Human Segmentation: Insights for Computer Vision

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CS 131
11-10-14
Today’s Agenda:

• Edges are not enough!

• Human perceptual organization is a bag of heuristics.

• Gestalt laws

• Figures and ground

• Texture segregation
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Types of V1 cells

simple cells

On-Center, Off-Center

Hubel & Wiesel (1962)
Mid-level vision: Here be dragons

3D structure; motion characteristics; surface properties

Recognition

Edge extraction

Image

Emphasis on ‘Bottom-up’ processing
Recognition

3D structure; motion characteristics; surface properties

Shape From stereo  Motion flow  Shape From motion  Color estimation  Shape From contour  Shape From shading  Shape From texture

Edge extraction

Image

Emphasis on ‘Bottom-up’ processing

Framework from Marr, 1982
Edges are not enough!
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- Depth discontinuity
- Surface pigmentation discontinuity
- Illumination discontinuity
- Specular highlights
Edges are not enough!

Depth discontinuity

Surface pigmentation discontinuity

Illumination discontinuity

Specular highlights
Where do conventional edge-detectors fail?

Detecting illusory contours

No luminance difference across long sections of the perceived contours
Properties of Illusory Contours:

Need not be based in prior experience
Properties of Illusory Contours:

Need not be based in prior experience

Can be induced with minimal stimulus
In class exercise:

Simple cell

Complex cell

Hypercomplex cell
End-stopped cells could “see” illusory contour
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V2 “sees” illusory contours:

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Priors: simplicity and context
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Pragnanz
Priors: simplicity and context
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Priors: simplicity and context

Demo from Stanford Graphics Group
Priors: simplicity and context

Demo from Stanford Graphics Group
Priors: simplicity and context
Photographs have accidental viewpoints
Motion helps disambiguate grouping

Pawan Sinha
Motion helps disambiguate grouping
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Perceptual Organization
“The whole is greater than the sum of the parts”
This phrase is often used when explaining Gestalt principles.
Gestalt Laws: Proximity
Gestalt Laws: Proximity
**Law of Continuity**

Objects will be grouped as a whole if they are co-linear, or follow a direction.
Gestalt Laws: Similarity
Gestalt Laws: Common Fate
Gestalt Law of Closure
Grouping by Synchrony
Grouping by Common Region

STOP WAR
PEACE NOW

STOP WAR
PEACE NOW

United States Senate
Grouping by Continuation
Grouping by Continuation
Grouping from Past Experience

Demo from Stanford Graphics Group
Grouping by Social Cues?
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Law of Figure and Ground
Law of Figure and Ground
Properties of Figures:

- Nearer to observer
- Bounded by contour
- Convexity
- Parallelism
- “Thinglike”
Properties of Figures:

Nearer to observer

Bounded by contour

Convexity

Parallelism

“Thinglike”
Properties of Figures:

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“Thinglike”
Properties of Figures:

Nearer to observer

Bounded by contour

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“Thinglike”
Prior experience

Peterson, Harvey & Weidenbacher, 1991
Ambiguous Figures:

Figure by Roger Shepard
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Texture Segmentation
Bush campaign digitally altered TV ad

President Bush’s campaign acknowledged Thursday that it had digitally altered a photo that appeared in a national cable television commercial. In the photo, a handful of soldiers were multiplied many times.
Texture Segmentation
High resolution only at fovea

![High resolution image](image1)

![Blurred image](image2)
High resolution only at fovea

“A + A

“Crowding”
High resolution only at fovea

A + BOARD

“Crowding”
Texture Segmentation

Summary statistics of orientation, not binding of elements
Texture Segmentation
Texture Segmentation
Texture Segmentation
These images are seen as the “same”

Rosenholtz, Huang & Ehinger, 2012
Application: Designing better subway maps
Application: Designing better subway maps
Application: Designing better subway maps
Whoa....
mrgreene@stanford.edu