The Art and Science of Depiction

Vision Solves Problems

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Plan

- Vision as an cognitive process
- Computational theory of vision
- Constancy, invariants

Distal vs. proximal stimulus

- Distal stimulus: reality
- Proximal stimulus: retinal image

Vision as an inverse problem

- The distal stimulus is projected into a proximal stimulus

Unconscious inference (Helmholtz)

- Our vision system solves a problem
- Under-constrained problem
  - A visible point $A'$ can correspond to an infinity of 3D points ($A_1, A_2, A, A_3, \ldots$)
Unconscious inference (Helmholtz)
- Our vision system solves a problem
- Under-constrained problem
- Assumptions on the scene

The Ames room
- Invalid assumption
- Wrong conclusions

Ames chair
- Different scenes
- Same projection
- We assume it is a chair

Patrick Hughes
- Perspective painting on the inverse geometry

The paradox of vision
- Available information: proximal stimulus
- Conscious information: distal stimulus

The paradox of Pictures
- Distal vs. proximal
- Available information: proximal stimulus
- Conscious information: distal stimulus
Pictures and inverse problem

- Can
  - Simplify analysis
  - Be a puzzle

Plan

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Vision as information processing

- Input: retinal image
- Output: 3D layout, object recognition, etc.

Computational theory of vision

- Marr’s stages (extended by Palmer et al.)
- Human and Computer Vision
- Classification of different kinds of processes
- Has proved fruitful in art studies

Retinal image

- Intensity
**Retinal image**

- Intensity: hard to comprehend

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**Image-based (primary sketch)**

- Contrast, edge detection

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**Surface-based**

- Visible surfaces, organization
- Distance, orientation

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**Retinal image**

- Intensity
Surface-based

- Visible surfaces, organization
- Distance, orientation

Local orientation

Object-based

- 3D properties, structure
- Nature of the description highly discussed

Feedback

- Bottom-up and top-bottom

Category-based

- Recognition, category, function

Cup
Scope of the theory

- Computer Vision
- Human Vision
- No direct correspondence in the brain
- Has proved fruitful conceptual tool

Relation to children drawing

- First children draw what they know
  - Object-centered
- Then, what they see
  - View-centered

Evolution of children’s drawings

- Asked to draw a table

What about adults?

- Reproduce two drawing with similar angles
- Wheel:
  - Accuracy ~5°
- Street:
  - Error: 32°

Drawing reproduction

- From Drawing on the right side of the brain
- Reproduction of Picasso’s portrait of Stravinsky

Relation to pictures

- How we see pictures
- Different classes of pictures for different stages
**Relation to pictures**

- Different classes of pictures for different stages
- Not a strict classification

**View-centered**
- Extrinsic

**Object-centered**
- Intrinsic

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**Relation to pictures**

- Chinese painting refuse extrinsic, only essential
- No shadow

**View-centered**
- Extrinsic

**Object-centered**
- Intrinsic

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**Retinal image**

- Impressionism

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**Retinal image**

- Impressionism
- Photography

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**Image-based**

- Line Drawing

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**Intermediate**

- View-based
- Cues for surface-based feature extraction are enhanced
  - Depth cues
  - Orientation cues
- No subjective feature (e.g. lighting)
**Intermediate**

- View-based
- Cues for surface-based feature extraction are enhanced
  - Depth cues
  - Orientation cues
- More subjective feature (lighting)

**Higher level**

- Primitive art
- Cubism
- Schema
- “What I know”

**Higher level**

- Primitive art
- Cubism
- Schema
- “What I know”

**Higher level**

- Primitive art
- Cubism
- Schema
- “What I know”
- Not limited to picture

**Expressionism**

- “What I feel”
**Relation with 2D/3D qualities**

- Almost the opposite!
- 3D quality correspond to retinal image
- 2D quality arises from higher-level pictures
- Because of vision paradox
  - Distal is seen when proximal is shown

**Relation with 2D/3D qualities**

- 3D quality but Retinal image

**Relation with 2D/3D qualities**

- 2D quality but
  - Higher level

**Further reading**

**Plan**

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**Constancy & Invariants**

- We see intrinsic properties of objects
- They are “invariant” or “constant”
- Ecological advantage
**Visual angle vs. size**

- We see cylinders with same size
- Valid most of the time

**Visual angle vs. size**

- Mirror experiment:
  - Draw your face on a mirror
  - Measure: the drawing is ½ your face
  - However, you see “full size”

**Visual angle vs. size**

- How do we do that?
  - Distance
  - Familiarity
  - Assumptions
- Here
  - Perspective
  - Position on ground plane
  - Similarity

**Brightness vs. lightness**

- Brightness: subjective amount of light
- Lightness: how “white”

The white cells in shadow are as dark as the black illuminated cells

**Lightness constancy**

- Sargent
- White in light and in shadow
Color constancy

- Chromaticity of light sources vary
- Chromatic adaptation
  - Similar to white balance on camcoder
  - Different films, filters

| Objective colors under neon lighting | With chromatic adaptation |

Constancy

- Size
- Lightness
- Color
- Position
- Orientation
- Shape

Degree of constancy

- Not always perfect
- Sometimes too much

Degree of size constancy

- The Moon illusion
  - The Moon appears bigger on the horizon
  - Because it looks farther (Emmert’s law)
  - Because references

Degree of color constancy

- Incandescent light looks warmer
- Sodium lighting looks yellowish
- Depends on intensity

Constancy & Pictures

- Estimate size of depicted objects
- Different virtual viewpoints
**Constancy & Pictures**
- Estimate slant of depicted objects
- Different real viewing angles

**Importance of frame**
- Estimate slant of depicted objects
- Different real viewing angles, invisible frame

**Constancy & Pictures**
- Hybrid constancy with respect to
  - Picture object
  - Depicted scene

**Constancy & Pictures**
- Hybrid constancy
- Problem
- Richness

**Degree of constancy**
- Vermeer *Soldier and a Laughing Girl*
- Too good to be true: use of camera obscura

**Size constancy failure**
**Size constancy failure**

- Middle-age
- Size = social importance

**Breaking size constancy for symbol**

- Surrealism (Magritte)

**Color constancy and pictures**

- Chromatic adaptation with respect to picture object, not with respect to dictated scene

**Constancy & architecture**

- Palazzo Spada in Rome (by Boromini)
- Short corridor
- Column size decreases
- Appears longer
**Intro to Visual Perception**

**Next session**

- Gestalt and picture organization
- Gaze movement and focal point

**Assignments**

- Piranesi
  - Tutorial 1 to 4
- Reading
  - Art and Illusion, Gombrich
  - Summary 1 to 2 pages
  - 2 Discussion issues
- Feedback, 1 picture

**Discussion**

- *The Man Who Mistook his Wife for a Hat*
- *The Colorblind Painter*
- Oliver Sacks