Class Goals

• Prepare you for computer vision research
  – Provide “big picture” (comparison to humans)
  – Give you experience reading papers
  – Familiarize you with SOA methods/algorithms
  – Familiarize you with open problems
  – Build real interactive systems
Vision Group Snapshot 2

Collaboration Using Speech, Gesture and Sight

Teaching Mode

June 2018

Colorado State University
Administrivia

• Programming assignments (50%)
  – At least 5 (maybe 6)
  – Roughly every two weeks
  – Programming teams of 2
  – Some assignments build on each other
  – Often grading based on demonstration

• 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, Echo
Programming Projects - Glimpse
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

Gaze, lens and iris are controlled by muscles under the control of the brain
Retina as Processor

- Five cell types:
  - receptor (rod/cones)
  - horizontal
  - bipolar cells
  - amacrine cells
  - ganglion cells

- Its inside out!
- Blind spot where the optic nerve passes through retina

*S. Palmer. Vision Science. P. 30*
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 ±2° (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 Connections

V1 is the starting point of cortical visual processing.

Dorsal projections lead to somatosensory and motor control areas.

Ventral projections lead toward associative memories.

From Van Essen 1992. Image can be found at http://webvision.med.utah.edu/images/swv/Visual-Cortex1.jpg
Anatomical Maps of Visual Cortex

1983 Version

1990 Version
Visualizing Two Subsystems

A Model of Human Vision

Information Shunting → Attention Shifting

Associate Memories

Spatial Properties Processing

Object Properties Processing

Visual Buffer

Attention Window

S. Kosslyn, 2006
Again ...