CS 498 VR

Lecture 12 - 3/5/2018

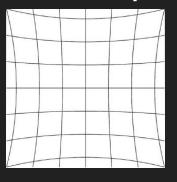
go.illinois.edu/VRlect12

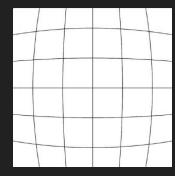
Review

 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?

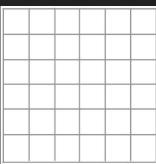
Optical Distortion





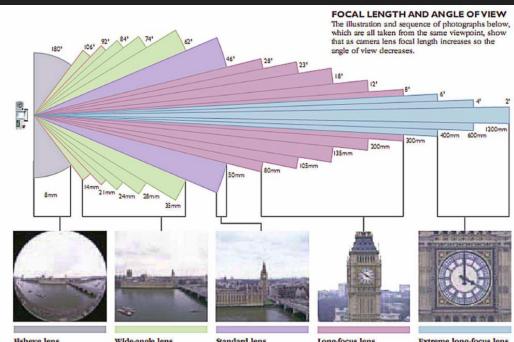
Do you notice problems? Blur? Color?

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



Hsheve lens

Extreme wide-angle lenses of 6-8mm are known as fisheves. They record a circular image of at least 180°, with some lenses even looking behind the camera with a 220° angle of view. The resulting image is very distorted, with vertical and horizontal lines bowed.

Wide-angle lens

Wide-angle lenses of 18-35mm have more general applications than fisheve lenses. Angles of view are generous and depth of field at all apertures is extensive. Poorquality wide-angle lenses may sometimes show some distortion toward the edges of the image.

Standard lens

A standard 50mm lens is fitted on most 35mm SLRs. Useful for most types of subject, it often has a wide maximum aperture. making it good in low light. It does not show the same distortion as a wide or long lens, and its angle of view is similar to that of the human eye.

Long-focus lens

Angles of view of longfocus lenses of 80-400mm start to diminish rapidly. With so little of the scene filling the frame, the subject is shown very large, making a long lens ideal for distant subjects or detailed close-ups. Depth of field decreases as the lens gets longer.

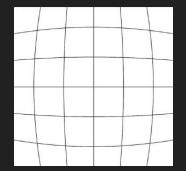
Extreme long-focus lens

Focal lengths above 400mm are specialized and are not usually found on standard zooms. The use of a tripod to support the lens is essential because of its relatively heavy weight. A long lens has a shallow depth of field and a small maximum aperture.

Trade-offs:

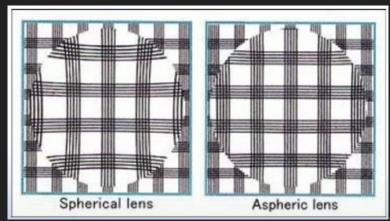
- Size
- Weight
- Focal length
- Field of view
- Distortion
- Cost of materials
- Ease of manufacturing

Optical Distortion



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

Barrel



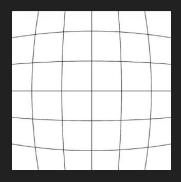


(Convex)

Pincushion

Optical Distortion Correction

Pincushion Distortion

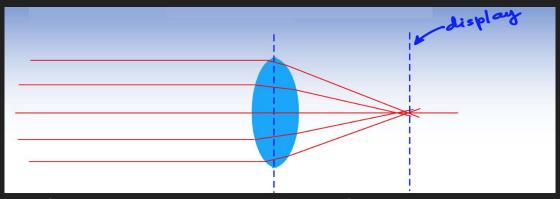


Barrel Distortion

Optical engineering challenges:

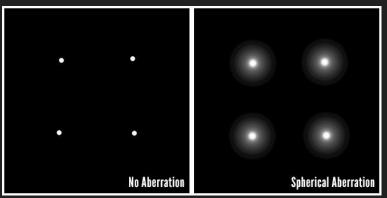
- Approximate lens distortion parameters
- Approximate the barrel-pincushion annihilation parameters
- How do you test the result? Do you trust your perception of parallel lines?

Spherical Aberrations



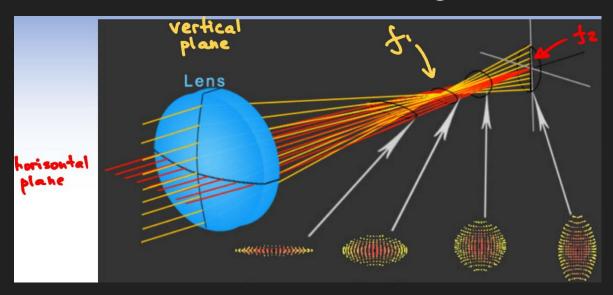
Spherical surfaces are the cheapest to manufacture!

Solution: aspheres





Astigmatism



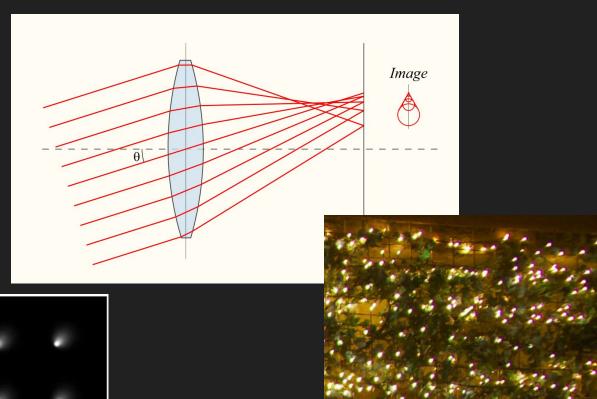
Fix?



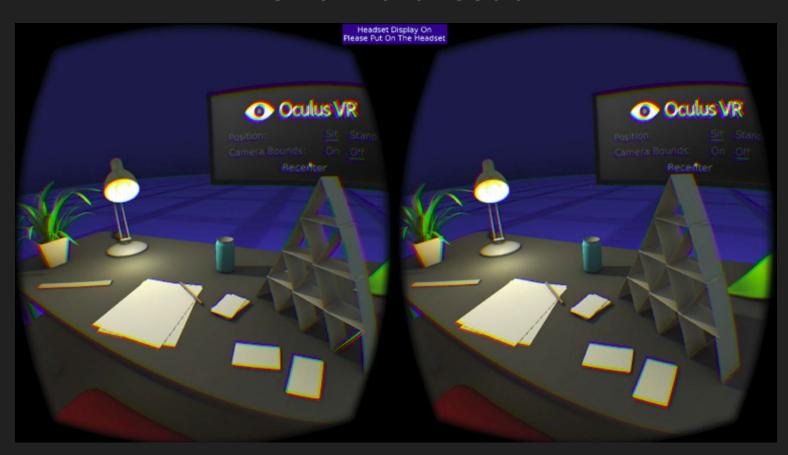


Coma

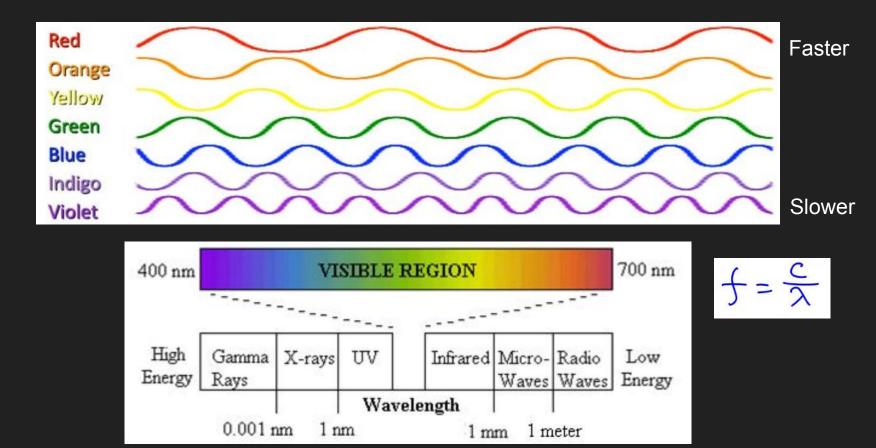
No Aberration



One More Issue



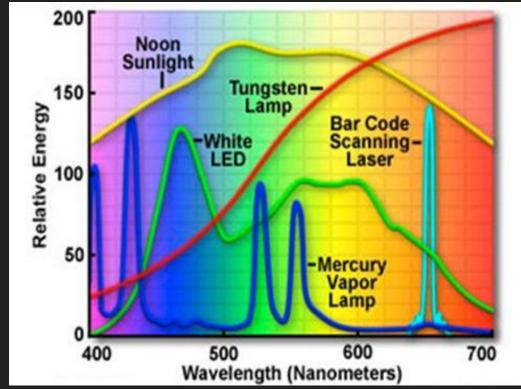
Electromagnetic vs. Visible Spectrum



Spectral Power of a Light Source

is like a histogram of _____





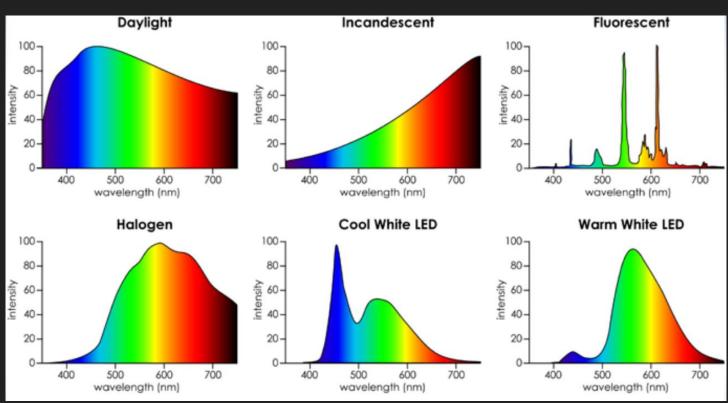




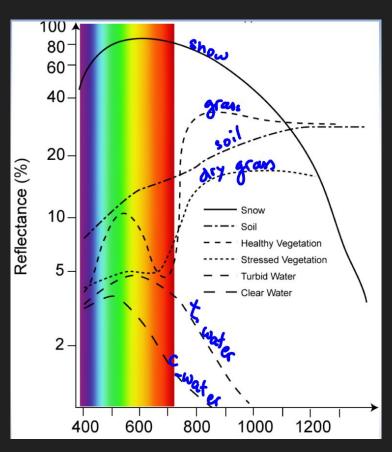


Spectral Power of a Light Source

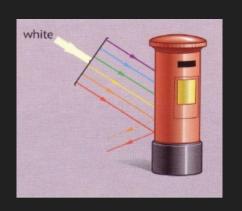
is like a histogram of _____

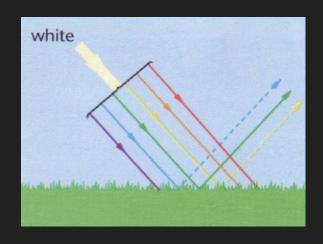


Spectral Reflectance of Material

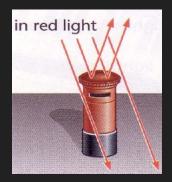


Perceiving Color of an Object





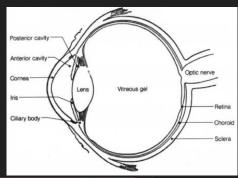






Spectral Power Models

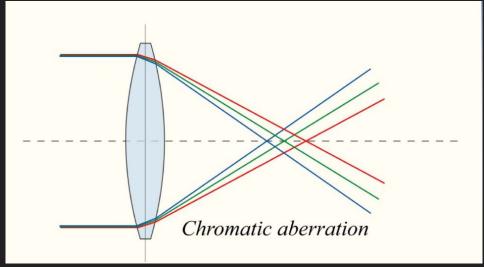








Chromatic Aberration

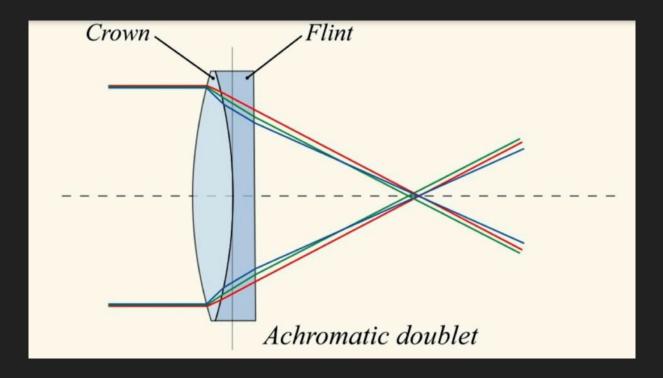






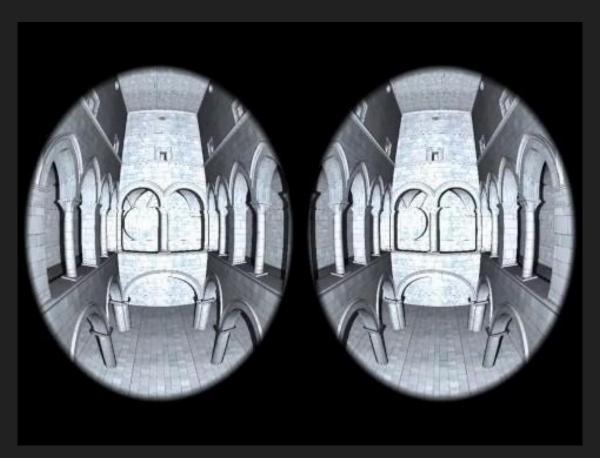
Chromatic Aberration Correction

Find and use material with a high Abbe number

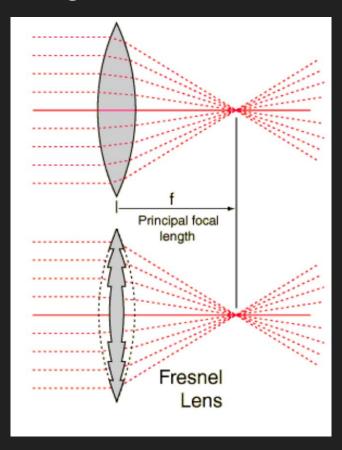


(Refractive index does not depend on wavelength)

Chromatic Aberration

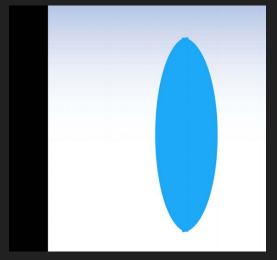


Reducing Weight and Cost: Fresnel Lens



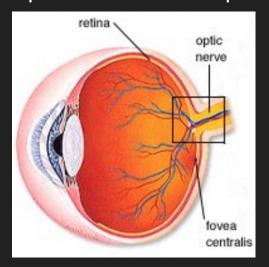
Imaging System Inside of a Human Eye

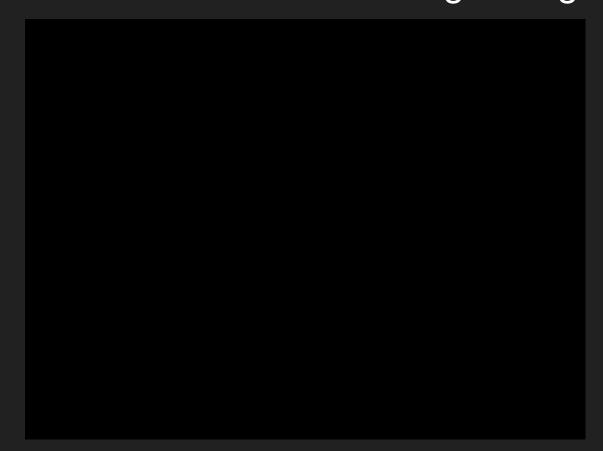
Output pixels: RGB





Input pixels: Photoreceptors



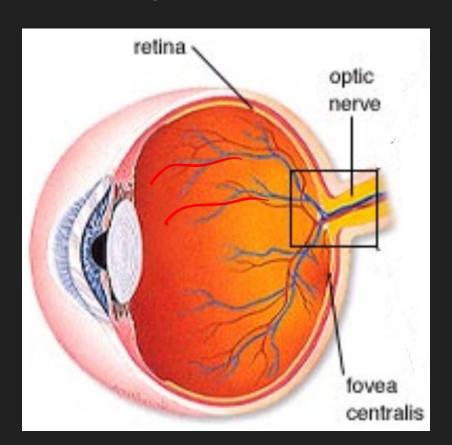








Peripheral Vision



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 <u>attendance will be logged</u> and <u>work you</u>
 <u>completed will be kept track of</u>. 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

