Human Visual System

Computer Vision I
CSE 252A
Lecture 2

Announcements

• Assignment 0: “Getting Started with Matlab” is posted to the web page

Ways to study human vision

1. Physiologically
2. Phenomenological/Psychophysical
3. Cellular recordings
4. Functional MRI
5. Computational modelling

Physiological level

What does this do?

Can we readily understand whole from understanding pieces?
Ways to study human vision

1. Physiologically
2. Phenomenological/Psychophysical
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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]

Ways to study human vision

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Computational Modeling

What is being computed and why?

Structure of the eye
The range of lighting

<table>
<thead>
<tr>
<th>Condition</th>
<th>Lux</th>
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</thead>
<tbody>
<tr>
<td>Direct sun</td>
<td>100000</td>
</tr>
<tr>
<td>Sunny day</td>
<td>50000</td>
</tr>
<tr>
<td>Cloudy day</td>
<td>5000</td>
</tr>
<tr>
<td>Office</td>
<td>400</td>
</tr>
<tr>
<td>Home lighting</td>
<td>10</td>
</tr>
<tr>
<td>Street lamps</td>
<td>1</td>
</tr>
<tr>
<td>Full moon</td>
<td>0.1</td>
</tr>
<tr>
<td>Quarter moon</td>
<td>0.01</td>
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<tr>
<td>Clear moonless</td>
<td>0.001</td>
</tr>
<tr>
<td>Cloudy moonless</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

Rods and cones

Rods & Cones

Color Matching Functions

Retina edge on
Retinal Neuron

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 mollusc.
• 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
Shading Cues

Which square is darker?

Context: Whose faces do you see?

Subjective Contours
Kanizsa’s Triangle
Fraser’s Spiral

Fixate at center
What color are the dots

A picture of a man

In this shot, what is his facial expression?

In this shot, what is his facial expression?