CS510: Image Computation

Ross Beveridge

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Class Goals

• Prepare you to do research in computer vision
  – Provide “big picture” (comparison to humans)
  – Give you experience reading papers
  – Familiarize you with SOA methods/algorithms
  – Familiarize you with open problems
  – Familiarize you with experimental methodology
Vision Group Snapshot 2

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Administrivia

• Programming assignments (40%)
  – At least 6 (hopefully 7)
  – Roughly every two weeks
  – Large assignments – teams of 2 or 3
  – Assignments build on each other
    • A single project

• Tests (40%)
  – 2 tests
  – Midterm and Final – equal weight.
**Administrivia (II)**

- **Readings**
  - Ungraded
  - Emphasized on tests
  - Make connections to project presentations
- **In class presentations (~10%)**
  - Details may vary by team (size, etc.)
  - Relate projects to readings, class lectures
- **Class web site:**
  [http://www.cs.colostate.edu/~cs510](http://www.cs.colostate.edu/~cs510)
  - Progress page has lectures & reading assignments
  - Assignments page has assignments
  - CANVAS used for grades, submissions, exams
Misconceptions about Vision

• Vision is passive
  – Bad metaphor: video recorder
  – Better metaphor: blind-folded touch

• Vision is 3D
  – Bad metaphor: 3D sensor
    • E.g. Kinect, ladar range finder, etc.
  – Better metaphor: theater with backdrop
Illusions

Kanizsa Triangle
Illusions

What's wrong with this picture?
Why Illusions?

• What do these illusions tell us?
  – Vision (sensing) is active
  – We select what we attend to
  – We construct percepts from what we sense

• What is the lesson for artificial vision?
  – Must actively seek information
  – Must be “like people”
Input: The Eye(s)

Start at the beginning:
• Lens focuses light
• Iris serves as aperture
• Retina contains receptors
• Optic nerve transmits to brain

Gaze, lens, iris are controlled by muscles under the control of the brain

Retina as Processor

• Five cell types:
  • receptor (rod/cones) *Species dependent*
  • horizontal
  • bipolar cells
  • amacrine cells
  • ganglion cells

• Its inside out!
• Blind spot where optic nerve passes through retina
Fields of View & Stereo

- Right hemisphere receives the left visual field from both eyes
  - And vice-versa
  - Splitting the field of view supports disparity computations

- High resolution in fovea, lower elsewhere
  - Fovea is $\pm 2^\circ$ (thumbnail at arms length)
Projections (LGN & S.C.)

Primary Visual Cortex (V1)

- First cortical visual area
  - Columnar (like all cortex)
- Retinotopically mapped
- Ocular dominance columns
- Edges (Gabor filters), color, disparity & motion maps
- Connects to other retinotopic areas (V2, V3, MT)

http://webvision.med.utah.edu/imageswv/capas-cortex.jpg
Proof of Retinotopic Mapping

Pattern flashed (like a strobe) in front of monkey injected with sugar dye

Left primary visual cortex of the same monkey

V1 is the starting point of cortical visual processing.

Dorsal projections lead to somatosensory and motor control areas.

Ventral projections lead toward associative memories.
Anatomical Maps of Visual Cortex

1983 Version

1990 Version
Visualizing Two Subsystems

A Model of Human Vision

Information Shunting

Associative Memories

Spatial Properties Processing

Object Properties Processing

Attention Shifting

Visual Buffer

Attention Window

S. Kosslyn, 2006
Again...

- Attention Shifting
- Information Shunting
- ST Associative Memory
- LT Associative Memory
- LT Associative Memory
- Object Properties Processing
- Attention Window
- Spatial Properties Processing
- Visual Buffer
- Attention Shifting

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