Stroke Perception

Karan Singh, Ryan Schmidt
Warning lights

http://www.michaelbach.de/ot/mot_sam/index.html
Warning lights

http://www.michaelbach.de/ot/mot_sam/index.html
Why do we see things?

- Shape (silhouettes, features, lines).
- Value (shading, curvature, lighting).
- Space (Segments, relationships of parts).
Shape (Necker Cube)
Value

Edward H. Adelson
Value

Edward H. Adelson
Space
Shape Understanding

- Gestalt (shape, value, space)
- NPR (shape, value, space)
- Geometry and Projection (shape, space)
Gestalt

http://graphics.stanford.edu/~niloy/research/emergence/emergence_image_siga_09.html
Gestalt (Emergence)

http://graphics.stanford.edu/~niloy/research/emergence/emergence_image_siga_09.html
Gestalt and Hidden Imagery
Gestalt and Hidden Imagery
NPR: Important lines

ridges & valleys

Rusinkiewicz et al. SIGGRAPH course notes 2008
Silhouettes

frontfacing

backfacing
Lines
Lines
Lines+Shading
Dithering/Halftoning

- **Halftoning:**
  - process to represent continuous tone in binary media - print or display.
- **Necessary loss of information due to limited resolution**
- **Approximate tone by using the human visual system**
Stippling and Cross-hatching

- Stippling: use a series of properly scaled and spaced spots.
- Crosshatching consists in crossing a series of lines of various lengths, widths and at various angles with which the artist constructs areas of tone and texture.
Shape Understanding

• Gestalt (shape, value, space)

• NPR (shape, value, space)

• Geometry and Projection (shape, space)
Geometry and projection (maya)
Perceptual Bias (low level)

[Wolfe, Maloney & Tam, Distortions of perceived length in the frontoparallel plane: tests of perspective theories, Perception & psychophysics, 2005]
Perceptual Bias (low level)

[Wolfe, Maloney & Tam, Distortions of perceived length in the frontoparallel plane: tests of perspective theories, Perception & psychophysics, 2005]
Perceptual bias (high level)
Perceptual bias (high level)
Perceptual bias (high level)

[Taylor & Mitchell, Judgements of apparent shape contaminated by knowledge of reality: viewing circles obliquely, *British Jnl. of Psych.*, 1997]
Sketching Dogma

“Sketching is for rough prototype drawings, where precision is not important”

“Only design intent is important in “conceptual design”

“Even though we can’t draw very well, real artists and designers can…”
Experts!

[Schmidt, Khan, Kurtenbach, Singh, On expert performance in 3D curve drawing tasks. SBIM 2009]
http://www.dgp.toronto.edu/~rms/data/CurveDrawing
Expert Drawing I: Circle-on-Plane
Expert Drawing I: Circle-on-Plane
Expert Drawing II: Line-on-Cylinder
Expert Drawing II: Line-on-Cylinder
Expert Drawing III: Silhouette Curves

Please fill in the missing curve section
Expert Drawing III: Silhouette Curves
Expert Drawing IV: Curve-on-Surface

Please draw the center-line along the surface
Implications for 3D Sketching

- Artists and Designers can’t draw either!
- Averaging Oversketches  
  - Reduces mechanical error
  - Converges on biased position
- Viewpoint selection
  - no free lunch, 45° largest bias
- Drawing on surfaces is just as hard

Humans have an audio IN and OUT, a biased video IN but no explicit video OUT!

^
Experts and drawing systems
Analytic Drawing

1. Pick a drawing system
   • 2-point perspective, isometric,…
   • Rules for how to interpret lines
2. Construct a 3D scaffold
3. Draw curves within the scaffold
Modeling Perceptual Bias

Rendering

Inference

1 : 0.69

x1.2
Bayesian Ideal Observer Theory

- $P(\text{scene} \mid \text{image}) \sim P(\text{image} \mid \text{scene}) \ P(\text{scene})$

- Perceptual systems evolve to fit “natural” distributions

- Collect natural distributions

- Predict biases
Take-aways

- Mechanical Error / Error of Intent
- Error of intent caused by perceptual bias (?)
- Multiple layers of perceptual bias

Low-Level “Projective”  
High-Level “object/semantic”

- Solutions will affect inference and rendering!