

3D User Interface Hardware

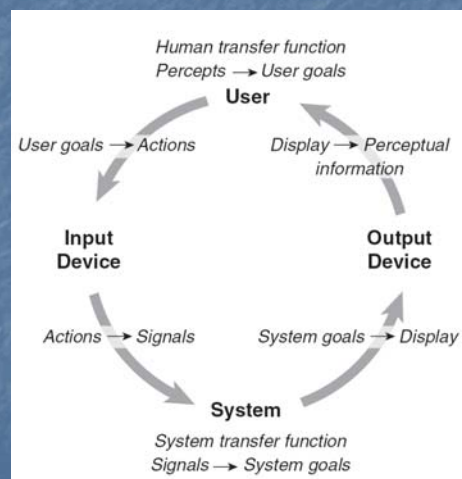
Lecture #6: Audio/Haptic Displays
Spring 2014
Joseph J. LaViola Jr.

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Interaction Workflow



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Introduction To Displays

- *Display*: device which presents perceptual information
- Goal: display devices which accurately represent perceptions in simulated world
- Displays do not have to be just visual
 - auditory
 - haptic, tactile
 - olfactory

Lecture Outline

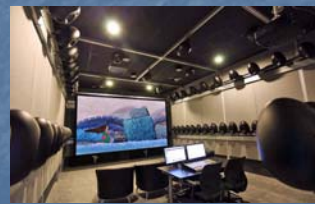
- Audio Displays
 - 3D sound localization depth cues
 - 3D sound generation
 - sound configurations
 - audio and 3DUIs
- Haptic/Tactile Displays
 - haptic cues
 - display characteristics
 - display types
 - haptics and 3DUIs
- Olfactory Displays

Audio Displays

- Present sound to the user
- Spatialized 3D sound
 - sound surrounds user
 - take advantage of localization
- Localization – psychoacoustic process of determining location and direction from which a sound emanates
- Many applications



<http://www.loonygames.com/content/2.4/feat/>



<http://www.proaudio-central.com/articles/pro-audio-asia/losono-and-SWD-Group-open-3D-sound-showroom-in-Shanghai>

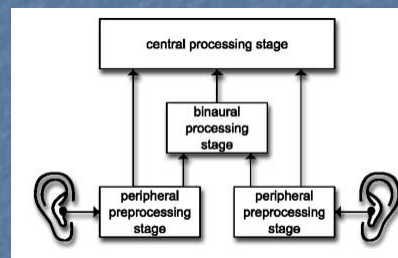
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3D Sound Localization – Binaural Cues

- Comparison of sound waves received by each ear
- Interaural time difference – time between arrival of sound at each ear
- Interaural intensity difference – difference in sound intensity at each ear
- Cue does have problems
 - ambiguous situations
 - when two or more sources where ITD and IID are the same



http://www.jeroenbreebaart.com/research_binaural.htm

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3D Sound Localization – Spectral and Dynamic Cues

- Dynamic head movement or sound source
 - moving source is fairly weak cue
- Utilize spectral content
 - interaction of sound wave with outer ear
 - occur at relatively high frequencies (above 6KHz)

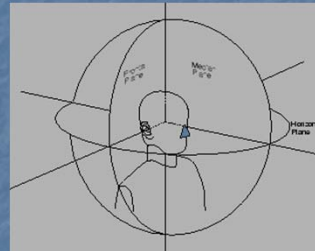
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3D Sound Localization – Head Related Transfer Functions

- Spatial filters that describe how sound waves interact with listener's body
 - listener specific
 - lack reverberation info
- Build in echo free chamber with head model



<http://www.tonmeister.ca/main/textbook/node320.html>

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3D Sound Localization – Reverberation

- Many factors affect a sound source
 - objects
 - atmospheric properties
- Sound hits listener directly and indirectly
- Aids in perception of distance, not direction

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3D Sound Localization – Others

- Intensity (i.e., loudness)
 - simple cue
 - common in 3D audio displays
- Vision and Environment
 - sounds in FOV make spatial percepts

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3D Sound Generation

- 3D sound sampling and synthesis
 - take samples from real environment
 - binaural audio recording
 - generate HRTFs for each ear
- Auralization
 - rendering a sound field
 - good for reverberation effects
 - wave-based modeling
 - ray-based modeling

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Sound System Configurations

- Headphones (stereophonic)
 - High level of channel separation
 - avoid crosstalk
 - isolate listener from external sounds
 - problems with inside the head localization
- External Speakers
 - place speakers around the room
 - no need to wear anything
 - problems with crosstalk
 - Two approaches –transaural audio and amplitude panning

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Audio in 3DUIs

- Localization
 - wayfinding aids
- Sonfication
 - turning information into sounds
- Ambient Effects
 - adding realism
- Sensory Substitution
 - sound for touch
- Annotation and Help

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Haptic Displays

- Provide user with sense of touch
 - simulate interaction between virtual objects and user
 - force (joint/muscle)
 - tactile (skin-based)



www.novint.com

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Haptic Cues – Tactile Cues

- Taction – perceived by variety of cutaneous receptors under skin surface
 - surface texture
 - temperature
 - pressure
 - pain
- Found in varying concentrations on the body

Haptic Cues – Kinesthetic Cues

- Perceived by receptors in muscles, joints and tendons
 - help to determine movement, position and torque of different body parts
 - relationship between user and object via muscular tension
- Both active (movement self-induced) and passive (movement by external force)

Haptic Display Characteristics

- Presentation capability – what types of output
- Resolution
 - Spatial – minimum proximity of stimuli
 - Temporal – refresh rate
- Ergonomics
 - Don't want to break anyone

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Haptic and Tactile Displays

- “For every action there is an equal and opposite reaction”
 - Sir Isaac Newton
- Main forms of feedback
 - ground referenced
 - body referenced
 - tactile
 - combination
 - passive – physical props



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Haptic Displays

- Motionware device
- Provides vestibular stimulation
- Sends signals to the 8th cranial nerve
- Gives user a sense of motion
- No longer exists

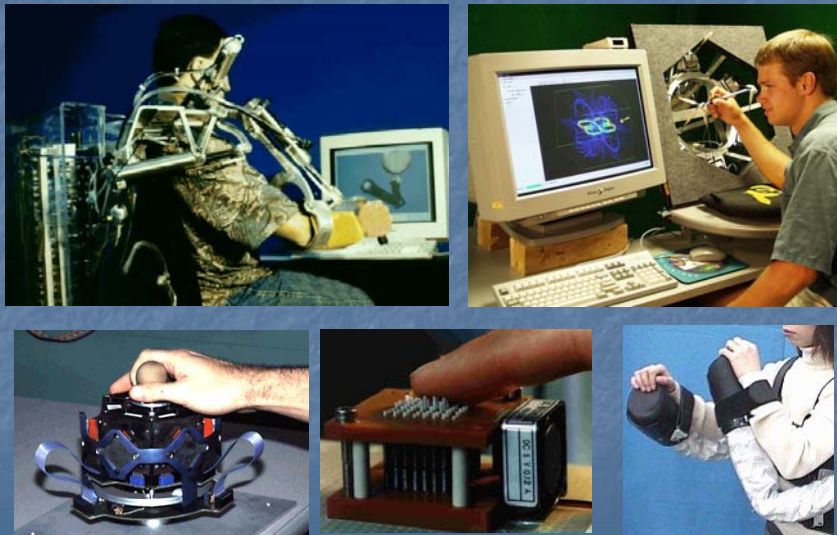


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Other Haptic Devices

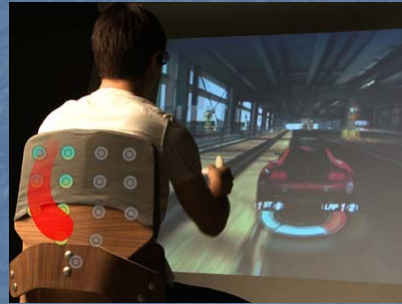
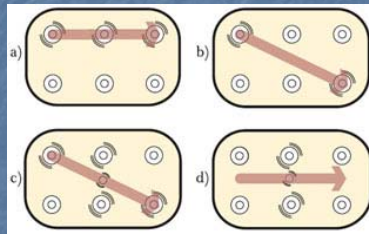


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Tactile Display Example



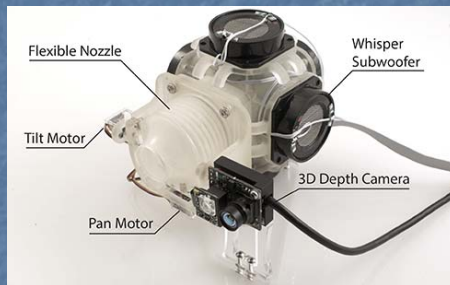
Surround Haptics – Disney Research Pittsburgh
<http://www.disneyresearch.com/project/surround-haptics/>

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Tactile Display Example (2)



Areal – Disney Research Pittsburgh
<http://www.disneyresearch.com/project/airal/>

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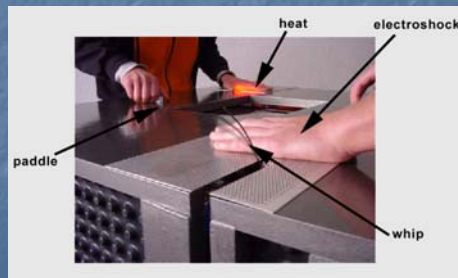
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PainPong

■ PainStation

- two person console
- electro shock, heat, whipping:
bad performance → pain



PainStation - Pong
Courtesy of www.painstation.de

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Hall of Pain (www.painstation.de)



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Haptics – Interface Design

- Useful for object manipulation
- Problem with these devices is they are very intimidating
- Mimic real world interaction
- Untapped area for games
 - scary too!!



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Olfactory Output

- Least developed area
 - maybe for good reason!
- Has practical applications
 - fire fighting
 - surgical training
- Number of practical problems

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Next Class

- Input devices
- Readings
 - 3DUI Book – Chapter 3, pages 59-86