The Art and Science of Depiction

Gaze Movement and Focal Points

Fredo Durand
MIT- Lab for Computer Science
Summary

- Visual field, highest precision in the fovea (~2°)
- Contrast processing
- Different pathways
- Computational theory of vision
- Invariants
Need for exploration

• We need to align the fovea with relevant features
Plan

• Different eye movements
• Visual exploration
• Saliency
• Focal points, composition
Eye movements

- Physiological nystagmus (involuntary)
- Saccade (scan visual field)
- Smooth pursuit (track moving objects)
- Vergence (depth adjustment)
- Vestibular (compensate head movement)
- Optokinetic (in moving environment)
Physiological nystagmus

- Involuntary movement
- All the time
- Avoid stabilized images
  - Because they disappear!
Saccade

- Scan the visual field
- Can be controlled
- The most important for us
- Ballistic movement: 30 ms and up to 900°/s
- Fixation ~300ms
- Saccadic suppression
  - No blur is experienced during movement
**Smooth Pursuit**

- Track moving objects
- Smooth
- Constant feedback and readjustment
- Slower than saccades (max 100°/s)
- Acuity
  - The image of the tracked object remains sharp

![Graph showing eye position over time](image-url)
Vergence

- Depends on object distance (depth cue)
- Less than 10°/s
Other movements

- Vestibular
  - compensate head movement
- Optokinetic
  - in moving environment
Saccadic exploration

- Reading: Javal, 1878
- Images: Yarbus, 1965
- Path
- Fixation time
David Hockney’s collages

- 1 photo = 1 gaze
- Distorted perspective because saliency
David Hockney’s collages

- Temporal too
Gaze movement & cubism

• Picasso

*Portrait of Kuhnweiler*
Gaze movement & cubism

- George Bracque
  *Le Portugais*
  1911-1912
Gaze attraction

- Bottom-up (stimulus-driven)
  - Contrast
  - Color
  - Patterns

- Top-bottom (High-level driven, potentially conscious)
  - Semantic information, familiarity
  - Human beings, eyes
  - Task
  - Personal context
Computational model

- Itti et al. (Caltech)
- Bottom-up only
- Different channels (colors, edges)
- Multi-resolution
- Lateral inhibition
Focal point

• Contrast
• Amount of details
• Image dynamics (lines)
• Semantics
Creating focus: edge burning
Focus
Focus via “spotlight”
Focus

• Arthus-Bertrand
Focus via contrast
Focus via contrast

- Tofoli
Focus through contrast

• Rembrandt
Focus through perspective

• Raphael, The School of Athens
**Foveal zone**

- Eugene Delacroix
  Study for a portrait of Chopin
Focus through make up

- Make-up: Aucoin
Focus using detail and color

- A. M. Cassandre, 1925
Focus on human

- Trevor Chamberlain
  *Railway viaduct*
- Human being
- Highlighted by closure
Gaze and image cognition

• Similar to scientific method
  – Make hypothesis
    (mental model of the scene)
  – Perform experiments
    (gaze)
Depends on task

- painting by Repin
- B: free
- C: economic level
- D: ages
- E: what were they doing
- F: remember cloth
Depends on task?

• Rembrandt, *The Anatomy Lesson*

• Different tasks:
  – A: Aesthetic
  – B: Semantic

• Very similar paths
Diversive vs. specific

• Different strategies (Berlyne 1971)

• Diversive exploration
  – Hunt for new stimulation
  – Dispersed
  – Shorter fixation (<300ms)

• Specific exploration
  – Seeks specific information
  – Longer fixation (>400ms)
Effect of training

• Compare naïve beholders with specialists
  – Radiologists
  – Art students, art historians

• Specialists more specific

• Naïve more diversive
Fixation time & style

- Depends on style “complexity”
- Shorter fixation for more complex style

![Graph showing fixation time and style comparison between Baroque and Classical styles.](image)
Gaze & balance

- Altered painting
- Inverses strategy of naïve and specialists
Number of focal point

- Dynamic of the image
- 1 region: imitates 1 foveation, striking
- Many regions: the gaze is transported, dynamism
- Path
Focus: Color contrast

- Arthus-Bertrand
Focus through contrast

• Rembrandt
Two focal zones

- Robert Mapplethorpe
  *Self-portrait*, 1988
Focus through perspective

• Raphael, The School of Athens
Focus: saliency + semantics
Turner’s Loire journey

• The gaze follows the journey
Triple focus and subject gaze

- Robert Doisneau
  Les Gosses de la place
  Hebert
Focal point and dynamics

- Abbas, 1978
- Pop-out leads to uniform
- Perspective leads to top
Focal point conflict

- Bottom-up is different from top down
- Makes image dynamic
Advertisement and focal points

- Evolution of saliency
The End…

• Of part I