The Art and Science of Depiction

Introduction to Visual Perception

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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

Before operation

After operation
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
Photoreceptors

- 100M rods
- 5M cones
- Variable density
- Fovea: most acuity, cone only
Field of view

- Fovea = 2-5 degrees
Field of view

- Fovea = 2 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
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Light

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• Receptors are wired to other neurons
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Hermann Grid
Hermann Grid

Florida Election Recount

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

- Contrast is enhanced at region boundaries
Relation with photo and painting

- Low contrast is not that much a problem
- A photo can be brighter/lighter than the original
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
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
Relation to visual arts

- Same elements:
  - Color
  - Form
  - Layout
  - Texture
- Selective treatment
  - Focus in brain
- Orchestra metaphor
Relation to visual arts

- Same elements:
  - Color
  - Form
  - Layout
  - Texture
- Selective treatment
  - Focus in brain
Form and color
Lines
Absence of color, contrast
Shape
Duet: shape and texture
Symphony
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