CS-525U: 3D User Interaction

Visual Displays

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Visual-Display Characteristics

- Field of regard (FOR) and Field of View (FOV)
- Spatial resolution
- Screen geometry
- Light-transfer mechanism
- Refresh rate
- Ergonomics

Field of Regard vs. Field of View

- Measures in degrees of visual field
- Cylinder has 360°degree FOR, but only 200° FOV
- HMD might have 40° FOV, but a 360° FOR
- FOV < FOR
- Note: Limited FOV might force unnatural behavior, e.g., excessive head movement

Spatial Resolution

- Often quoted in dots-per-inch
- Resolution is *not* in pixels
- Displays might have same number of pixels, but have different screen sizes, giving us a different number of dots per inch.
- User's distance to the display also affects spatial resolution

Screen Geometry

- Rectangular
- L-shaped
- Hemispherical
- Cubic
- Might require image pre-distortion

Light-Transfer Mechanism and Refresh Rate

- Front/Rear projection
- Laser light onto the retina

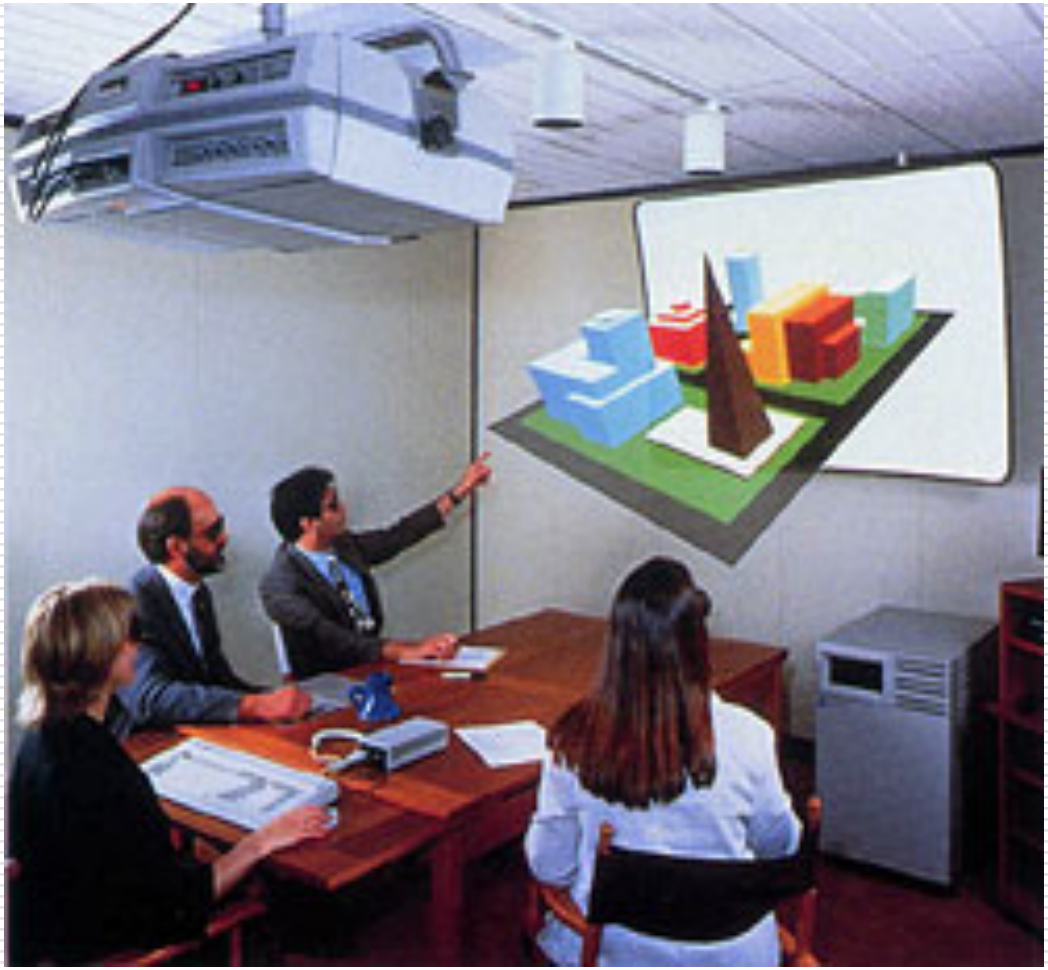
Refresh rate

- Speed at which display is updated (Hertz)
- Not the same as frame rate

3D Cues

- Depth
  - Monocular, static cues
    - Occlusion
    - Linear perspective
    - Aerial perspective (color)
    - Shadows
  - Oculomotor cues
    - Accommodation
    - Convergence
  - Motion parallax
  - Binocular disparity

3D Displays

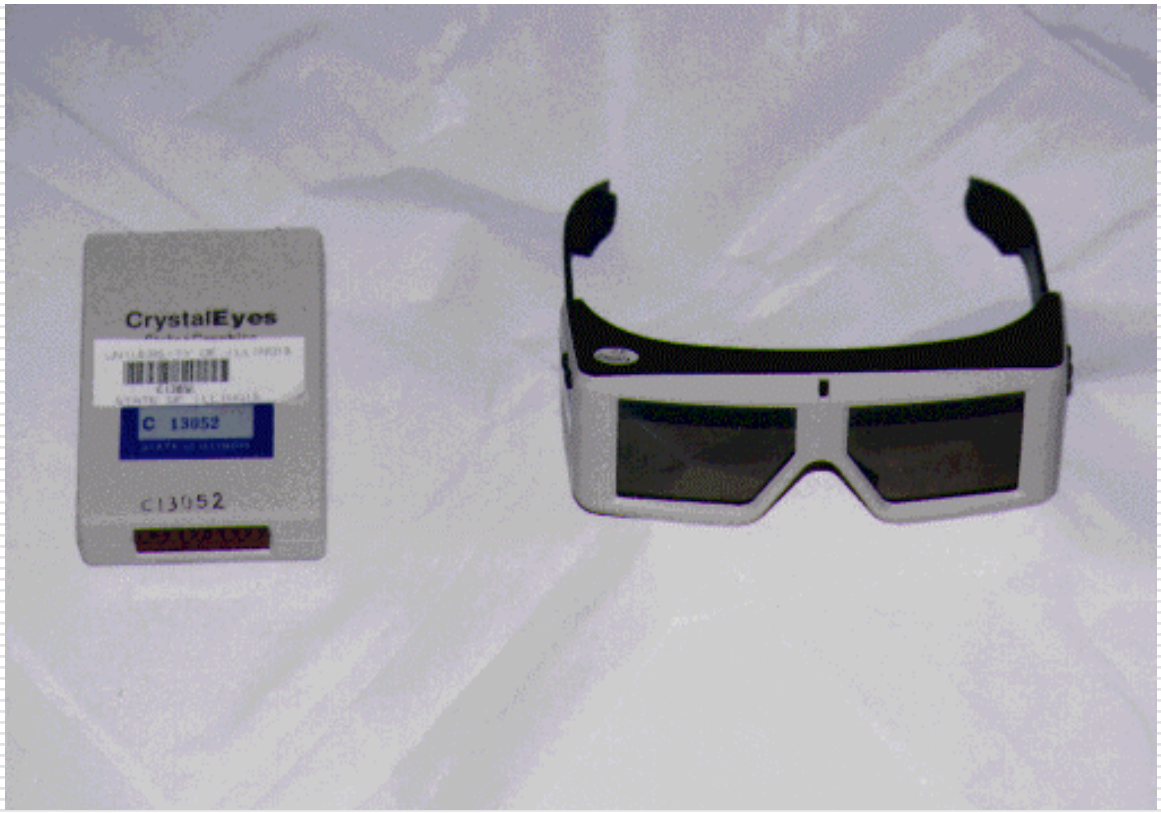


- 1838-1948 - Early Systems
- 1967 - Traub's Varifocal Mirror
- 1979 - LEEP Optics
- 1970s - Computer-based stereo displays
- 1985 - Commercial LC shutter displays

Early 3D Displays

1838 - Wheatstone Stereoscope
1849 - Brewster Stereoscope
1903 - Parallax Barrier
1915 - First 3D movie
1948 - Holography

Commercial Shutter Glasses for CRT-based Stereoscopic Display

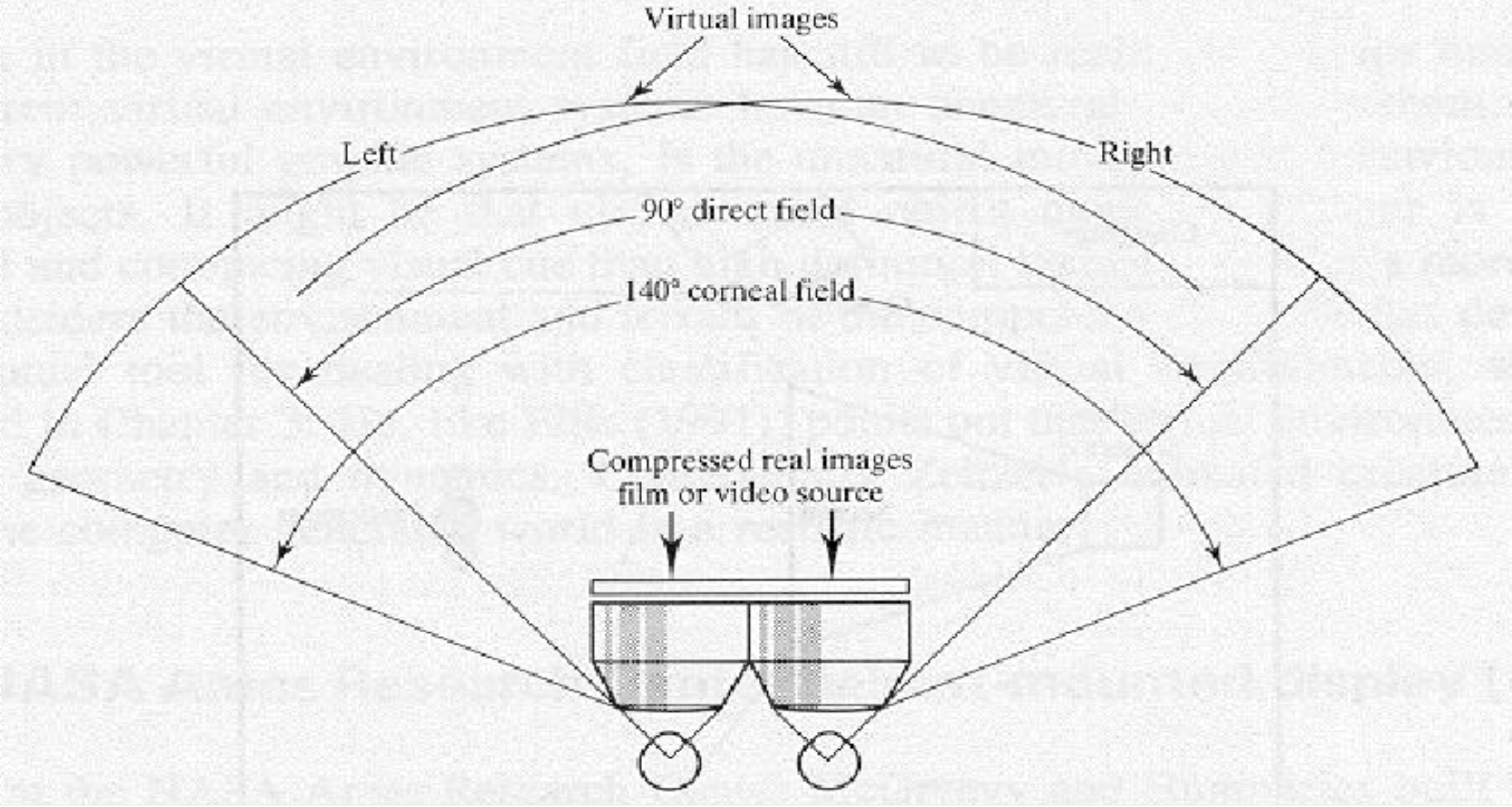


- Time-multiplexed stereoscopic display
  - 1970s – PLZT Ceramic Shutters
  - 1985 - Commercial LC shutter displays

LEEP Optics

- Eric Howlett, Pop-Optix Labs 1979
- Large Expanse, Extra Perspective (LEEP)
- Originally for stereoscopic still photo viewing
- Lenses correct for intentional camera distortion
- Later used in HMDs

LEEP Optics


Virtual images
Left
Right
90° direct field
140° corneal field
Compressed real images
film or video source

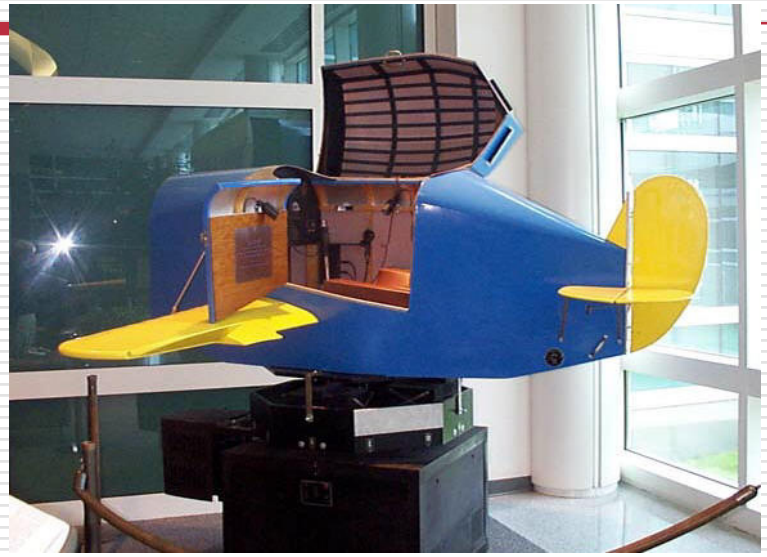
Virtual Reality Systems

- 1929 – Link Flight Simulator
- 1946 – First computer (ENIAC)
- 1956 – Sensorama
- 1960 – Heileg's HMD
- 1965-68 – The Ultimate Display
- 1972 – Pong
- 1973 – Evans & Sutherland Computer Corp.
- 1976 – Videoplace
- 1977 – Apple, Commodore, and Radio Shack PCs
- 1979 – First Data Glove [Sayre] (powerglove -89)
- 1981 – SGI founded
- 1985 – NASA AMES
- 1986-89 – Super Cockpit Program
- 1990s – Boom Displays
- 1992 – CAVE (at SIGGRAPH)
- 1995 – Workbench
- 1998 – Walking Experiment

Link Flight Simulator

- 1929 - Edward Link develops a *mechanical flight simulator*
- Train in a synthetic environment
- Used mechanical linkages
- Instrument (blind) flying

- http://www.wpafb.af.mil/museum/early_years/ey19a.htm



Instrument panel of the Link on display
The Link trainer was donated by Simulation Products Division, The Singer Co., Binghamton, NY.

Sensorama

Morton Heilig, 1956

Motorcycle simulator - all senses

- **visual (city scenes)**
- **sound (engine, city sounds)**
- **vibration (engine)**
- **smell (exhaust, food)**

Extend the notion of a ‘movie’