

Interfaces:  
Input and Display Technologies

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Input Technologies

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Input Technologies

- Position Tracking
- Gesture Tracking
- Facial Tracking
- Biosignal
- Haptic Input
- Locomotion
- Speech

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Position Tracking:

### General

- Permits users to experience being “in” the environment.
- Associated with HMD to provide Head-Coupling.
- Active (uses emitters) vs. Passive (no emitters).
- Active: Inside-out (sensor inside) vs. Outside-in (sensor outside).

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Position Tracking:

### Optical

- Tracking light emitters (active) or image shape (passive)



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Position Tracking:

### Magnetic



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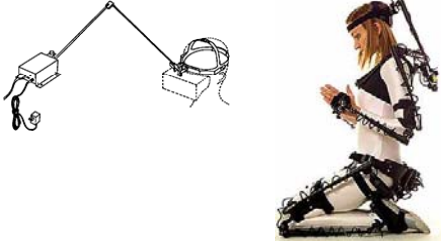
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Position Tracking:  
Mechanical



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Position Tracking:  
Acoustical



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Position Tracking:  
Inertial



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Gesture Tracking:  
Gloves



DataGlove



CyberGlove

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Gesture Tracking:  
Gloves



PowerGlove (1989)

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Facial Tracking:  
Markers vs. No Markers



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Biosignal:

### Many Different Possibilities

- Myoelectric
  - Muscular movement
- Cerebroelectric
  - Brain signals
- Skin Conductance
- Heart Rate



BBCI - EEG

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Biosignal:

### Bio Feedback Games



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Haptic Input:

### 6 DOF Manipulation



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Haptic Input:  
Single Point Pressure



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Haptic Input:  
Hand Motion



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Locomotion:  
Steppers



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Locomotion:  
Cycles



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Locomotion:  
Omnidirectional Treadmills



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Locomotion:  
Rollers



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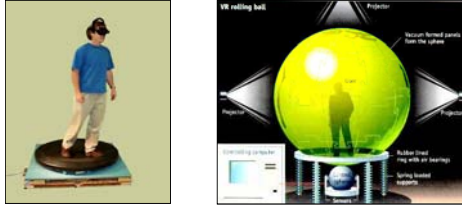
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Locomotion:  
Giant Pad and Trackball!



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Locomotion:  
Robot Floor



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Display Technologies

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## Display Technologies

- Path of perception
  - **Distal Stimulus**: the source
  - **Proximal Stimulus**: what hits the receptor
  - **Perceptual Hypothesis**: inference about distal from proximal
  - **Percept**: mental representation of world
  - **Perceptual Constancy**: maintaining hypothesis
- Display technologies can start with reproducing proximal stimuli

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## Display Technologies

- Visual Displays
- Acoustic Displays
- Haptic Displays
- Motion Displays

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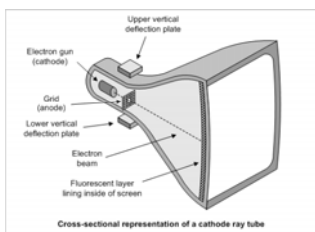
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## Visual Displays - Image Sources: Cathode Ray Tubes



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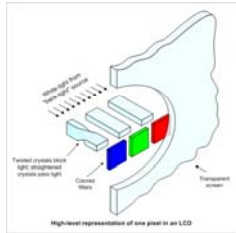
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Visual Displays - Image Sources:  
Liquid Crystal Displays



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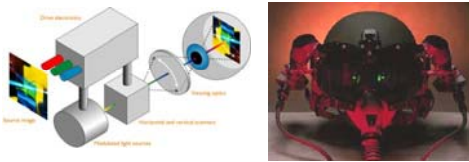
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Visual Displays - Image Sources:  
Retinal Scan Displays



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Visual Displays - Optical Systems:  
Head-mounted Displays

- Reflective can support see-through, but loose brightness.
- Refractive are bright but unwieldy.



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Visual Displays - Optical Systems:  
**BOOM Technology**



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Visual Displays - Optical Systems:  
**Shutter Glasses**



- Block out one eye at a time in synchrony with alternating images on a monitor.
- Full monitor resolution.
- Needs tracking for viewpoint dependent images.

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Visual Displays - Optical Systems:  
**Polarized Glasses**

- Images from two sources are combined, each with a different polarization.
- Polarized glasses separate them again.



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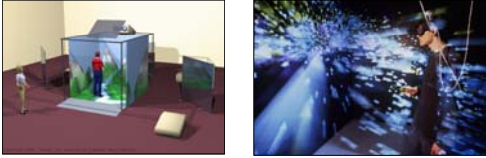
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Visual Displays - Optical Systems:

### CAVEs

- Large displays on more than one side.



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Visual Displays - Optical Systems:

### CAVEs



CAVEUT 2004

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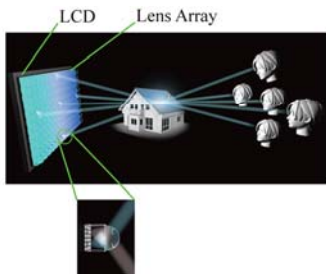
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Visual Displays - Optical Systems:

### Autostereoscopic Displays



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Visual Displays:  
Performance

- Orthostereoscopy
  - Depth perception tricks
- Resolution
  - Pixellation
- Responsiveness
  - Refresh and update rates
- Field of View
  - Should be at least 60°

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Acoustic Displays:  
Generally

- Virtual acoustic displays present virtual auditory worlds (VAWs).
- Synthesize the cues that are used by humans in localizing sounds.
- Still some controversy regarding what cues are required to produce externalization.
- Both visual and acoustic displays require rendering and presentation.

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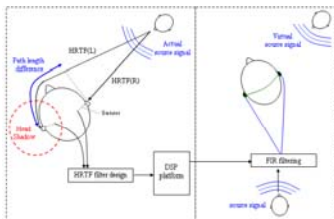
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Acoustic Displays:  
Head-Related Transfer Function



- HRTF are measured by fitting human subjects (or mannequin heads) with probe microphones, deep within their ears, and then by measuring the signals that reach them when sounds from a large number of locations are played in an anechoic chamber.
- From this filters are created to process sound before it is presented to the user.

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Acoustic Displays:  
Additional 3D Cues

- Distance effects
  - Attenuation
- Field patterns
  - Directionality
  - Occlusions
- Doppler effect
- Early echoes
- Reverberation



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Haptic Displays:  
Tactile Feedback

- Vibro-tactile
  - Motorized vibration or rumble
- Pneumatic
  - Jets of air
- Electrocutaneous
  - Pulses of electricity
- Shape-memory alloys
  - Bending alloys press on skin
- Functional neuromuscular stimulation
  - Direct stimulation of neuromuscular system

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Haptic Displays:  
Force Feedback

- Joystick or wheel
- Motorized Arm
- Exoskeleton



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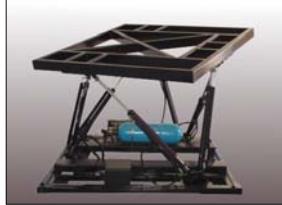
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Motion Displays:  
Inertial Platforms



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Motion Displays:  
Locomotive Platforms



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