The Art and Science of Depiction

Introduction to Visual Perception

Fredo Durand and Julie Dorsey
MIT Lab for Computer Science

Vision is not straightforward
- The complexity of the problem was completely overlooked because
  - The problem is so difficult
  - The human visual system is so efficient

Vision and pictures
- Explain
- Inspire
- Malfunction & art
- Technical simplification
  - Cinema, Color, JPG
- Pictures can challenge or simplify perception
- Emphasize or eliminate cues or channels
  - Time, color

Beware of the El-Greco Fallacy
- El-Greco, elongated characters
- Were supposed due to astigmatism
- However, pictures and real people would have been stretched equally
- Almost as fallacious as assuming painting should be inverted because our eyes invert what we see

However...
- Monet had a cataract operation
- Cataract makes vision blurry and yellowish

Textbooks
**Plan**
- Eye
- Low-level processing
- Different pathways
- Organization
- High-level
- Focus, attention
- Color

**Eye: optics**
- Image is inverted (mainly by cornea)
- Lens makes the focus

**Eye: visual angle**
- Corresponds to size of the projection on retina
- Depends on real size and distance

**Retina**
- Layer of photoreceptors
- Light->neural signal
- Optic nerve

**Photoreceptors**
- Rod: night vision
- Cone: bright, color vision
- 100M rods
- 5M cones
- Variable density
- Fovea: most acuity, cone only
Field of view

- Fovea = 2-5 degrees

Summary

- Light is transformed into 100M neural signals
- But… optic nerve has only 1M nerve fibers

Overview of pathway

- Input from both eyes is dispatched
- Left brain: right part of visual field

Visual processing

- First step in the retina itself

Contrast processing

- We are sensitive to contrast, not to absolute luminance
- Useful because contrast is more invariant (it depends less on illumination)
Contrast processing

- Receptors are wired to other neurons
- Center-surround organization

Light

Receptors

Bipolar Cell

Contrast processing

- Receptors are wired to other neurons
- Center-surround organization

Light

Receptors

Bipolar Cell

Hermann Grid

Florida Election Recount

Count and total black dots for Al Gore and white dots for George Bush. Recount to confirm
Vasarely, Supernovae

Relation with photo and painting
- Low contrast is not that much a problem
- A photo can be brighter/lighter than the original

Mach Bands
- Contrast is enhanced at region boundaries

Visual processing
- First step in the retina itself
- ... Next step: visual cortex area V1

Edge detection
- Similar to center-surround
- Measured using micro-electrodes

Edge detection: Multi-resolution
- Edge of different sizes
**Edge detection: not so simple**
- Edges are only a special case
- Patterns

**Retinotopic**
- Close optical stimulus map to close parts of V1
- A monkey is shown A
- Radioactive tracer
- His V1 area is shown in B

**Retinotopic**
- Close optical stimulus map to close parts of V1
- But not complete correspondence

**Relation with line drawing**
- The information is ~ the same
- Drawing simplifies edge detection
- Some neurologist believe that line drawing nicely excites areas of the brain

**Optical art**
- Op’ Art directly exploits low-level vision

**Higher-level visual processing**
- More complex
- Less understood or “measured”
- Different pathways
**Dorsal vs. Ventral pathways**

- Ventral pathway: What?
  - Object recognition
- Dorsal Pathway: Where?
  - Location
- Study on monkeys with damaged brain

**Different visual channels**

- Quite complex interactions
- Not sequential
- Not one-way
- Not strictly separate

- Some interconnections in the Monkey brain

**Relation to visual arts**

- Same elements:
  - Color
  - Form
  - Layout
  - Texture
- Selective treatment
  - Focus in brain
- Orchestra metaphor
Plan of the few next sessions
• Stepping back
• Organization, Gestalt
• Perceiving shape and objects
• Focus, attention
• Color vision

Assignments
• Feedback
• Image
• Reading
• Piranesi

Reading
• Do not forget Gombrich…

Assignment
• Piranesi tutorial
  – Demo version on the class web page
  – Non-photorealistic rendering
  – Tutorial 1 to 3
  – Skip 2.4

Talk
• Decision next week
• Either come with a subject
• Or look on the class web page for suggestions