Binocular Cues

- Stereopsis

Images laid out for “free viewing” (with unaided eyes) in “cross-eyed stereo” (with right and left images on left and right, respectively)

http://www.physics.utoledo.edu/~lsa/_color/19_depth.htm
Binocular Cues

- Stereopsis
  - Vergence–accommodation mismatch can be caused by using fixed distance displays to present stereo imagery

![Diagram showing stereopsis and vergence-accommodation mismatch.](image)

- Binocular disparity
- Binocular rivalry

© Wheatstone, 1838
Relative Effectiveness of Cues
J. Cutting & P. Vishton, 1995

Personal space (up to arm’s length and slightly beyond, ~ 2m)
< Action space (< 30m)
< Vista space

Visual Display Characteristics

- Field of Regard (FOR)
  - Visual angle within which imagery can be presented by a display
  - Often measured in horizontal, vertical (or diagonal) degrees
  - Depends on location of user relative to display
- Field of View (FOV)
  - Portion of the FOR that can be seen by a user at a given point in time

Feiner, COMS W4172, Spring 2018
Visual Display Characteristics

- Resolution
  - Absolute: Pixels per linear inch
  - Relative: Pixels per degree
  - May vary across display
    - Absolute variance caused by unequal pixel distribution
      - E.g., Higher pixel density at center of display in world coordinates
    - Relative variance caused by user position relative to display
      - E.g., Higher pixel density at periphery in projection on retina

- Surface geometry
  - Planar
  - Curved
  - Hemispheric

CAVE (Cave Automatic Virtual Environment)

http://www.mechdyne.com/curv.aspx
www.elumens.com RIP
www.evl.uic.edu
Visual Display Characteristics

- Surface geometry
  - Multiple surfaces
    - KAUST Immersive Cube
      - 24 4096×2160 pixel projectors (4 per wall)
      - 100M pixels @ 10K lumens, stereo

Images courtesy: Tom DeFanti

https://vimeo.com/122661332

Visual Display Characteristics

- Surface orientation
  - Absolute
    - Vertical
    - Slanted
    - Horizontal
Visual Display Characteristics

- Surface orientation
  - Relative
    - Held/worn by user (how and with what is it held/mounted/worn)
      - Hand
      - Head
      - Wrist

Visual Display Characteristics

- Tiling
  - Multiple panels
  - Multiple projectors

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Visual Display Characteristics

- Light transfer approach
  - Example: surface in environment
    - Emissive / transmissive
      - E.g., rear projection, or flat panel
      - Screen can be obscured from eye (e.g., by user)
    - Reflective
      - E.g., front projection
      - Screen can be obscured from projector (e.g., by user)
  - Consequences differ depending on form factor

Visual Display Characteristics

- Refresh rate
  - Number of times per second (Hz) displayed image is refreshed from memory
- Frame rate
  - Number of times per second (Hz) image is generated from representation
- Refresh rate is limiting factor
  - However, if frame rate >> refresh rate, multiple different frames can be accumulated for each refresh to improve quality (e.g., antialiasing)
Visual Display Characteristics

- Brightness
- Black level
- Dynamic range
- Transfer function
- Duty cycle
- Persistence
- Color gamut

Stereoscopic Viewing

Passive

- Spatial multiplexing
  - “Free viewing”
- Stereoscope
  - Present each eye with its own view

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Brewster

Holmes
Stereoscopic Viewing
Passive

- Spatial multiplexing
  - “Free viewing”
  - Stereoscope presents each eye with its own view