CS 498 VR

Lecture 12 - 3/5/2018

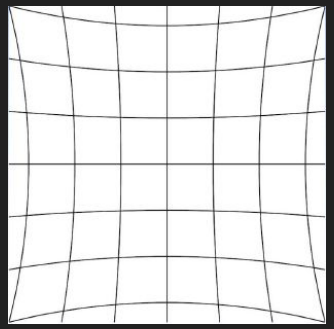
go.illinois.edu/VRlect12

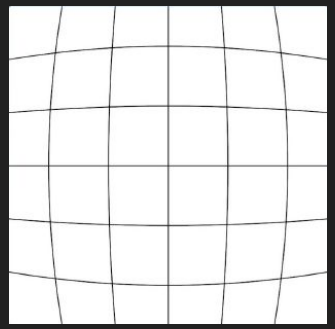
Review

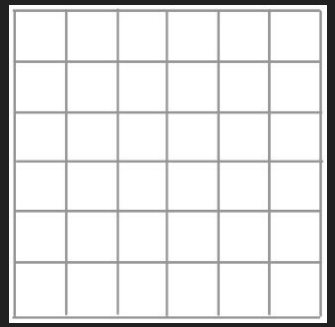
- How far should a point be from a lens to produce parallel rays on the other side?

- What is the diopter of the human eye? By how much can the ciliary muscle increase the diopter of the eye?

Optical Distortion



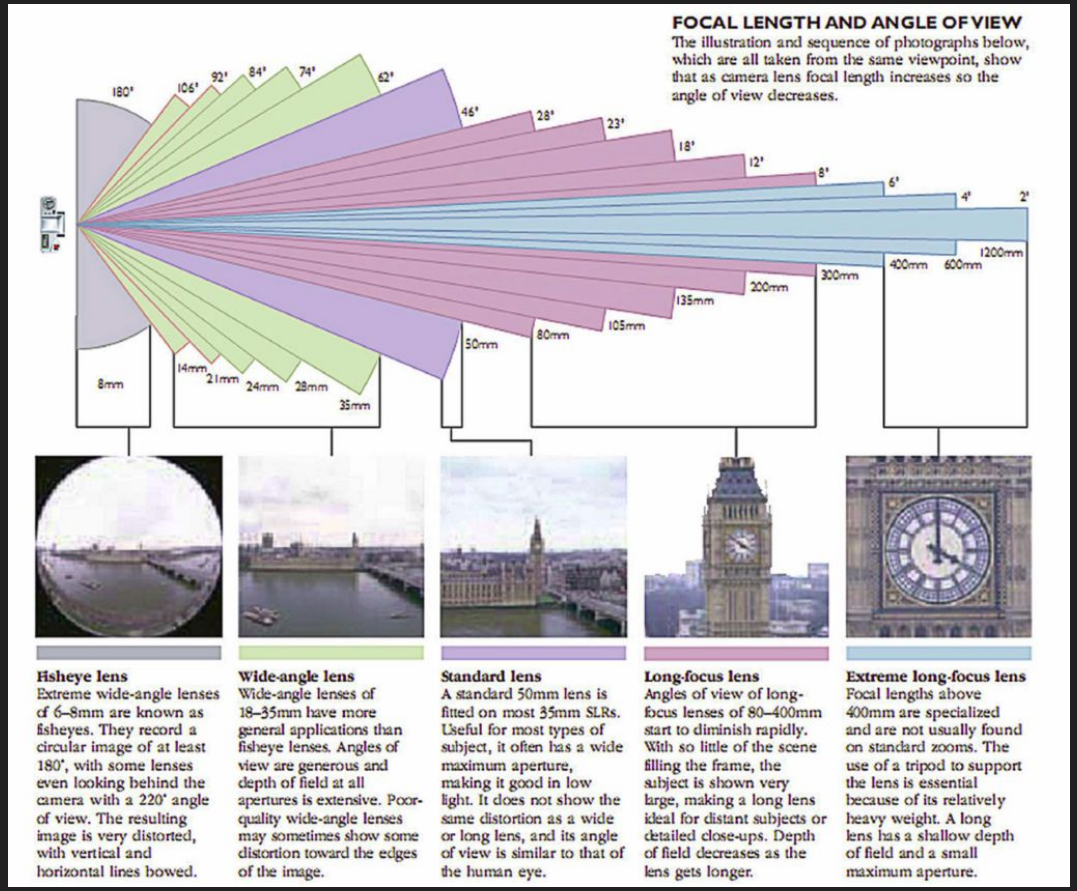




Do you notice problems?
Blur?
Color?
Shape?

Put the Oculus Rift lens 40mm away from the paper. Look through the lens and see which grid “appears” to be the least distorted. Mark your result!

Lens Focal Length, FOV trade-off



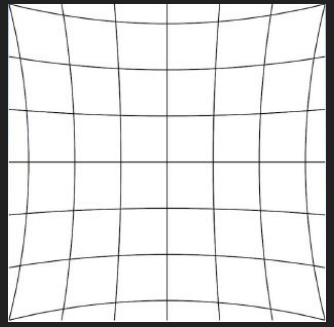
Trade-offs:

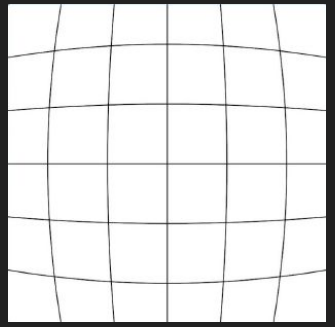
- Size
- Weight
- Focal length
- Field of view
- Distortion
- Cost of materials
- Ease of manufacturing

Optical Distortion

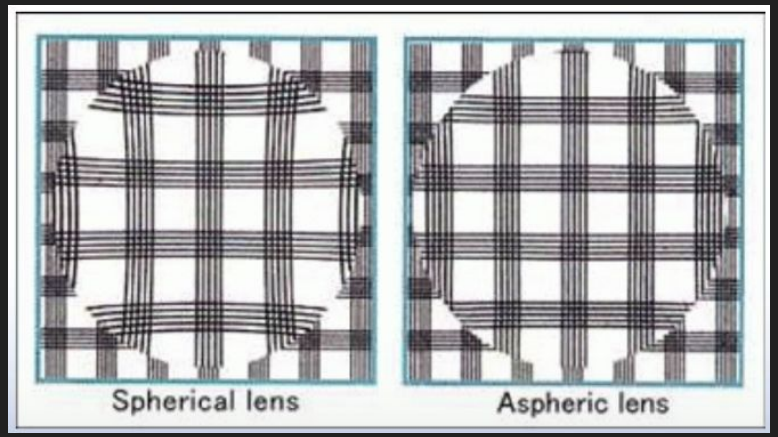
- Less in the center
- More on the periphery (for wide FOV)

Pincushion





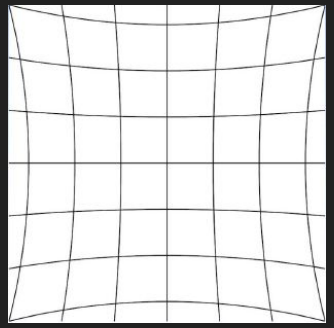
Barrel

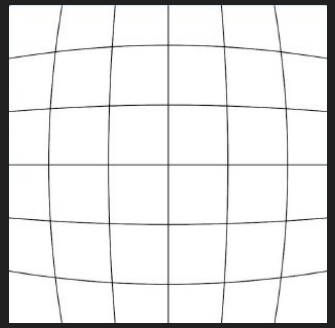


(Convex)

Optical Distortion Correction

Pincushion Distortion



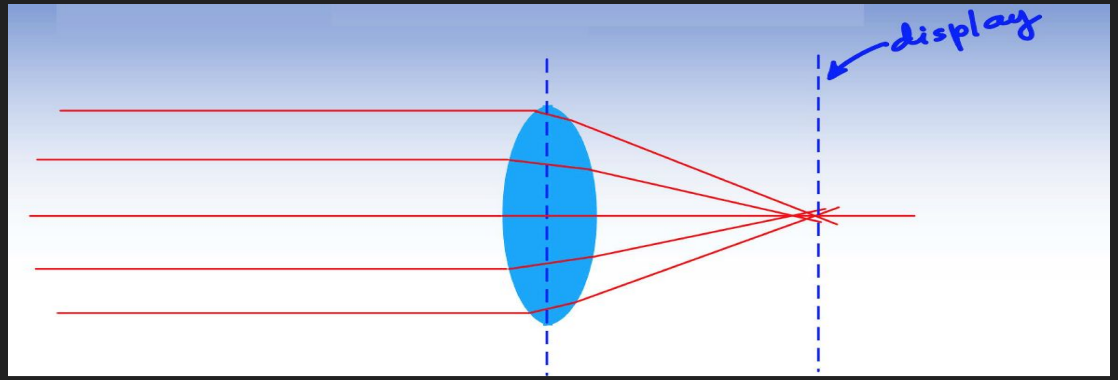


Barrel Distortion

Optical engineering challenges:

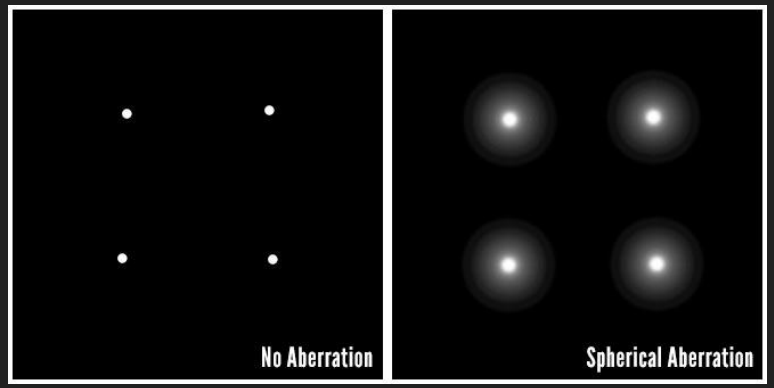
- Approximate lens distortion parameters
- Approximate the barrel-pincushion annihilation parameters
- How do you test the result? Do you trust your perception of parallel lines?

Spherical Aberrations

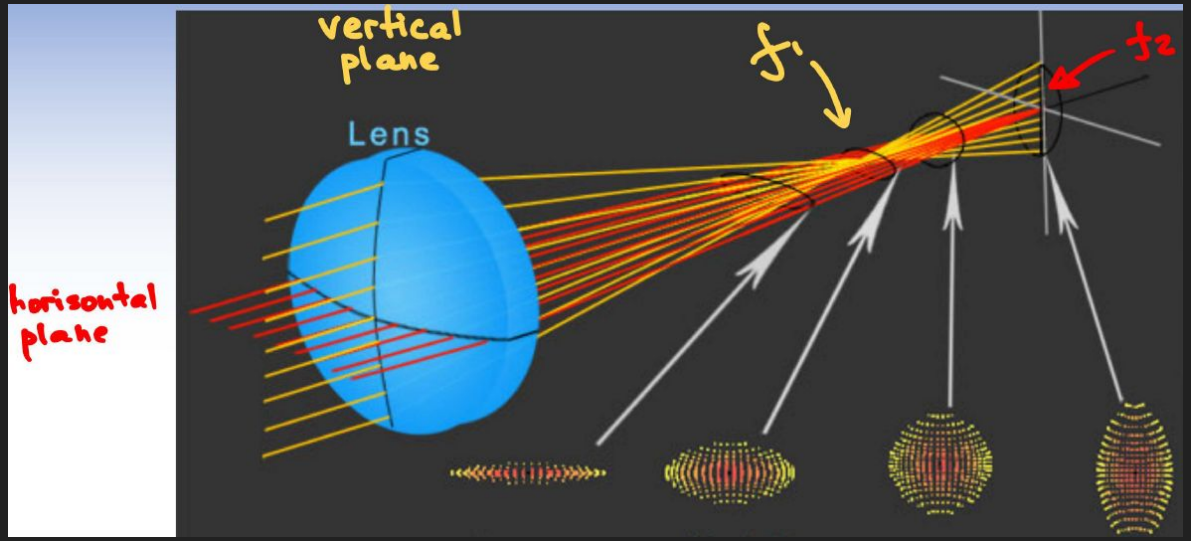


Spherical surfaces are the cheapest to manufacture!

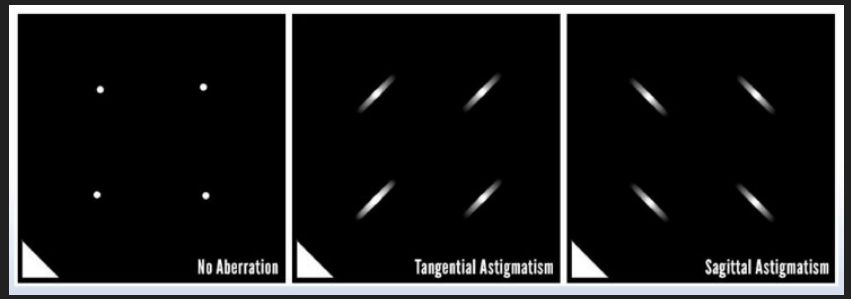
Solution: aspheres



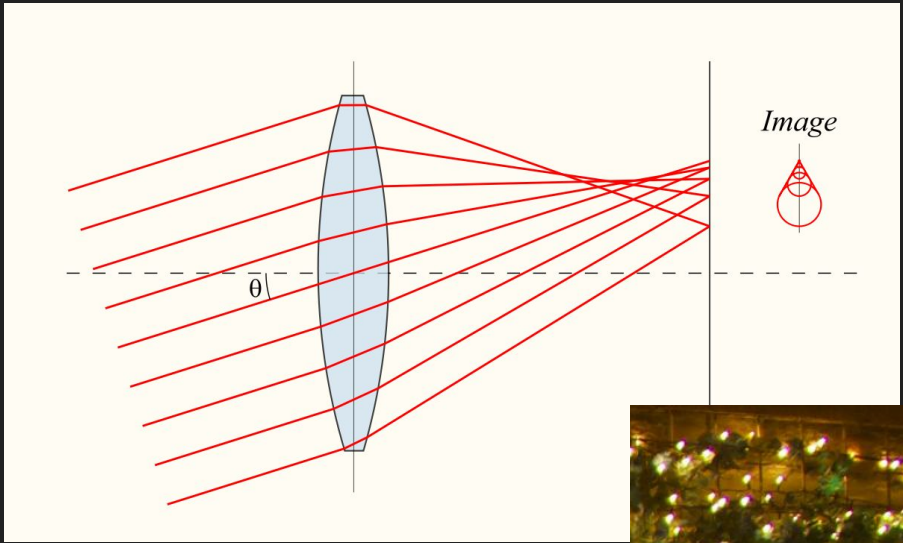
Astigmatism

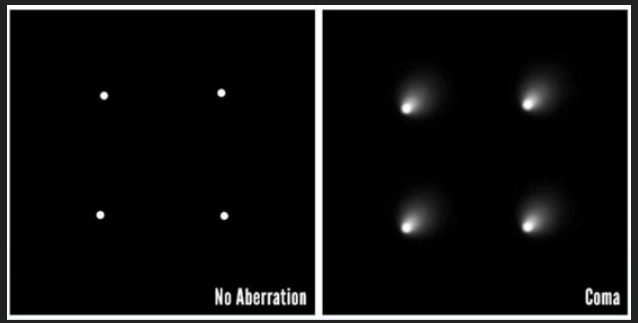


Fix?

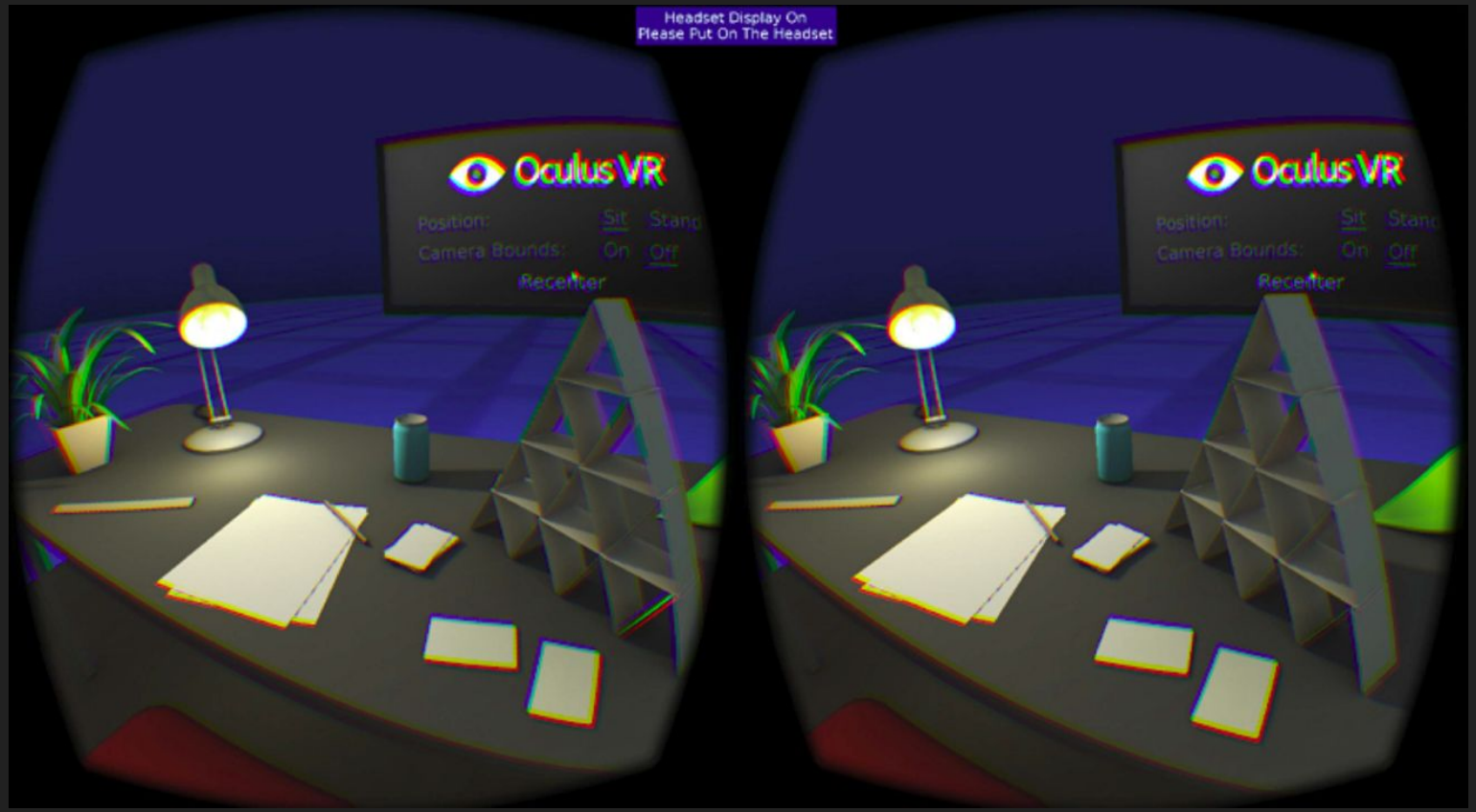


Coma

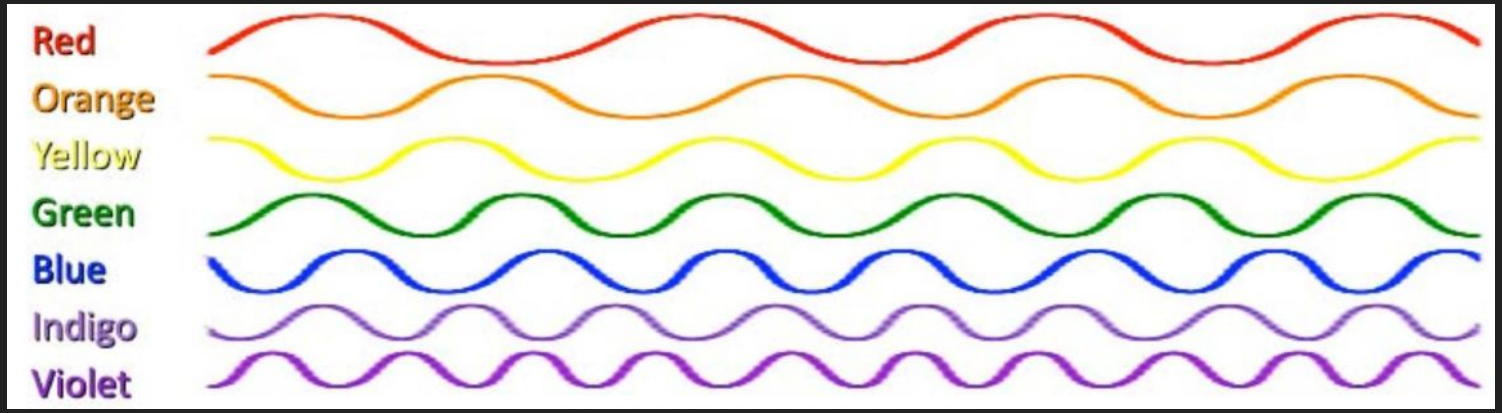


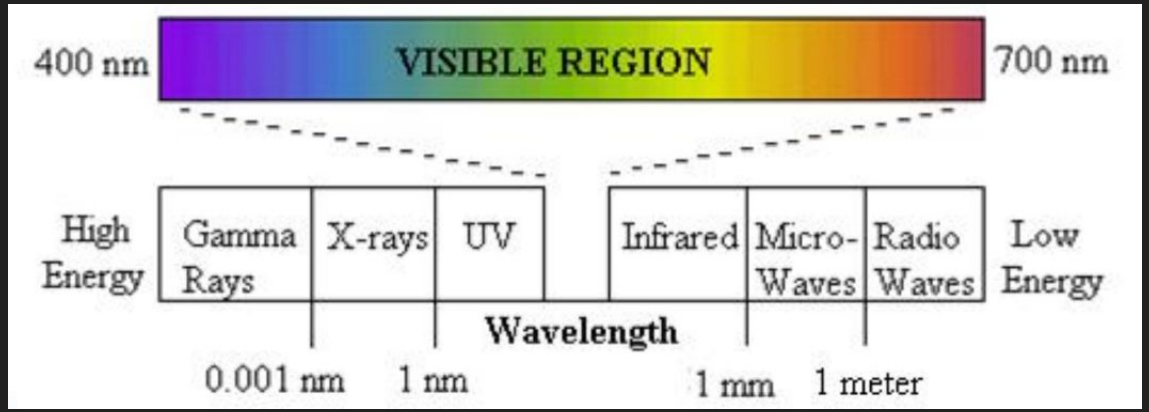


One More Issue



Electromagnetic vs. Visible Spectrum

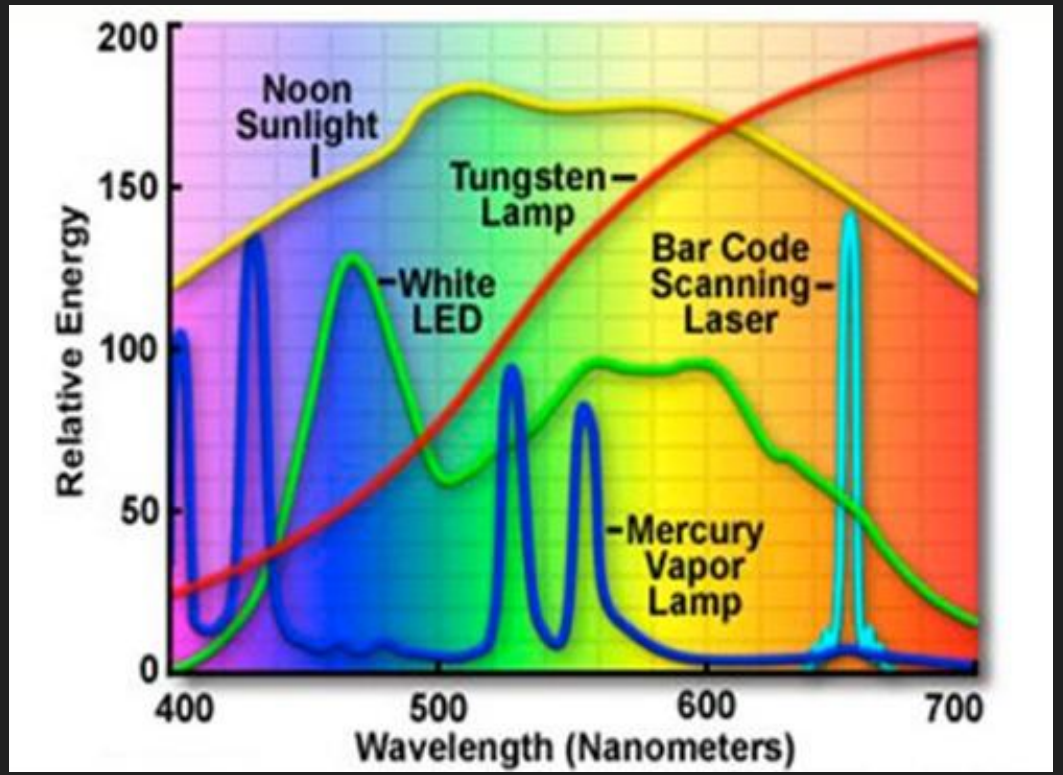


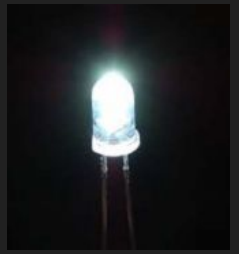


$$f = \frac{c}{\lambda}$$

Spectral Power of a Light Source

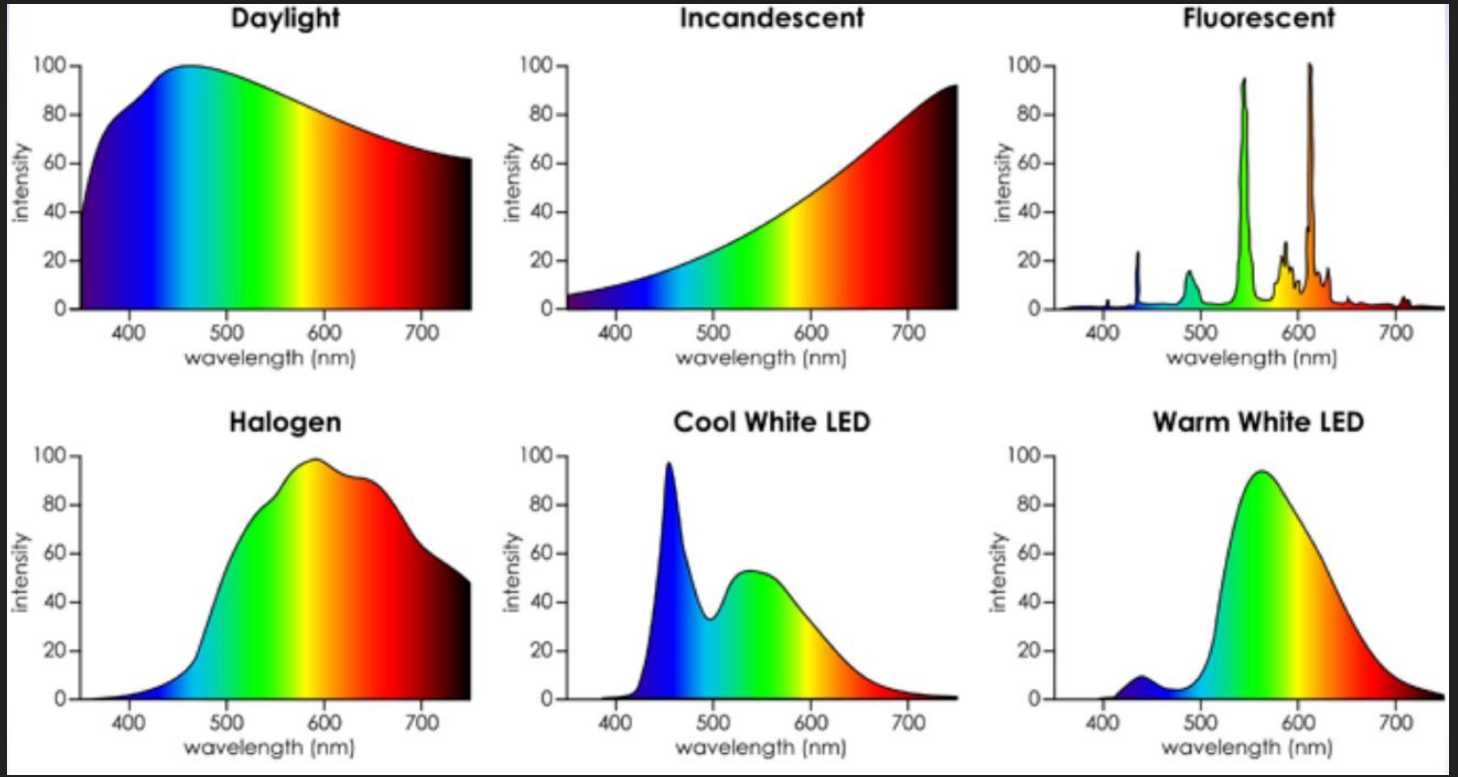
is like a histogram of _____



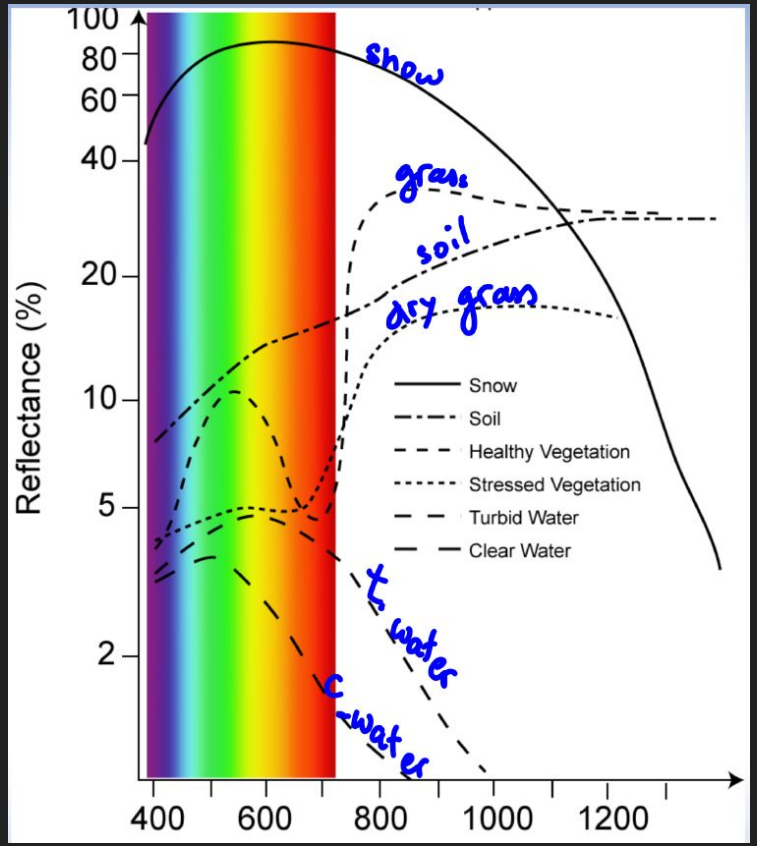


Spectral Power of a Light Source

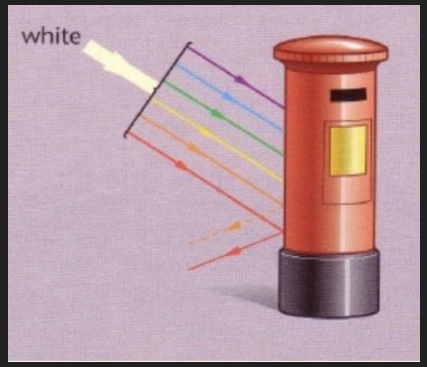
is like a histogram of _____

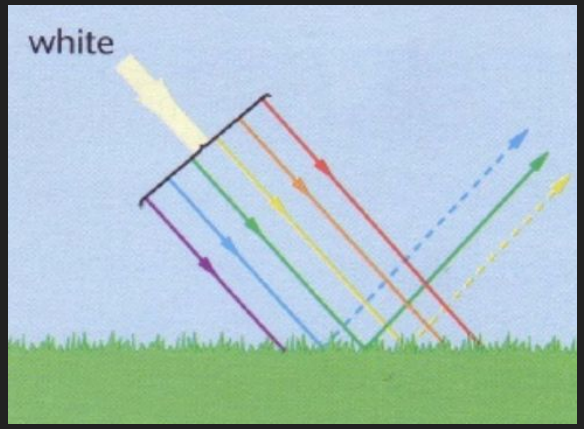


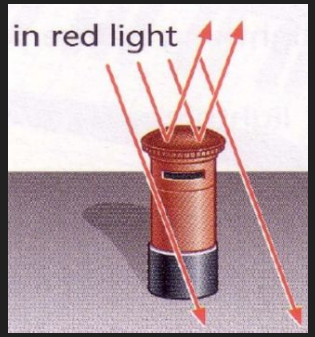
Spectral Reflectance of Material



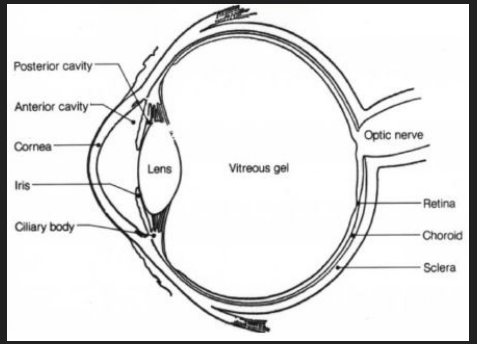
Perceiving Color of an Object

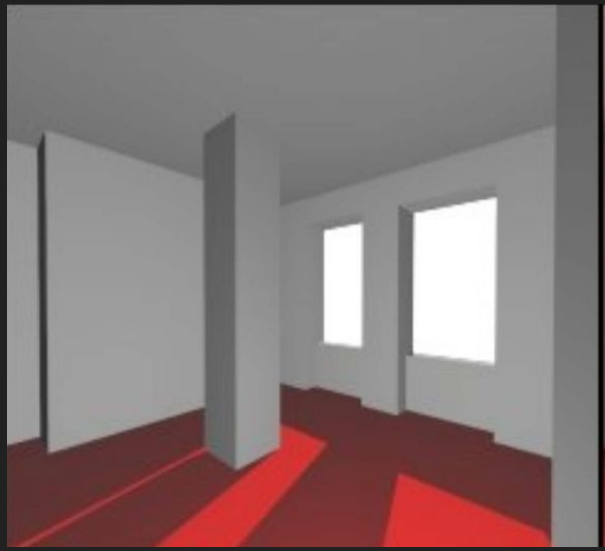




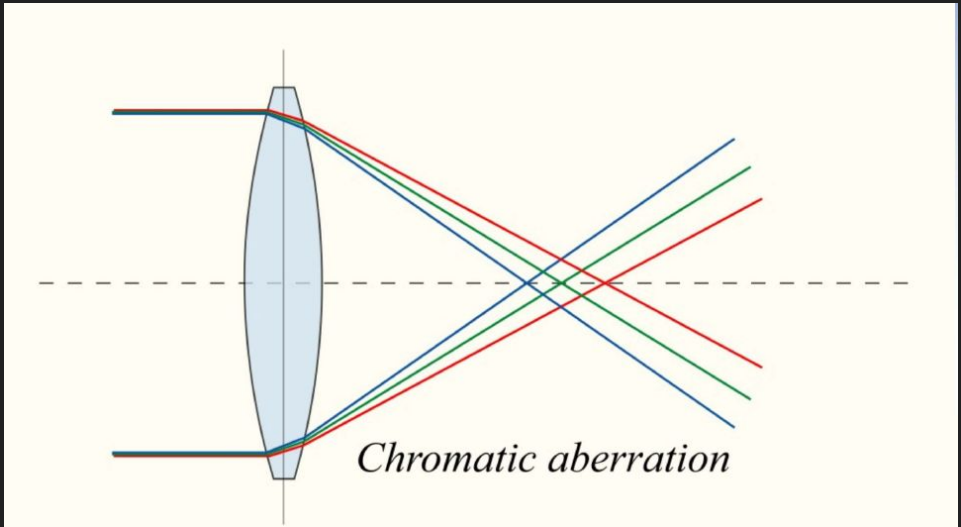


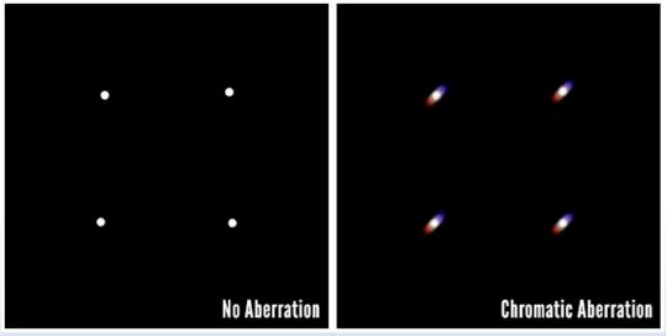
Spectral Power Models





Chromatic Aberration

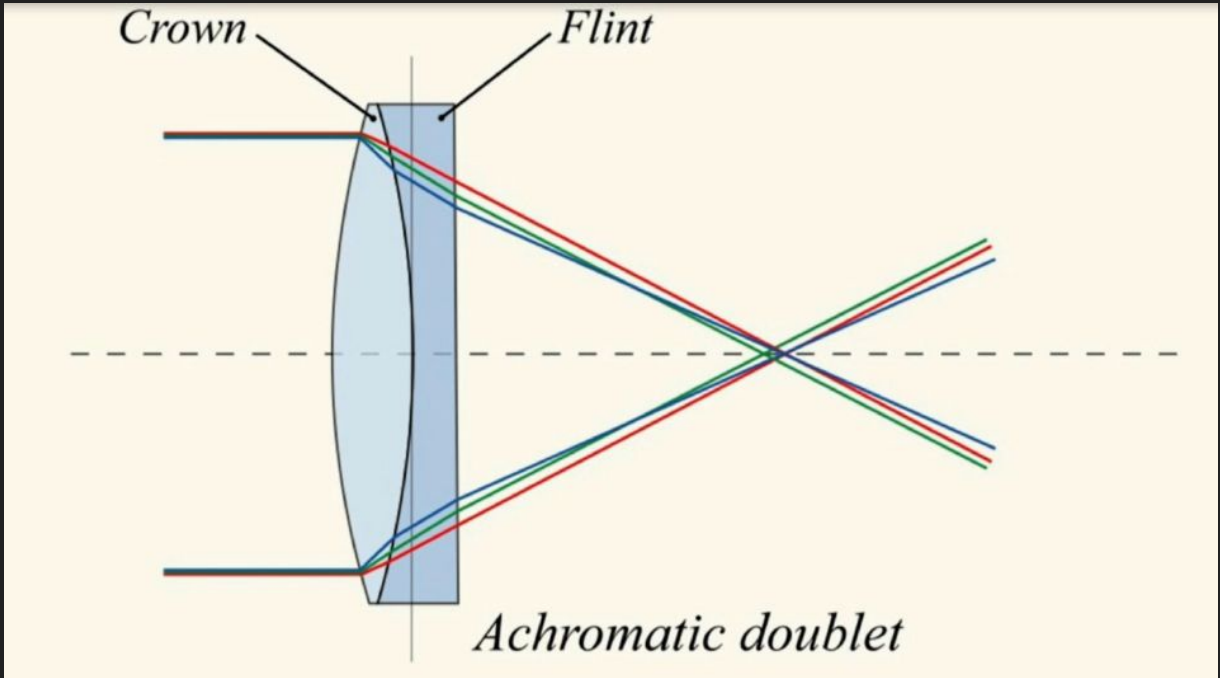




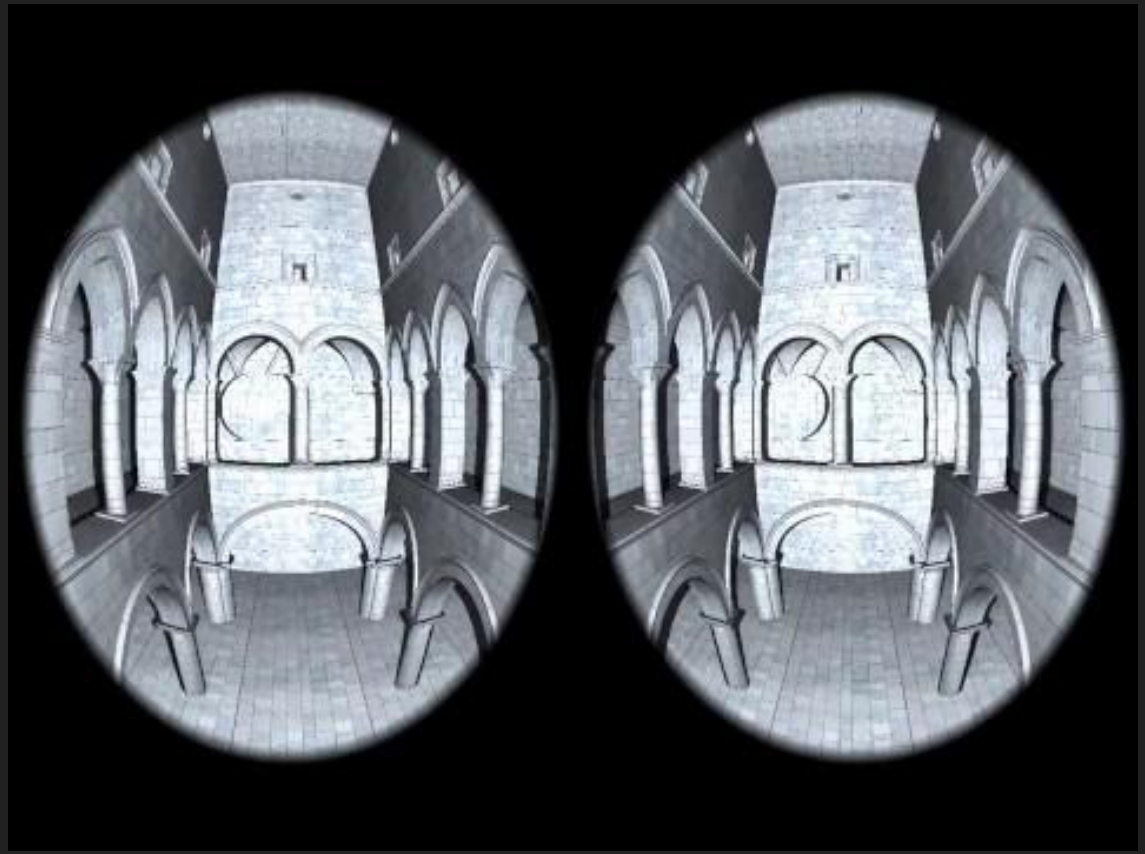
Chromatic Aberration Correction

- Find and use material with a high Abbe number

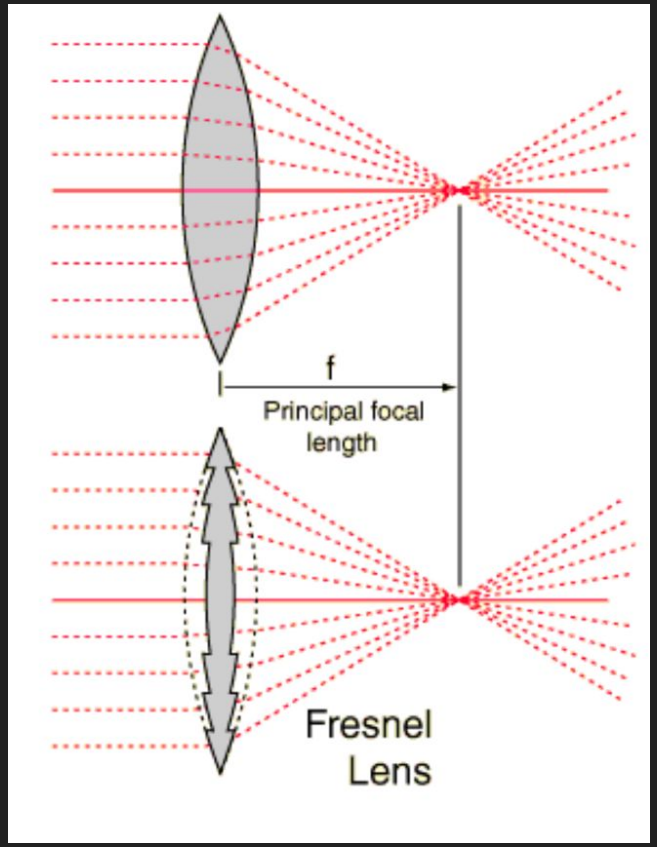
(Refractive index does not depend on wavelength)



Chromatic Aberration

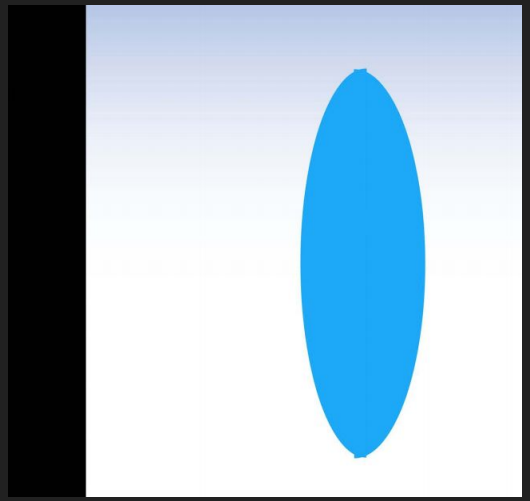


Reducing Weight and Cost: Fresnel Lens

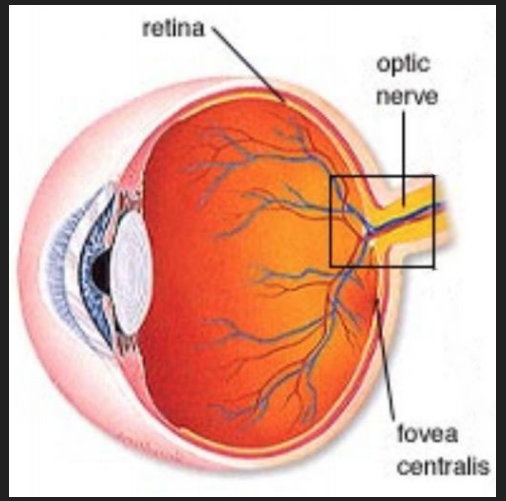


Imaging System Inside of a Human Eye

Output pixels: RGB



Input pixels: Photoreceptors



How Does Our Brain Piece Images Together?

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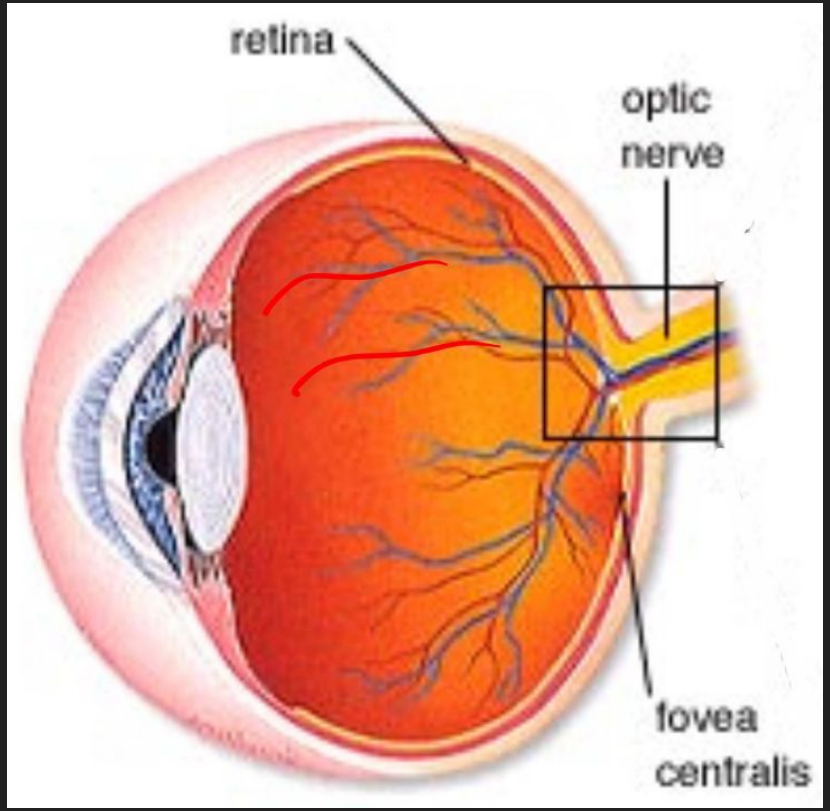
Peripheral Vision



Review

- What are the two main types of optical distortion?
- How can these two types of optical distortions be corrected: through hardware or software?
- Think about light rays in 3 dimensions. If the rays are off-axis in one dimension, but aligned in another, then what type of optical aberration will result?
- What is the main cause of Chromatic Aberration? (Why does it happen?)

Announcements

- MP 4 due March 26th - but start early!
  - Takes a long time to do & lab will be full closer to due date so start now!

- From now on, you will have mandatory weekly final project meetings - TA for your project will contact you

- Your attendance will be logged and work you completed will be kept track of. You could get a lower grade than the rest of your team if you don't contribute equally to the final project

Read LaValle, Chapter 4, 5