Human Visual System

Caveat: This lecture is not like most of the course

Computer Vision I
CSE 252
Lecture 2

Announcements

• Web page is up at http://cseweb.ucsd.edu/classes/fa13/cse252A-a
• Questions on Syllabus?
• Office hours Tuesday at 1:30-2:30
• Assignment 0: “Getting started with Matlab” is posted to the web page and is due on Thursday
• Wait list – still working on it.
  • If you decide that you’re not going to take the class, please drop to make room for others.
• Read:
  – Chapters 1 & 2 of Forsyth & Ponce

About working together

• You may work together on homework assignments to discuss ideas and methods, however what you turn in should be your own work and any code should be your own coding. Copying is not permitted.

Ways to study human vision

1. Physiological
2. Phenomenological/Psychophysical
3. Cellular recordings
4. Functional MRI
5. Computational modeling

Physiological level
What does this do? Can we readily understand whole from understanding pieces?

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Psychophysical Testing of Subjects
Example: Show gratings w/ different spatial frequencies

Gradients/Motion
Perceptual Organization
Occlusion provides a different organization
Ways to study human vision

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Single Cell Recordings

fMRI

Activation in the right fusiform gyrus.
[Tarr, Cheng 2003]

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Computational Modeling

What is being computed and why?
Structure of the eye

**Rods and cones**

Cones

Distribution of Rods & Cones

**The range of lighting**

Three types of cones: R,G,B

Response of k'th cone = \( \int \rho_k(\lambda)E(\lambda)d\lambda \)

There are three types of cones:
- S: Short wave lengths (Blue)
- M: Mid wave lengths (Green)
- L: Long wave lengths (Red)

• Three attributes to a color
• Three numbers to describe a color

Retina edge on
Retinal Neuron

Bipolar Cell

Ganglion

5.2 RETINAL NEURONS. There are many different types and sizes. The cell body of a bipolar cell consists of the inner nuclear layer. Its dendrites make contact with the photoreceptors to collect visual information, whereas its axons, which emerge from the inner plexiform layer, project to the ganglion cells of the retina (layer 4). The retinal ganglion cells form a lattice of the ganglion cell layer of the retina (layer 4). This lattice structure is responsible for the image formation in the retina. The ganglion cell layer contains the axons of all the ganglion cells, which eventually converge on the optic nerve (layer 1). The ganglion cell axons then project to the brain where they make contact with the visual cortex, which processes the information to form an image.

Other Eyes

Trilobite Visual System

- Most ancient known visual system.
- Compound eye with single crystal for each lens.

Electron Micrograph of Holochroal eye

Good trilobite eye info at: http://www.aloha.net/~smgon/eyes.htm

Scallop eyes

- Hundreds of primitives eyes, mirror in back
- Changes in light and motion and very rough images are registered on the retinas of the mollusk.
- Nice material at: http://soma.npa.uiuc.edu/courses/bio303/Ch11b.html

Stomatopod eyes

- Dumb bell shaped, compound eyes (next slide)
- Stereo vision with just one eye;
- Each eye is up on a stalk, with a wide range of motion;
- Stomatopods have up to 16 visual pigments stomatopods can see ultra-violet and infra-red light
- some can see polarized light.
- See http://www.ucmp.berkeley.edu/aquarius/

Mantis Shrimp

Trinocular vision
Visual Pathways

Single Cell Recordings

What: Recognition, Object representation
Where: Location & Motion, control

CUES

Fixate at center
What color are the dots

Shading Cues
Subjective Contours
Kanizsa’s Triangle

Which square is darker?