Human Visual System

Computer Vision I
CSE 152
Lecture 2

Ways to study human vision
1. Physiologically
2. Phenomenological/Psychophysical
3. Cellular recordings
4. Functional MRI
5. Computational modelling

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

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

Structure of the eye

The range of lighting

Electronic images

Direct sun 100,000 Lux
Sunny day 50,000 Lux
Cloudy day 5,000 Lux
Office 400 Lux
House lighting 10 Lux
Street lamps 1 Lux
Full moon 0.1 Lux
Quater moon 0.01 Lux
Clear moonless night 0.001 Lux
Cloudy moonless night 0.0001 Lux
Three types of cones: R, G, B

Response of k'th cone = \[ \int p_k(\lambda)E(\lambda)d\lambda \]

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
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
- 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 also see ultra-violet and infra-red light, and some can even see polarized light.
- See http://www.ucmp.berkeley.edu/aquarius/

Visual Pathways

Single Cell Recordings
What:
Recognition, Object representation

Where:
Location & Motion, control

Fixate at center
What color are the dots

Subjective Contours
Kanizsa’s Triangle

Shading Cues

Which square is darker?
Which square is darker?

Fraser’s Spiral

Context

Context: Whose faces do you see?
A picture of a man

In this shot, what is his facial expression?

In this shot, what is his facial expression?

Thatcher illusion

Hidden Human Face