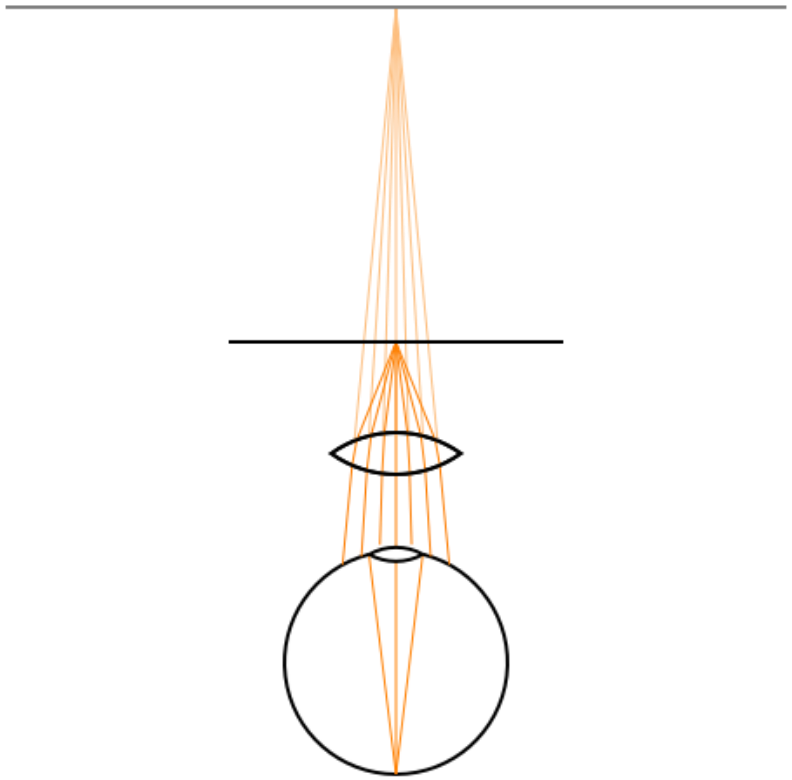
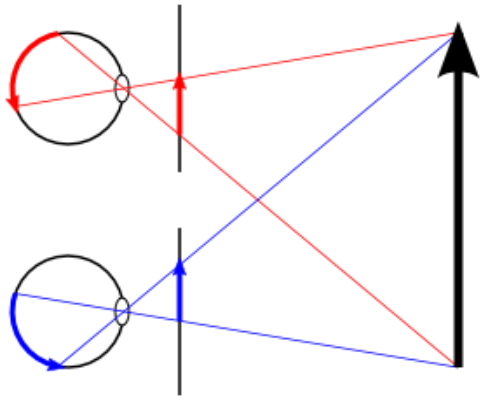


Head-mounted Displays



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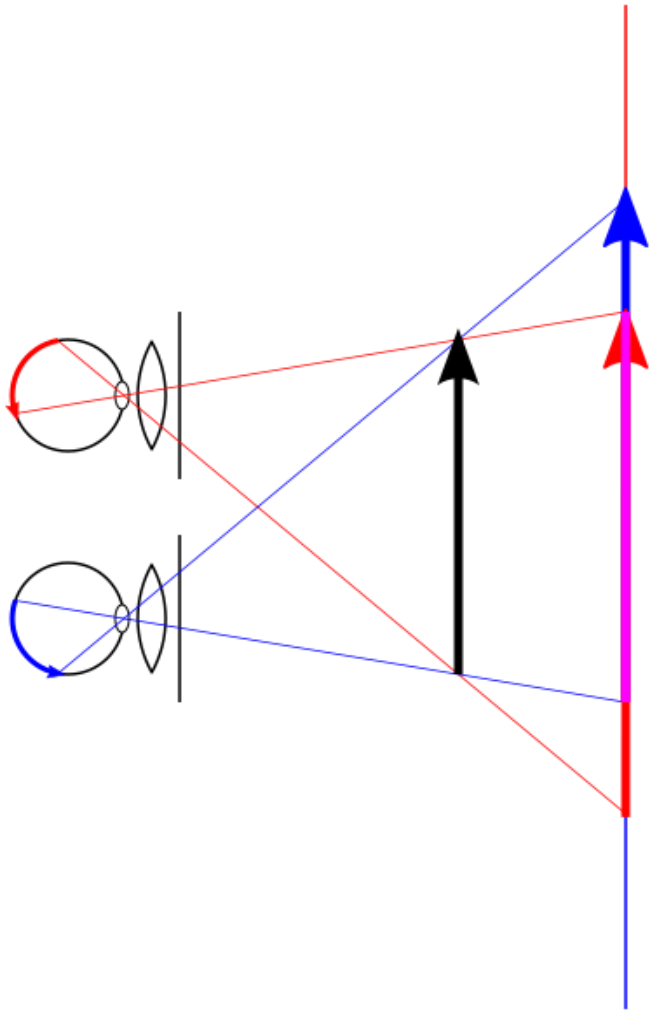

Lens Distortion

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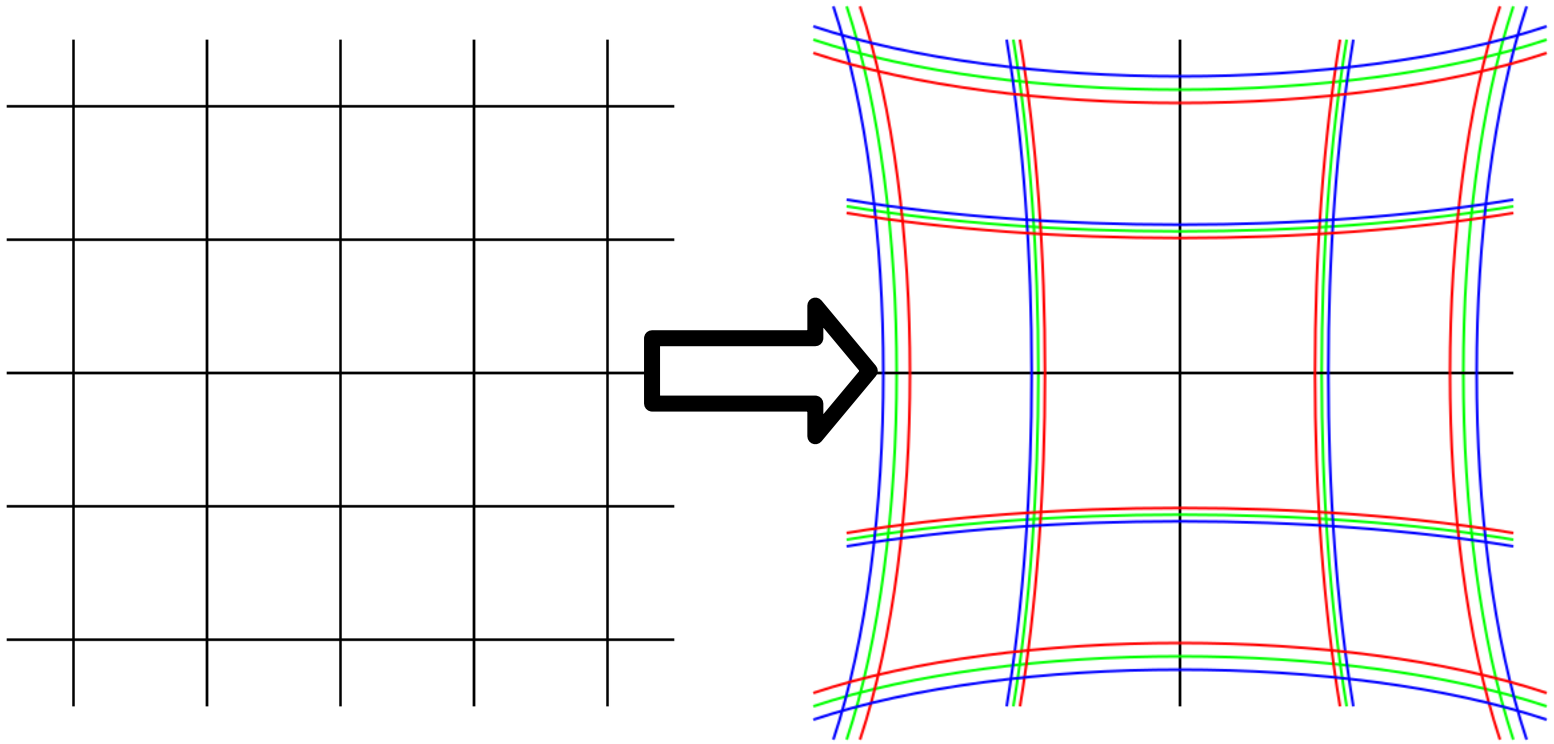
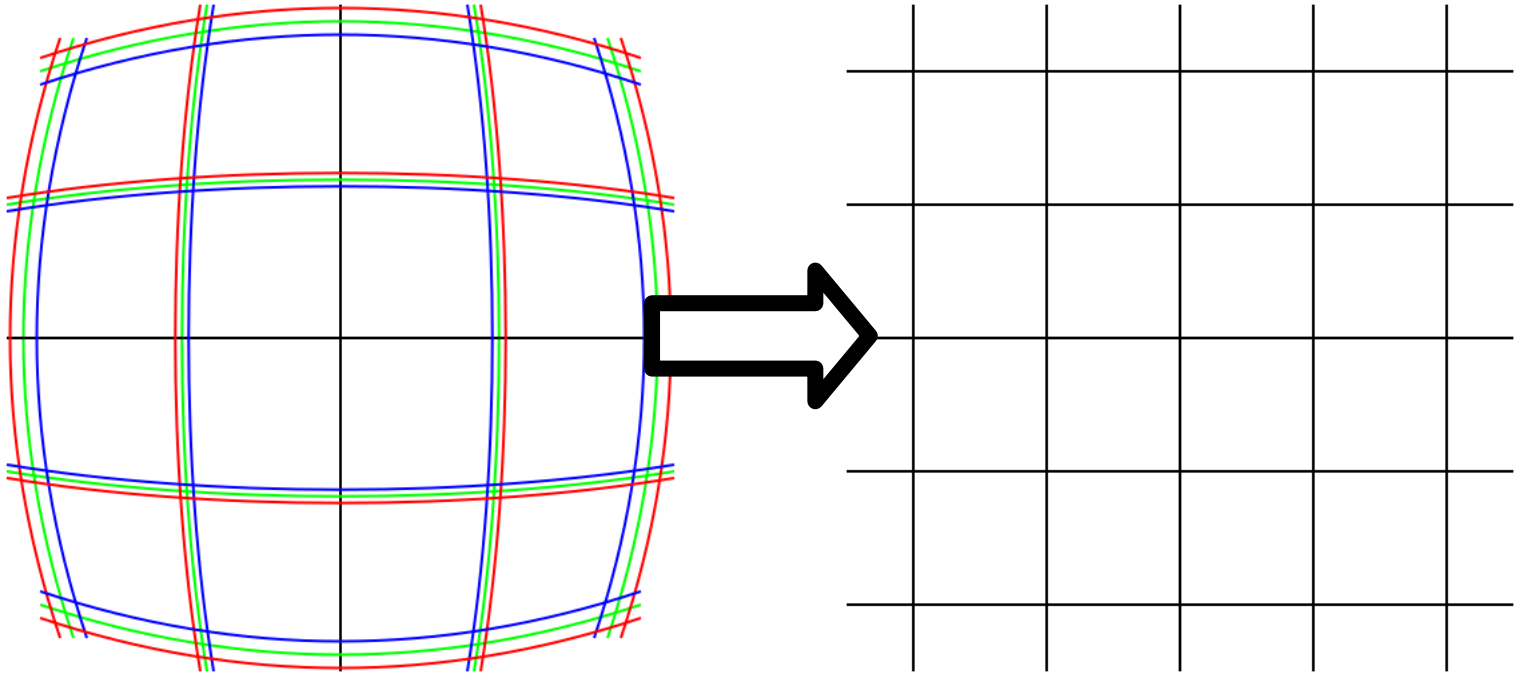


Lens Correction



Configuration

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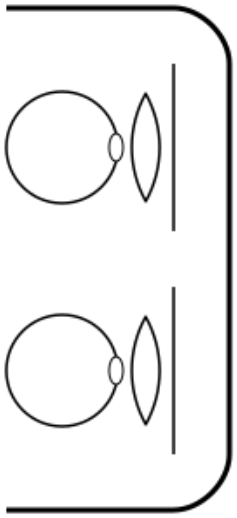
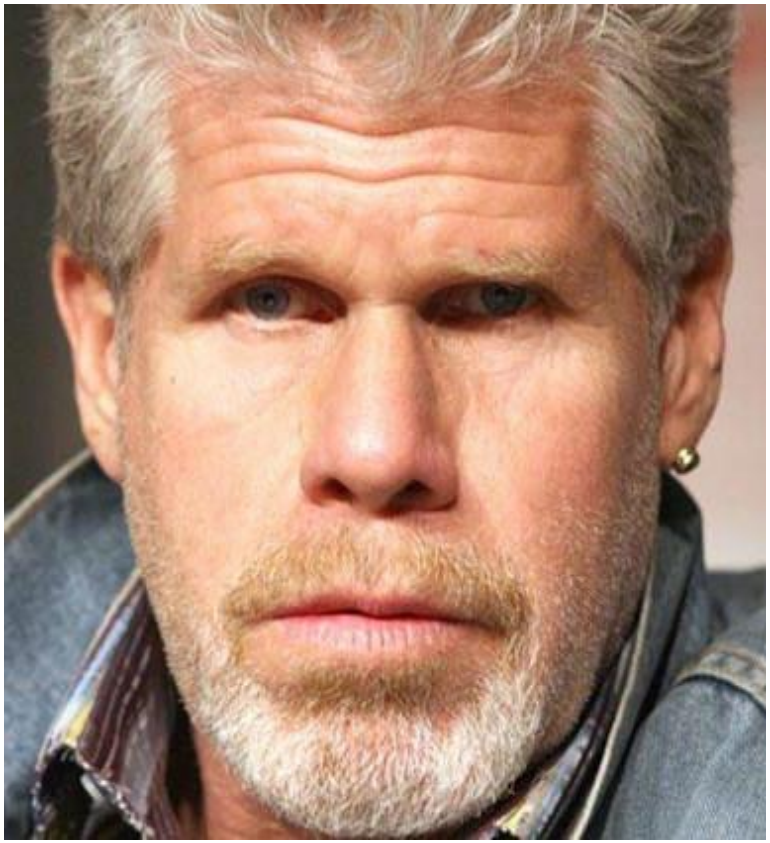


Physiognomy



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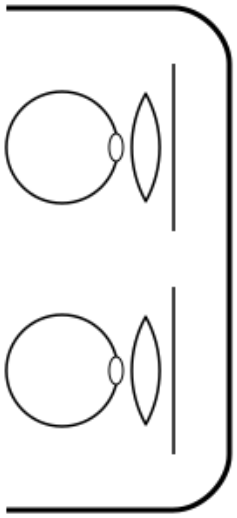

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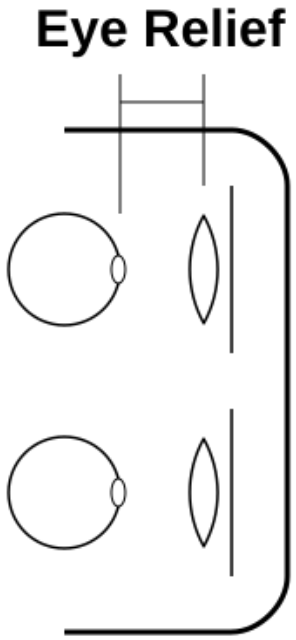

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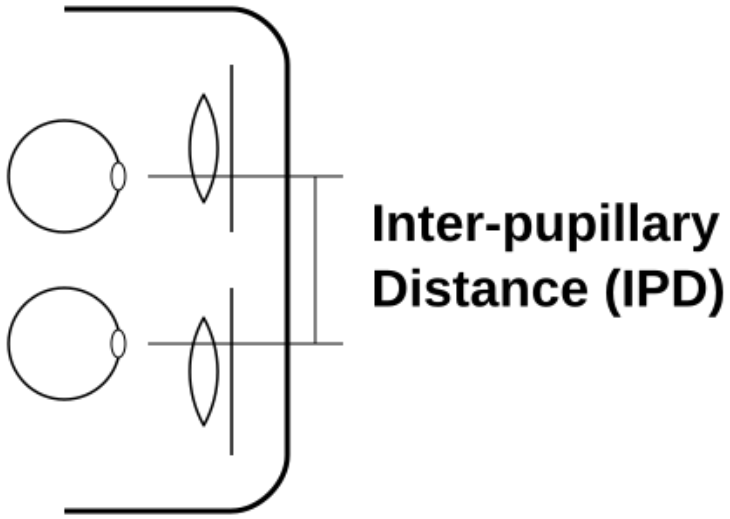
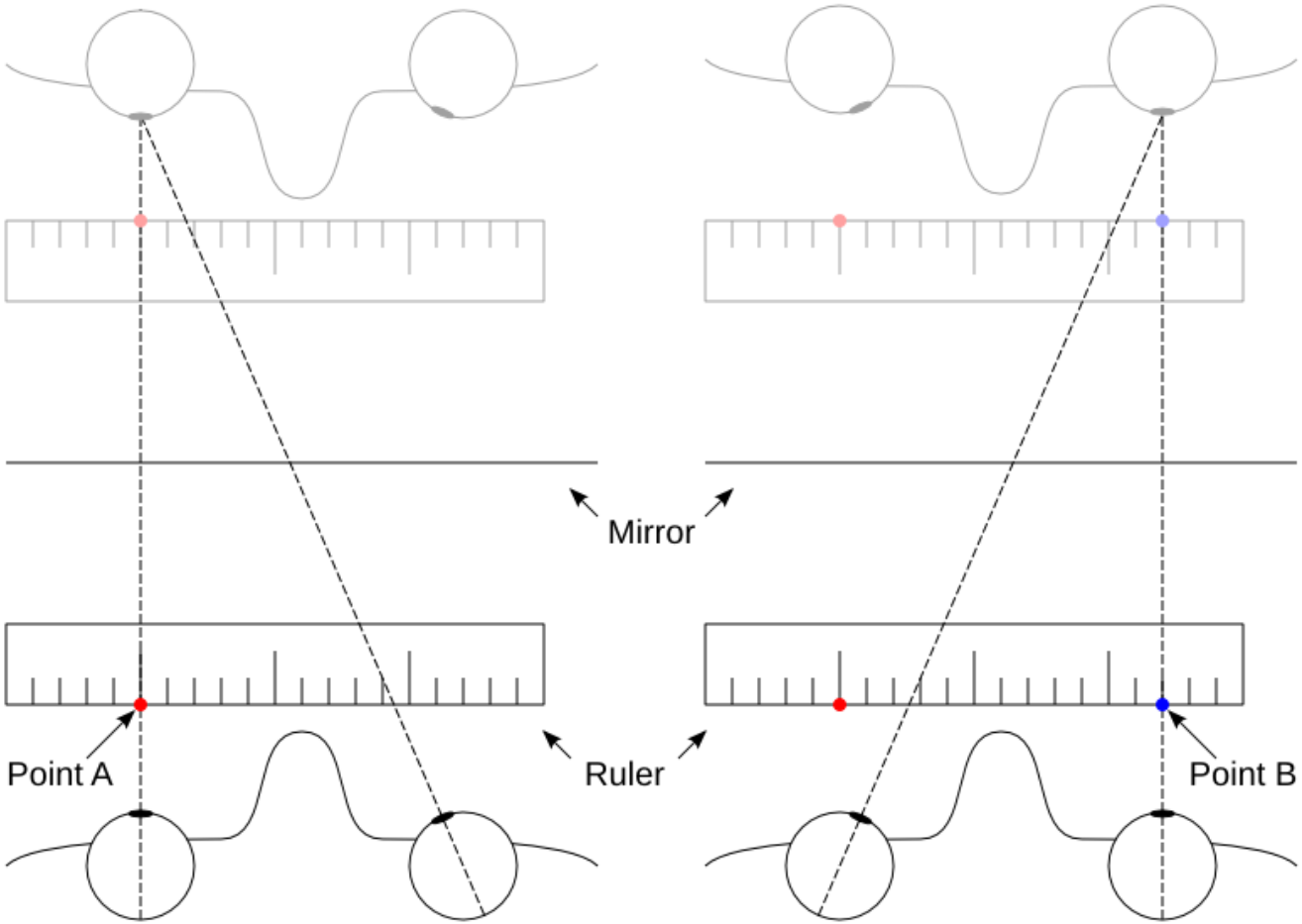


How to measure your IPD



Mis-configuration

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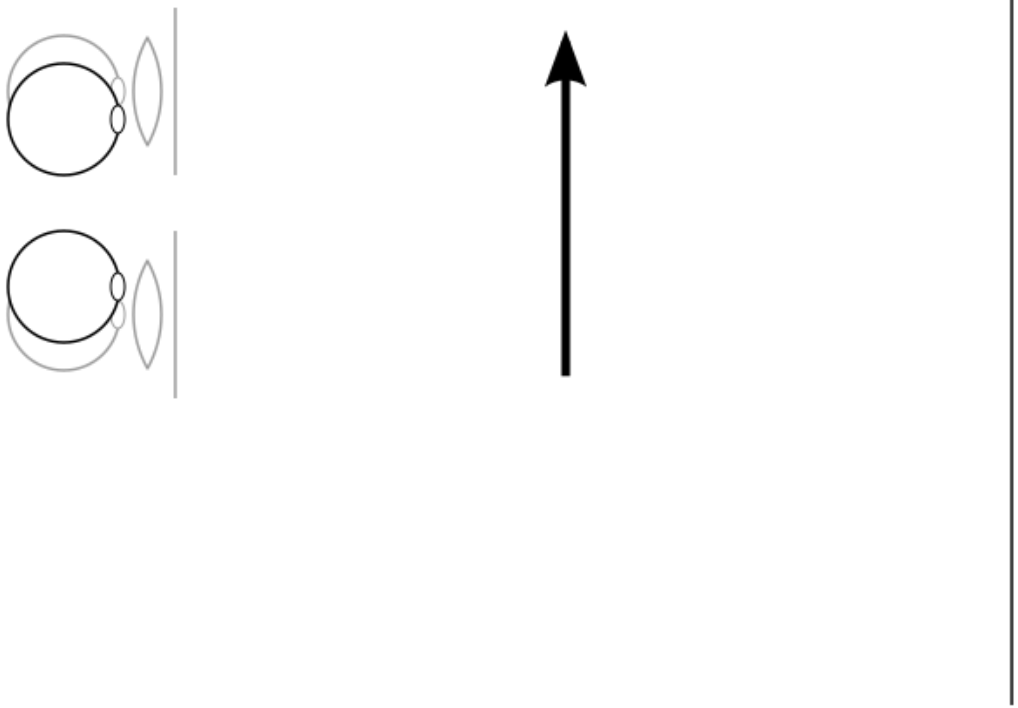

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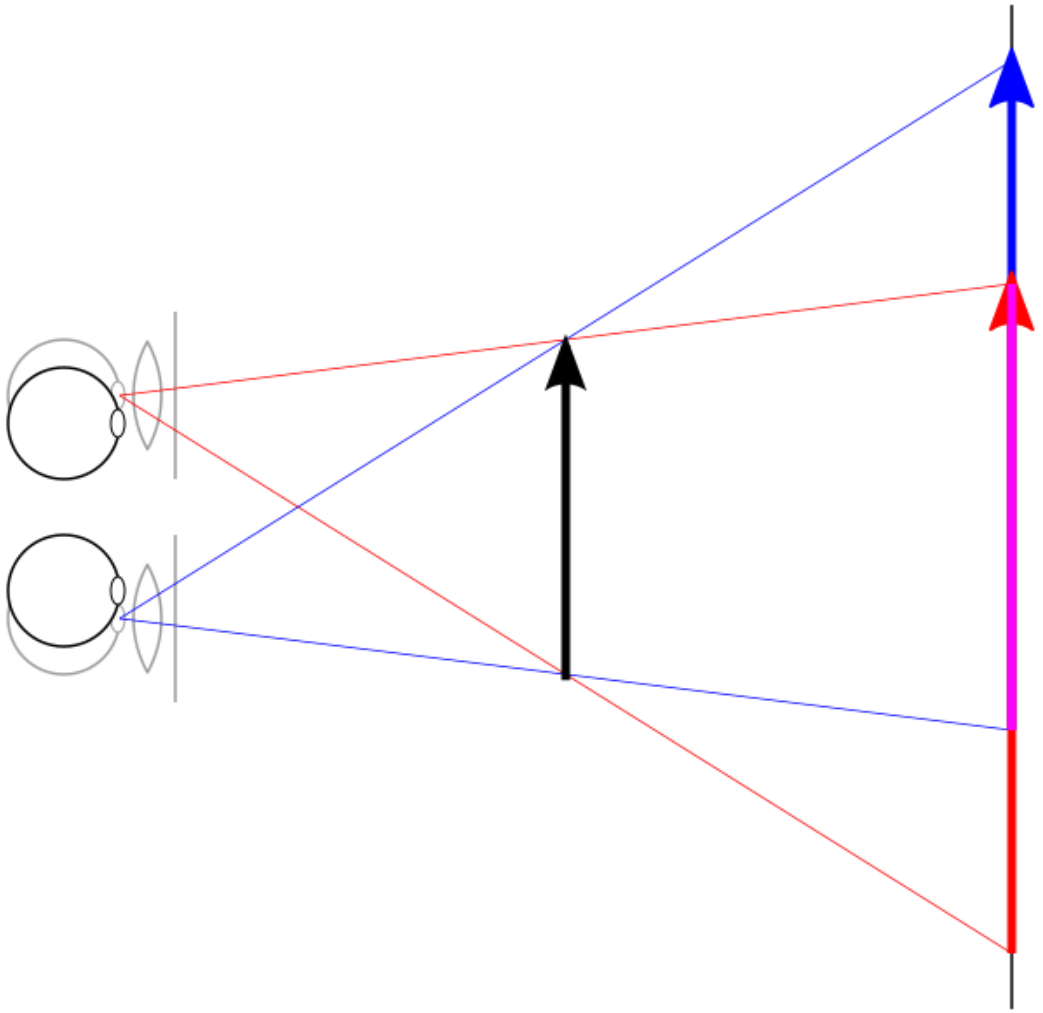
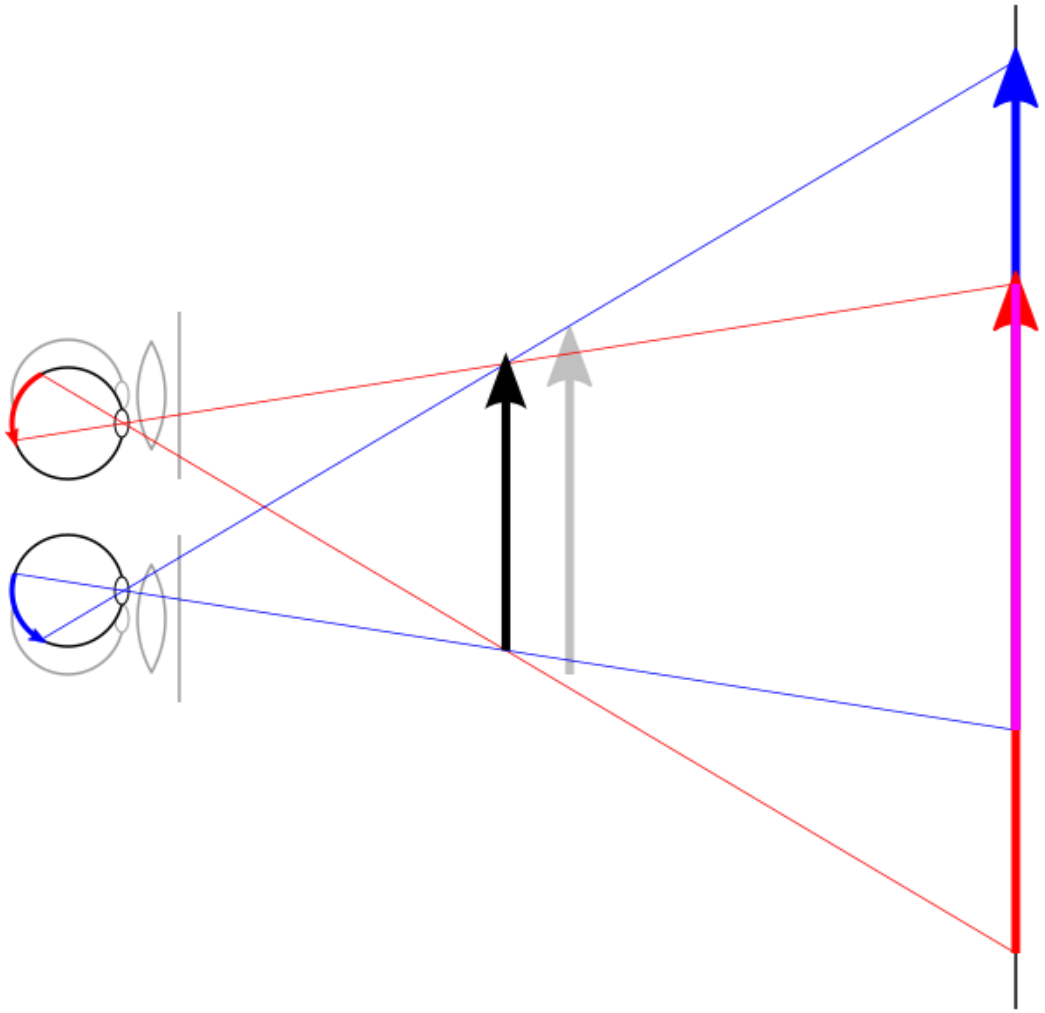


Mis-configuration (depth inaccuracy)

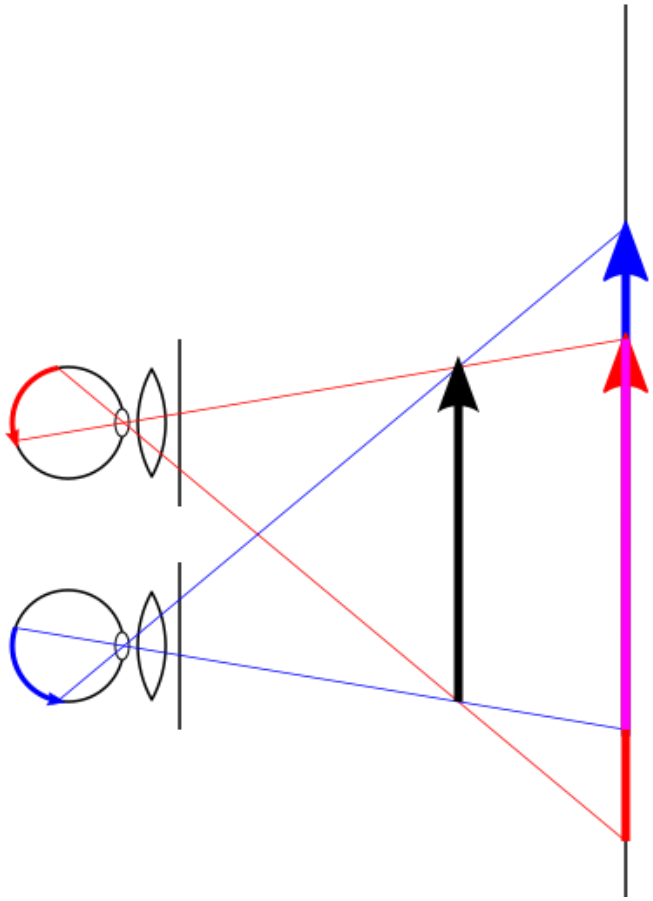


What VR Needs

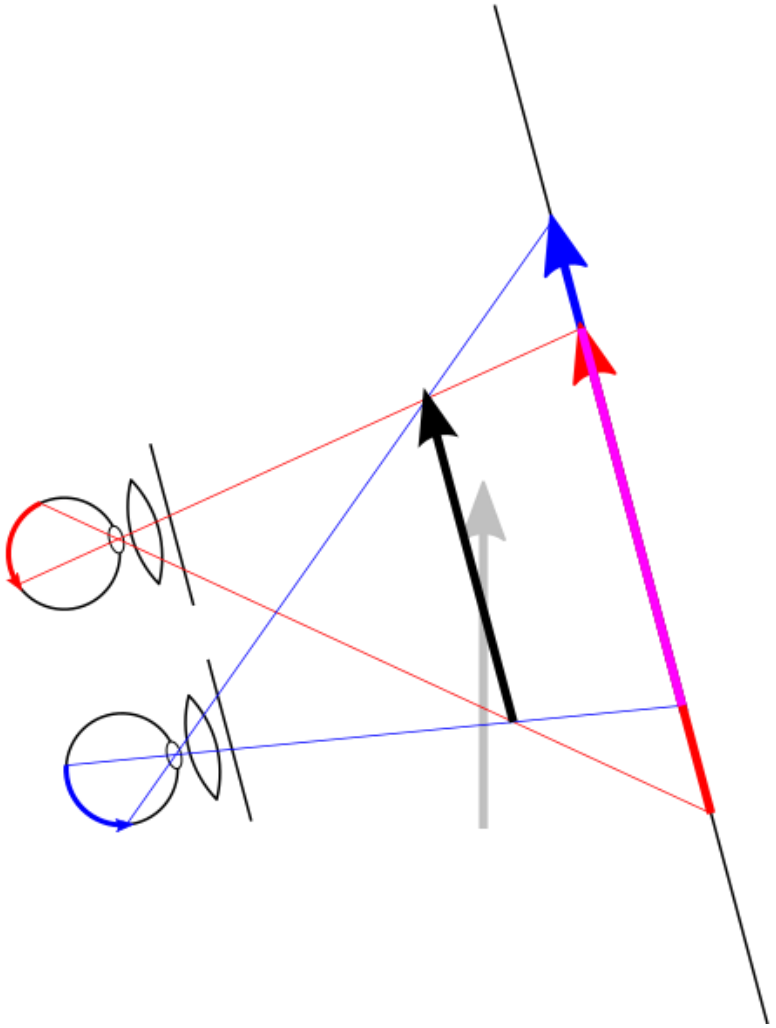
- Good screens and lenses
- Good internal calibration
- High-precision head tracking
- Good user calibration
- Ideally eye tracking
- Low end-to-end latency

End-to-end Latency

End-to-end Latency



End-to-end Latency



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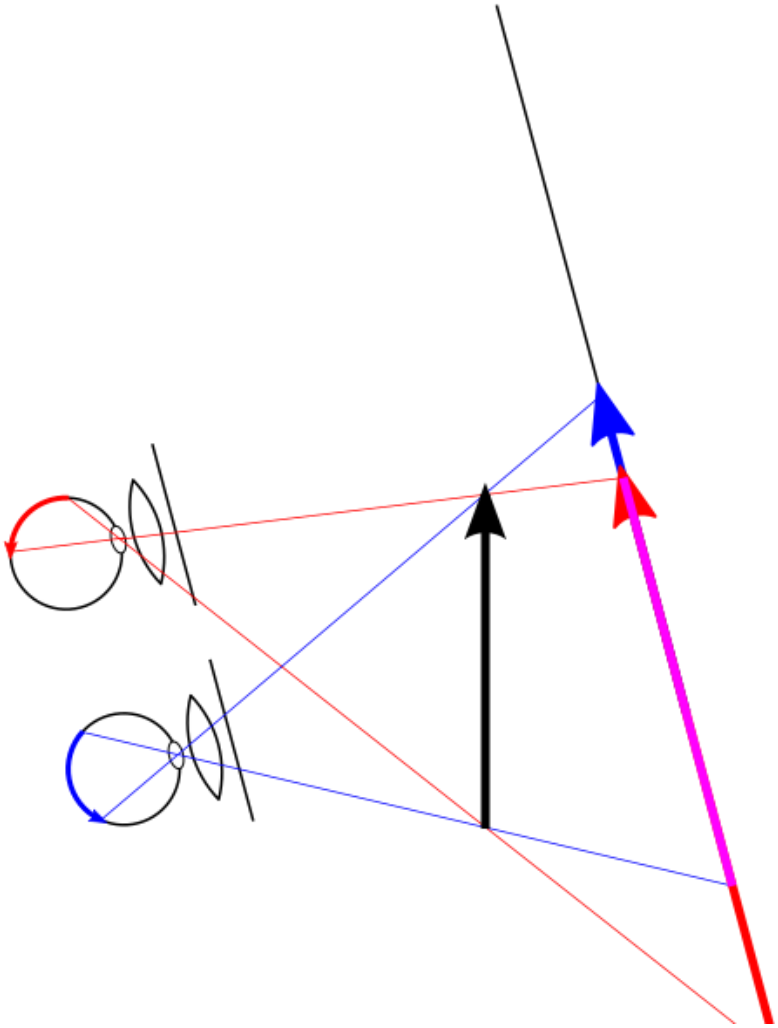


What Else Can Go Wrong?

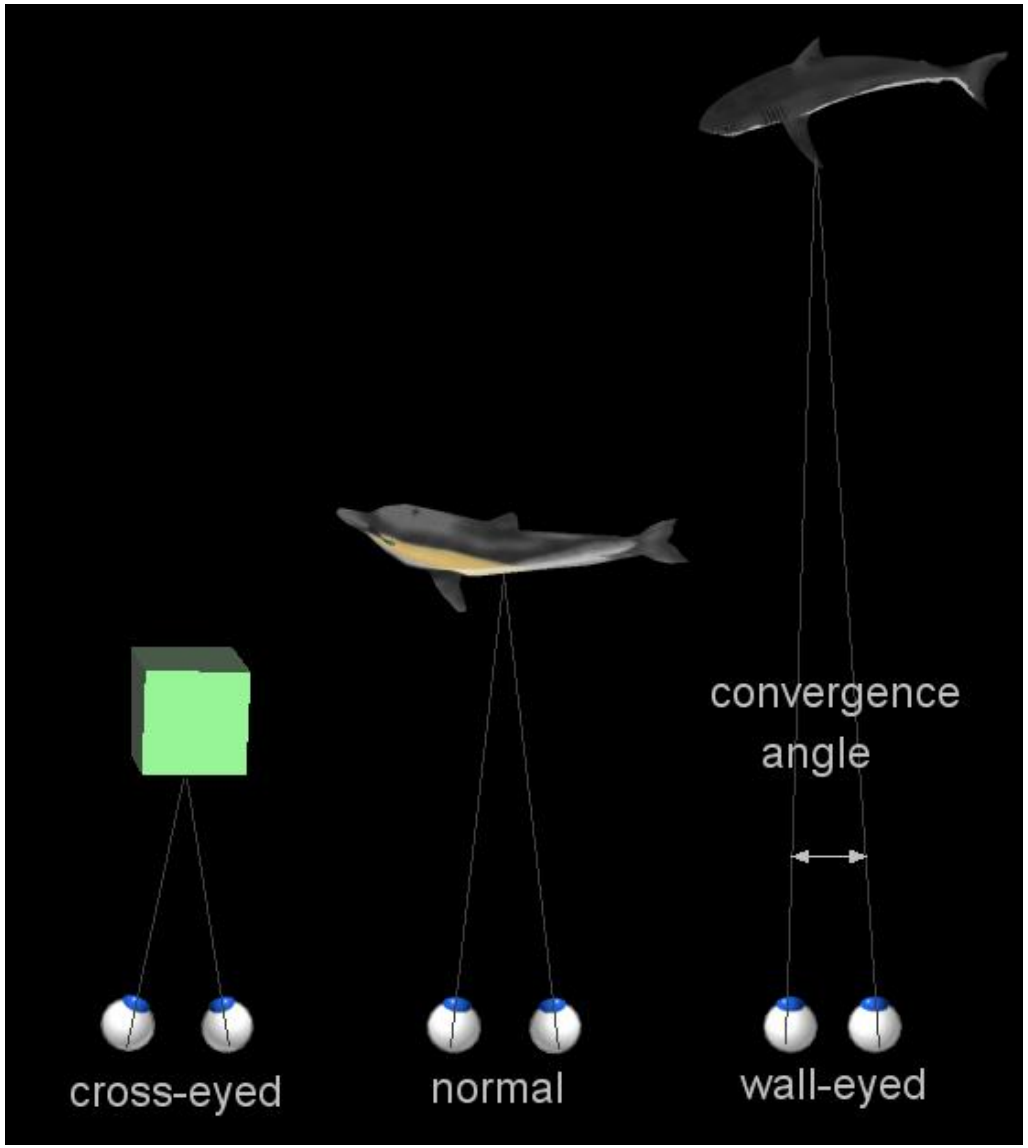
- Artificial locomotion
  - Mismatch between “seen” and “felt” motion
  - Vection-vestibular conflict

Accomodation 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?

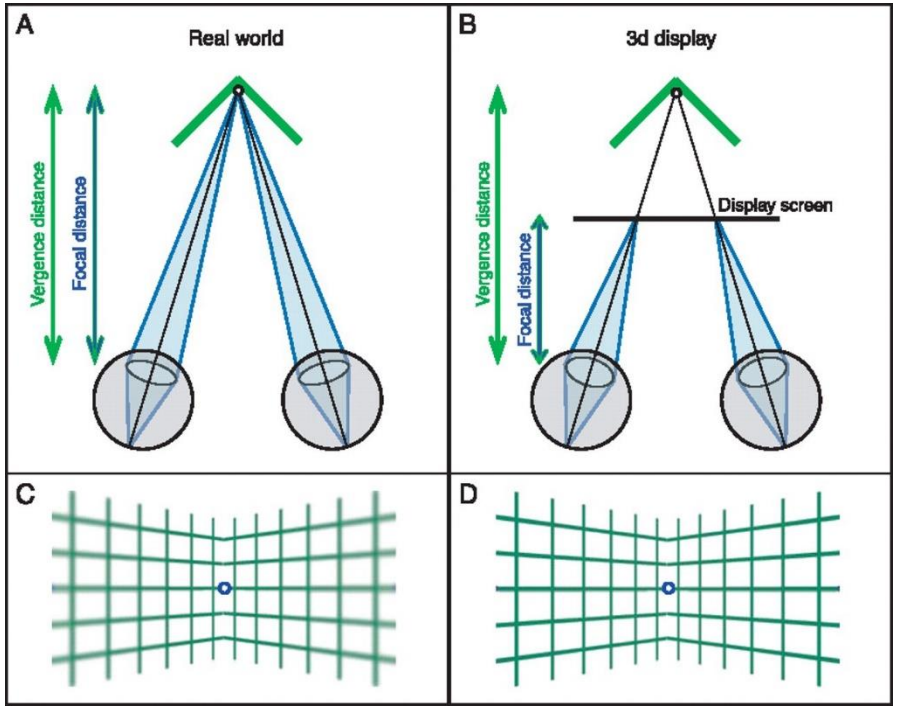
Vergence



Accomodation-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 **de**coupling.
- 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.