Human–Centered Computer Graphics

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(with slides from Reynold Bailey, RIT)
Introductions

• Find a partner – you will introduce that person and he/she will introduce you
  – Name
  – Year
  – Major/Department
  – Fun fact
Information

• You are registered for CIS4930 (097B) or CIS6930 (01EE)
• Class times: Tuesday Period 7 (1:55-2:45pm), Thursday Period 7-8 (1:55-3:50pm)
• Location: FAB 0105
• Prerequisites: COP 3530 (Data Structures and Algorithms), CAP 4730 (Computer Graphics) or equivalent, OR, CAP 5100 (Human Computer Interaction) or equivalent. If you don't meet the prereqs, please email the instructor to discuss.
• You should be comfortable programming in a language of your choice.
• Instructor: Dr. Eakta Jain
  - ejain@cise.ufl.edu
  - Office: E540
  - Office hours: Tuesday 2:45-3:45 in E540
• Course TA: You Zhou (Your first point of contact.)
  - youzhou@cise.ufl.edu
  - Office hours:
Grading

- Homework (20 points)
- Project (50 points)
  - Proposal (10 points)
  - Mid-term presentation (10 points)
  - Final movie (30 points)
  - Best project by class vote (Extra Credit 5 points)
- Research Paper Presentation (14 points)
- Study Participation (10 points)
  - 2 points per study
  - Can get up to 4 points Extra Credit if you would like to do additional study participation
- Class Participation (6 points)
  - Ask a question at a research paper presentation (2 points)
Central Idea: Human-centered Algorithms

User → Idea → Computer Graphics → Creation → Viewer

(Physics, Mathematics, Algorithms,...)

Challenge: Humans are inexact.
Human Visual Perception in Art

• Traditional Artists:
  – Little knowledge of inner workings of human visual system.
  
  – Able to create sense of depth and motion on flat static surfaces.
  
  – They view the human visual system as a black box. Through experimentation, they learned to exploit its features.
  
  – In a sense, they have reverse engineered the human visual system to learn what type of inputs elicit certain responses in the brain.
Knowledge About Human Visual System

• We now have a much better understanding of inner workings of human visual system:
  – Extensive research from various fields of science:
    • Physics
    • Biology
    • Psychology
    • Physiology
    • Neuroscience

  – In–depth studies of visual system of macaque
Knowledge About Human Visual System

• The visual system is far from being fully understood, but the knowledge gained thus far is quite substantial:
  – Especially of the early stages of the visual pathway.
Knowledge About Human Visual System

• The oldest theories about vision, light, and the eye date back to the early Greek philosophers.
  – Empedocles (490 – 430 BC)
  – Plato (428 – 348 BC)
  – Aristotle (384 – 322 BC)
  – Ptolemy (367 – 283 BC)
  – Euclid (325 – 265 BC)

• Their speculation about vision tended to be egocentric.

• They believed that the eyes produced rays which interacted with objects in the environment to facilitate vision.

• These theories persisted for several centuries.
Knowledge About Human Visual System

Earliest known diagram of the eye shows an area designated as the visual spirit.
Knowledge About Human Visual System

• Scientific study of vision did not begin until the start of the Enlightenment Period in the early 17th century.

• Why did it take so long?
  – Speculative and egocentric theories did not encourage scientific study.
  – Much of Europe was ravaged by poverty, plagues, and religious wars during the Middle Ages.
    • 5th century – 15th century
Historical Perspective

- **Speculation by early Greek philosophers:** Plato, Aristotle, Empedocles
- **Scientific study of vision begins:** 1604 – First explanation of the optics of the eye, 1666 – Newton prism experiments begin color science
- **The age of the computer:** 1946 – First programmable computer (ENIAC), 1960 – The term “computer graphics” is coined, 1961 – First video game (Spacewars)

Interest in the role of perception in computer graphics:
- Mid 90's to present – Advances in virtual reality, head-mounted display systems and eye tracking technology.
Broad Topic Areas

- Perceptual Studies
- Eyetracking
- Motion Capture
- Crowdsourcing
- Social Saliency
- You are allowed to suggest topics
  – Bonus topics!
Historical Perspective

- **Vision research**
- **Computer age**
- **Applied visual perception in computer graphics**
Theories about visual perception from early Greek philosophers

First microscopic observation of the retina

Young proposes three receptor theory of color vision

Hering proposes opponent theory of color vision

First random dot stereogram published

400 BC

First explanation of the optics of the eye

1600

Middle Ages: little done to advance understanding of vision

1650

Newton’s Opticks published

1700

Newton’s prism experiments: the field of color science is born

1750

Luminance and contrast thresholds measured

1800

Wheatstone invents the stereoscope

1850

First recording of electrical activity in optic nerve

1900

Stroboscopic movement discovered

1950

First complete description of retinal neuroanatomy

2000

Spatial maps of cone inputs to receptive fields of cells created

Vision research

Computer age

Applied visual perception in computer graphics and display systems
Further Reading

• Computer graphics historical timeline:
  – http://design.osu.edu/carlson/history/timeline.html

• Important dates in vision science 1600–1960:
  – http://www.arts.rpi.edu/~ruiz/stereo_history/text/visionsc.html

• Visual science before 1600:
Research Papers – Class Presentations

• Where do I find papers?

  – http://www.apgv.org/ (look at the archives)

  – http://tap.acm.org/

  – ACM SIGGRAPH

  – ACM SIGCHI

  – Eye Tracking Research and Applications Conferences (ETRA)

  – http://visionscience.com/
Ideas to motivate you as you think about

• http://www.disneyresearch.com/project/teslatouch/

• http://www.disneyresearch.com/project/revel-programming-the-sense-of-touch/


• http://vimeo.com/51920182

• http://www.youtube.com/watch?v=8QocWsWd7fc

• http://www.youtube.com/watch?v=Jd3–eiid–Uw

• http://www.youtube.com/watch?v=bBQQEcfkHoE
Egocentric Cameras

• Third person view
• First person view
• How to capture first person view?
  – Egocentric cameras
  – Head mounted / chest mounted
• SIGGRAPH 2014 paper
  – Automatic Editing of Footage from Multiple Social Cameras
Classroom Activity

• **Group 1**
  – A scenario which they would like to capture via egocentric cameras
  – What is your goal: what is the question you would like to ask / what are you going to do with this data

• **Group 2**
  – “Improv” act out this scenario
  – So, Group 2 does the data collection

• **Group 1**
  – How will you analyze the data to achieve your goal

• 15 mins to come up with scenario + goal
• Improv: 5 mins * 6 groups = 30 mins
• Workflow thought experiment: 10 mins * 6 groups = 60 mins
• Group 1
  – sleight of hand
  – Card trick
• Group 2
  – Telling a joke
  – Who does the joke teller direct the narrative to
• Group 3
  – Charades
  – does the actor target different clues to different team members
• Group 4
  – Dolphins being attacked by shark, scuba diver films it
  – Tag boxing — train sportsperson
• Group 5
  – Awkward scenario