Reviews from last lecture

- List all possible light models
  - Do rays converge or diverge?
- Why do we use Snell’s Law?
Imaging Properties of a Lens

f depends on: shape, material property

\[ D = \frac{1}{f} \]
Structure of the Human Eye

What is the diopter of the human eye?
Structure of the Human Eye

- Image surface (non-planar)
- Light rays
- Lens (variable focal depth)
- Cornea (powerful lens but fixed focal depth)
Optical Power of the Human Eye

1. $n_1 = 1.009$ (air)
2. $n_2 = 1.376$ (cornea)
3. $n_3 = 1.336$ (aqueous fluid)
4. $n_4 = 1.413$ (lens)
5. $n_5 = 1.337$ (vitreous fluid)

Figure 4.25: A ray of light travels through five media before hitting the retina. The indices of refraction are indicated. Considering Snell’s law, the greatest bending occurs due to the transition from air to the cornea. Note that once the ray enters the eye, it passes through only liquid or solid materials.
Imaging Properties of a Lens

How far should a point be from the lens to produce parallel rays?
\[ \frac{1}{S_1} + \frac{1}{S_2} = \frac{1}{f} \]
Imaging Properties of a Lens

Do the formula still work for parallel rays?

\[ \frac{1}{s_1} + \frac{1}{s_2} = \frac{1}{f} \]
Imaging Properties of a Lens

Object is at distance ____ f, its “real image” is in focus at distance ____ f.
Object is at distance _____ f, its “real image” is ______ focus.

The “virtual image” is formed at distance ________________.
Examples of Use Cases
Examples of Use Cases
Structure of the Human Eye

The diopter of the human eye is about ____.
Eye lens is not ____________.
Retina (and retinal image) is not _____.
Ciliary muscle has the ability ________________
_____________________(lose at age ≈ 40).
Optic nerve forms ____________________.

Assume the person has no vision defect.
Imaging System Inside of a Human Eye

The eye muscle is __________.
Object is at ___ Rays are ______
Rays ___ get converged ___ retina.
The image is __________.
Imaging System Inside of a Human Eye

The eye muscle is ________.
Object is at ___________ Rays are __________.
The rays _______ get converged on retina.
The image is __________.
Imagine Properties of the Human Eye

How strong are your eye muscles?

How far can an object be so you can focus on it?

- $X > 30\text{cm}$
- $X = 20 - 30\text{cm}$
- $X = 10 - 20\text{cm}$
- $X = 5 - 10\text{cm}$
- $X = X < 5\text{cm}$
The eye muscle is _______.

Object is at ____________ Rays are ___________.

The rays _____ get converged ___ retina.

The image is ________.
Vision Defects of a Human Eye

- Relaxed muscles
- Objects at infinity

Hard to diagnose
The eye muscle is ________.
Object is at _______________
Rays are ________________.
The rays ____ get converged ____ retina.
The image is ______.
Imaging System Inside of a Human Eye

Accommodation: the process of "zooming in", focusing on a nearby object.

Accommodation is normally coupled with...
Imaging System Inside of a Human Eye

The eye muscle is ________.
Object is at ___________ Rays are _________.
Rays _____ get converged __________________________ retina.
Lens Aberrations

Trade off:
- Size
- Weight
- Focus length
- Field of view
- Distortion
- Cost
- Ease of manufacturing
Recap from today lecture

- How does an image appear on the retina?
  - Is it a real image or virtual image?

- Is the human eye a concave or convex lens?
  - After light rays pass through a convex lens, what does the focus distance depend on?
Announcements

- MP 2.2-2.4 was due before this lecture!
- MP 3 & 4 are posted!
- Teams for final projects are posted!
- Details for the 4th credit hour assignment are posted!

- Read Ch. 4 & 5.1