Variety of XR Devices

VR

- Meta Quest series
- HTC Vive series

AR

- Magic Leap
- Snap AR Spectacles
- Smartphones with camera feed

MR

- Microsoft holo lens

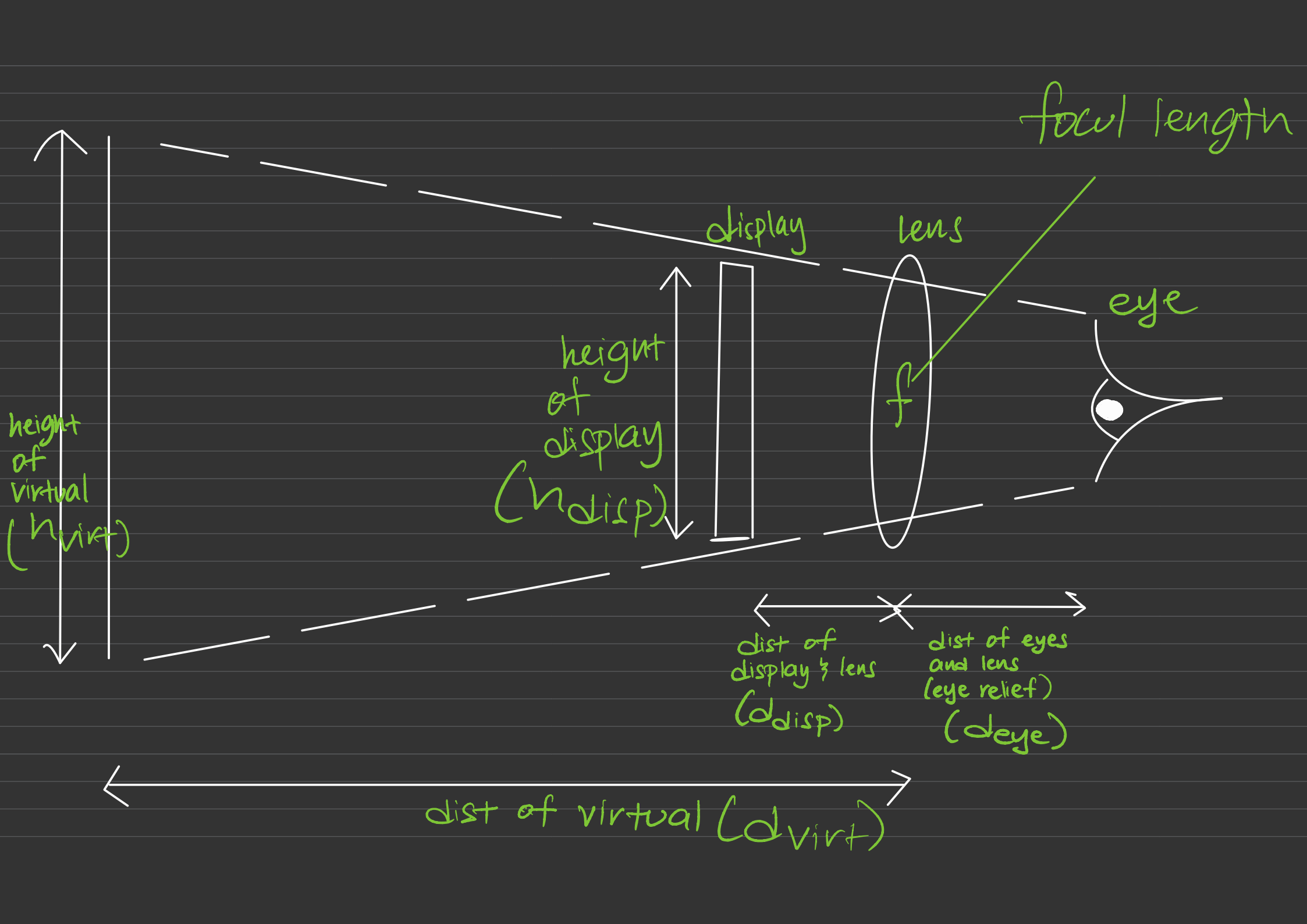
VR HMDs
- PC VR
- Standalone or all-in-one VR

AR HMDs
- Smartphones
- Smartglasses

XR HMDs (multi-form / hybrid)

HMDs

- Display screen
- two magnifier glasses
- Specialized controllers
  - emit infrared array lights
  - have motion tracking sensors to detect these lights
- Other motion tracking sensors in the HMD
- Cameras all over
- Battery
- Speakers
- GPU
- CPU
- Compact motherboard
- Other sensors that can be found on a smartphone


focal length
display
lens
eye
height of display (h_{disp})
height of virtual (h_{virt})
f
dist of display & lens (d_{disp})
dist of eyes and lens (eye relief) (d_{eye})
dist of virtual (d_{virt})

Gaussian Thin Lens formula

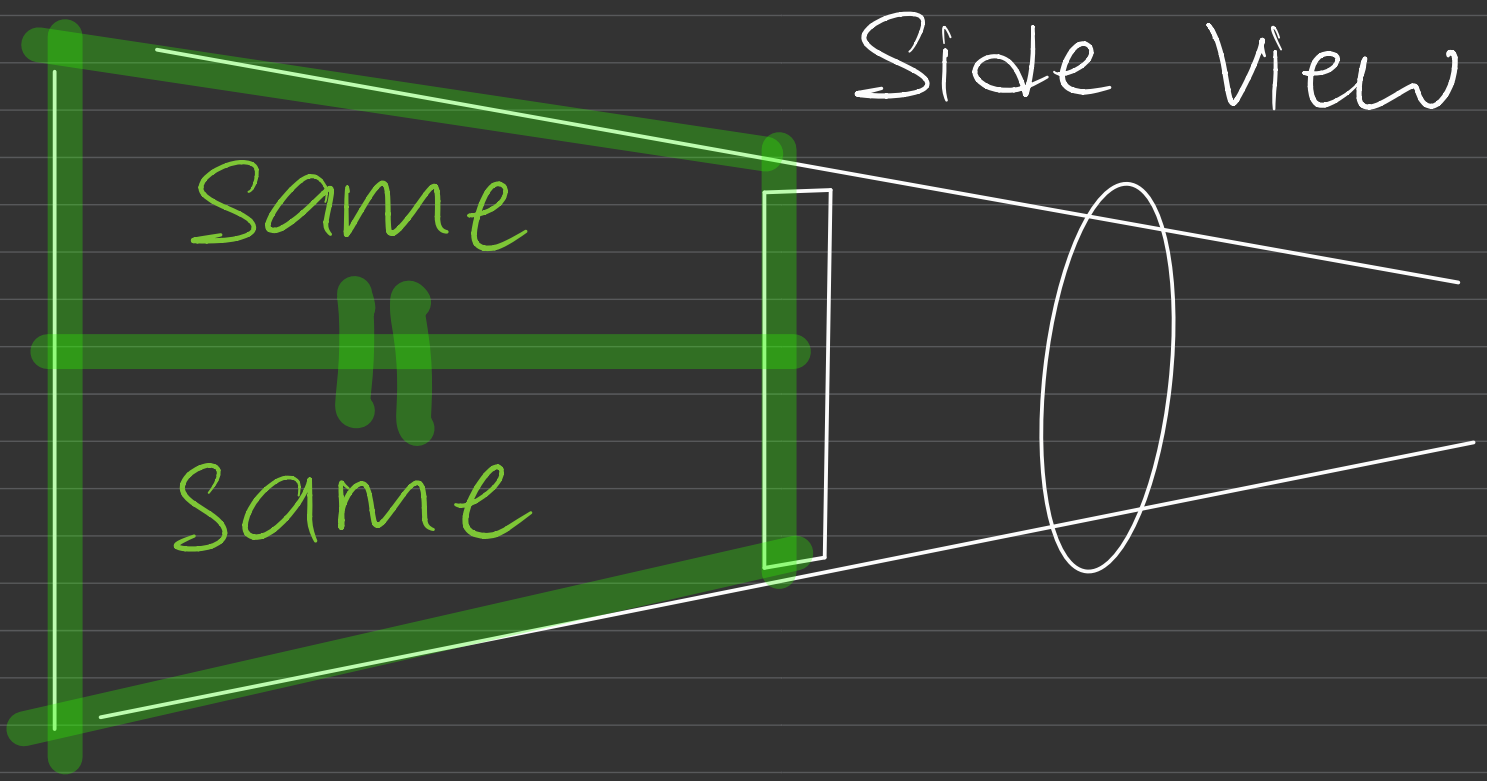
$$\frac{1}{d_{virt}} + \frac{1}{d_{disp}} = \frac{1}{f}$$

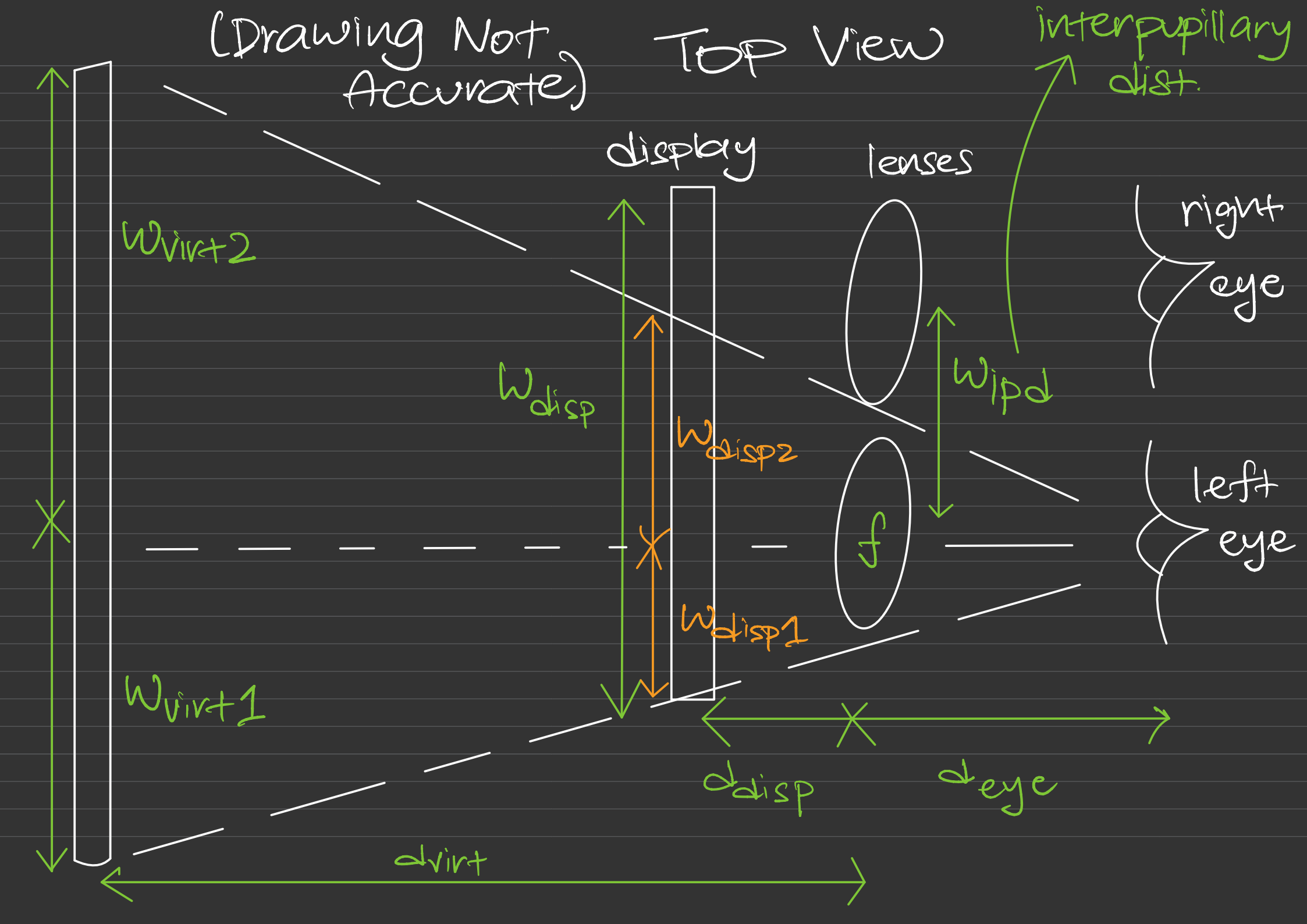
$$d_{virt} = \left| \frac{1}{\frac{1}{f} - \frac{1}{d_{disp}}} \right| \quad //$$

$$\text{Magnification } M = \frac{f}{f - d_{disp}}$$

$$h_{virt} = M\, h_{disp}$$

View frustrum




(Drawing Not Accurate)
Top View
interpupillary dist.
display
lenses
right eye
left eye
w_{virt2}
w_{disp}
w_{disp2}
w_{ipd}
f
w_{disp1}
w_{virt1}
d_{disp}
d_{eye}
d_{virt}

The closer the ipd of the device is to the ipd of your eyes, the better viewing experience

$$W_{virt2} = M\left(\frac{W_{ipd}}{2}\right)$$

$$W_{virt1} = M\left(\frac{W_{disp} - W_{ipd}}{2}\right)$$

$$z = d_{disp} + d_{eye}, \quad d = d_{virt} + d_{eye}$$

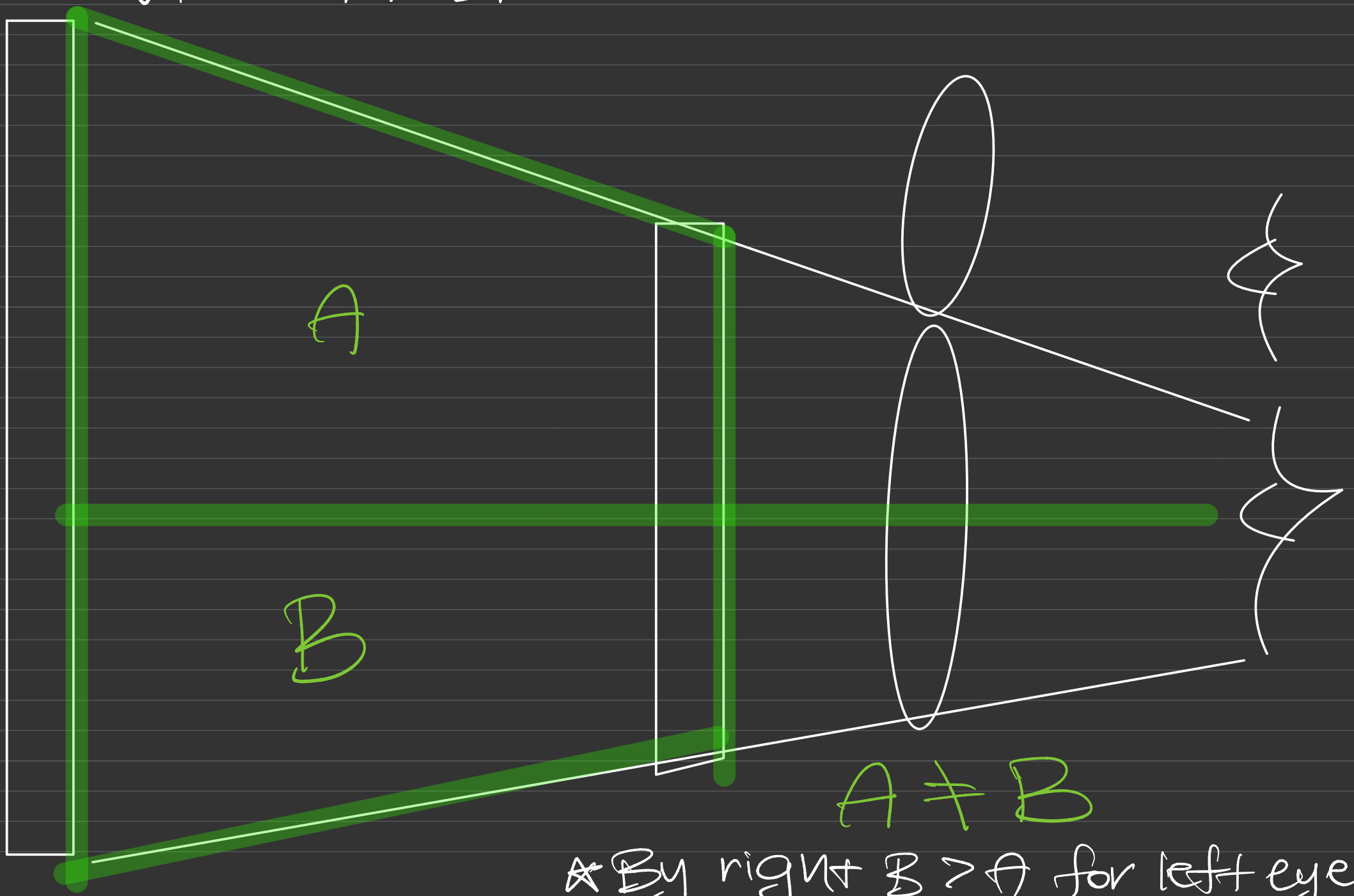
$$W_{disp2} = z\left(\frac{W_{virt2}}{d}\right)$$

$$W_{disp1} = -z\left(\frac{W_{virt1}}{d}\right)$$

For LEFT eye, $W_{virt1} > W_{virt2}$

For RIGHT eye, $W_{virt2} > W_{virt1}$

View Frustrum



* By right B > A for left eye but I suck

Vertically (side view), view frustrum symmetric

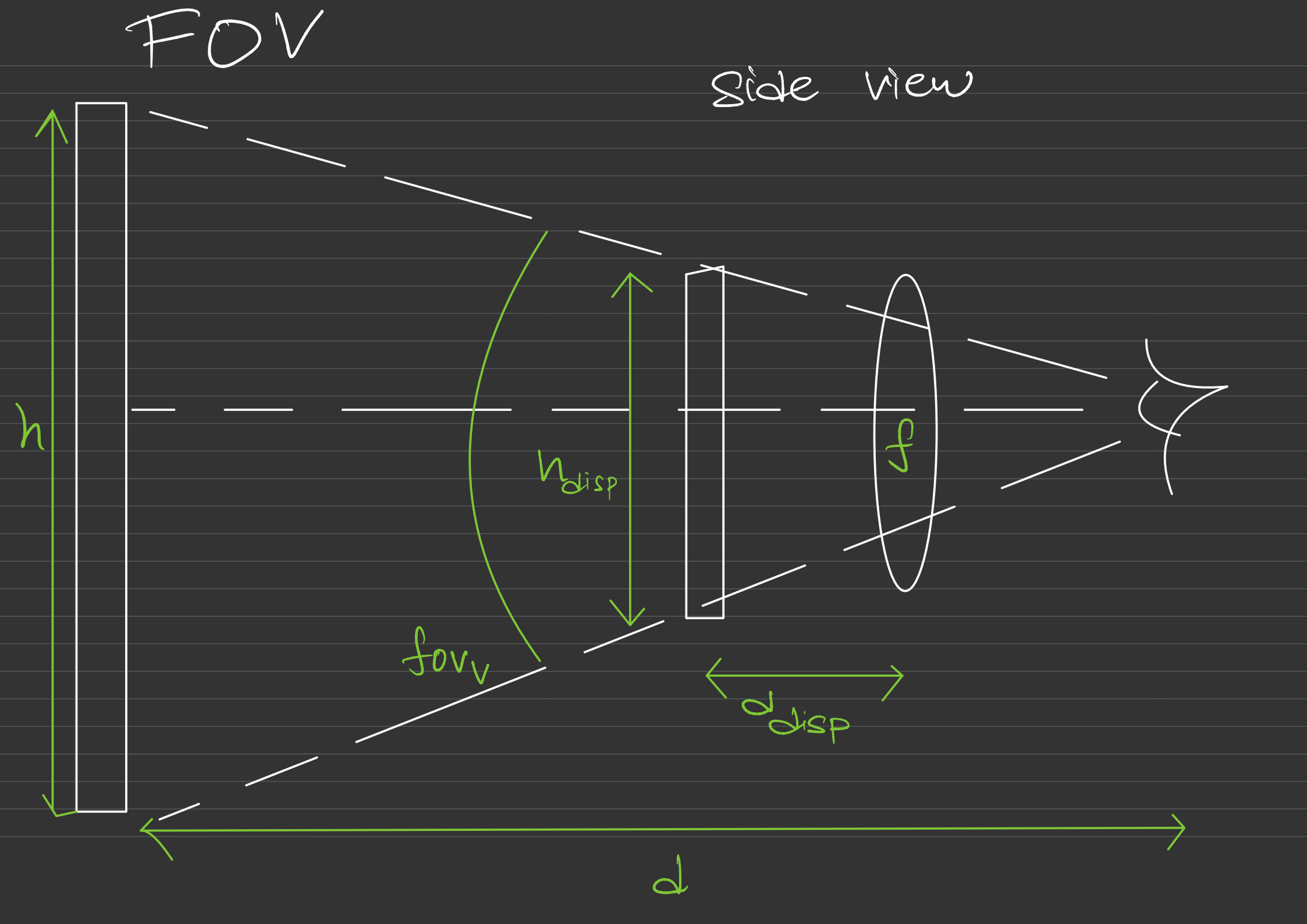
Horizontally (top view), view frustrum asymmetric

- Due to offset of the world formed
- i think at centre

HMD key dimensions:
- focal length (f)
- IPD (w_{ipd})
- Screen-lens dist (d_{disp})
- eye relief (d_{eye})

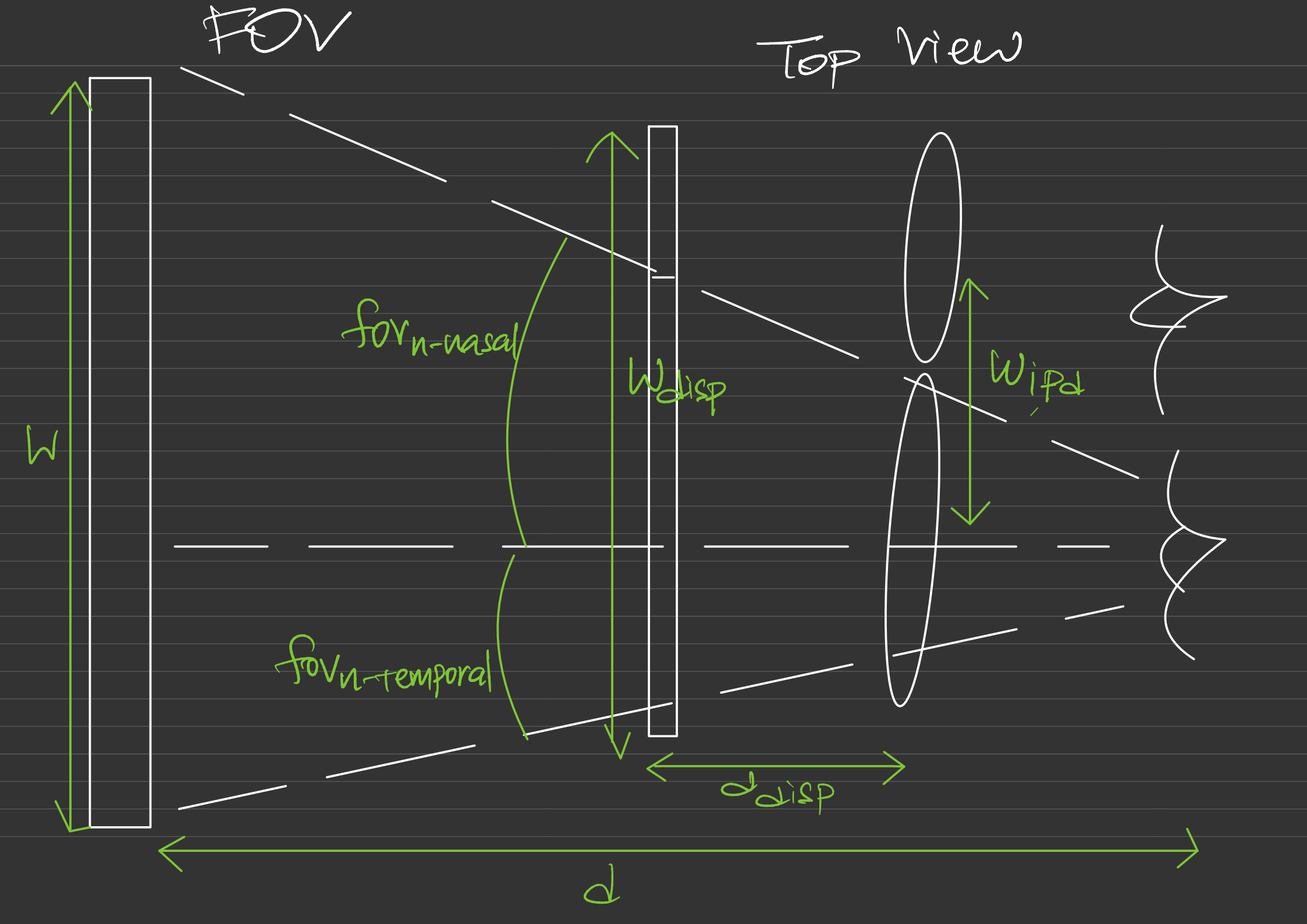
FOV

Side view



$$M = \frac{f}{f - d_{disp}}$$

$$fov_v = 2 \tan^{-1}\left(\frac{M\left(\frac{h}{2}\right)}{d}\right)$$

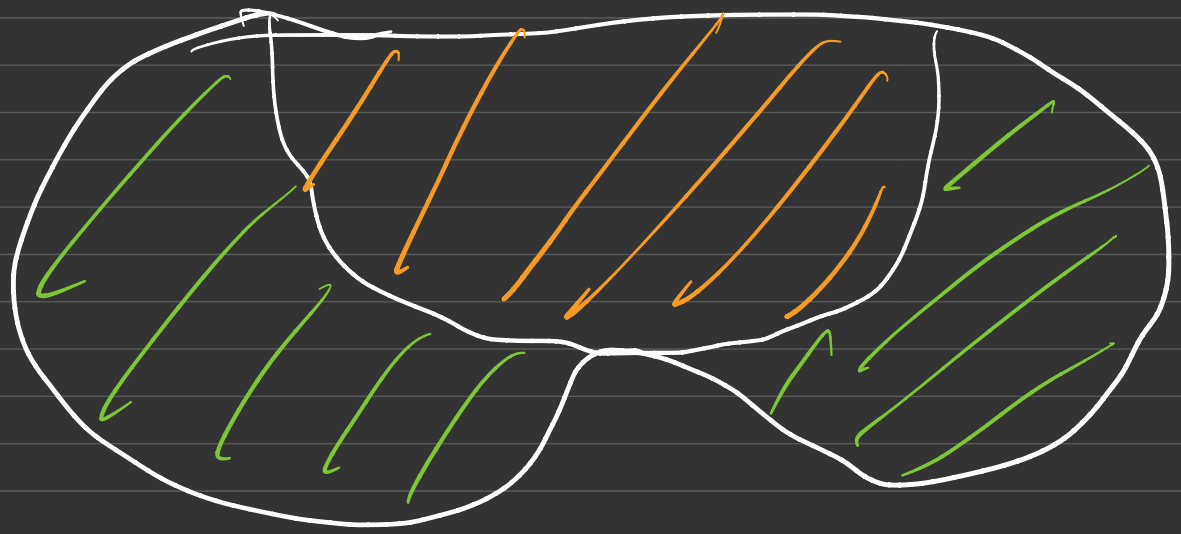

FOV
Top View
$fov_{n\text{-}nasal}$
W_{disp}
W_{ipd}
W
$fov_{n\text{-}temporal}$
d_{disp}
d

$$fov_n = fov_{n\text{-}nasal} + fov_{n\text{-}temporal}$$

$$= \tan^{-1}\left(\frac{M\left(\frac{W_{ipd}}{2}\right)}{d}\right) + \tan^{-1}\left(\frac{M\left(\frac{W - W_{ipd}}{2}\right)}{d}\right)$$

Binocular FOV - combined visual span from the overlapping vision seen by both eyes

Monocular FOV - combined visual span seen individually by the non overlapping area, separately seen by each eye



BINOCULAR

MONOCULAR

Lens Distortion

- The further the point is from the centre, the more it needs to be shifted in order to counter the distortion introduced by the curved lenses
- Chromatic Aberration

Other modern Hardware
- Wearable motion trackers
  - Vive trackers
- Eye tracking

Video Games $\subseteq$ interactive real-time simulation

Software components
- Rendering (Graphics) system
- Physics system
- Input handler
- Audio processor
- AI system
- Entity Component System (ECS)
- etc.