IMGD 5100: Immersive HCI

Output Devices - Visual

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Overview

Here we are concerned with technology for stimulating the senses.
Motivation

- We need to display the state of the world to the user
  - Display: a method of presenting information to any of the senses
- We need to display the user to the user (maybe)
- We need to feed each sense appropriately
- We need to feed multiple senses in concert
  - Display for one sense shouldn't get in the way of display for another sense
- May need to quickly don/doff displays
Some Things to Remember

- Humans are animals, and hence, have evolved over time.
- Evolutionary forces have guided the development of our senses.
- Displays that leverage this fact have a better shot of being effective.
General Types of Displays

- The senses
  - Visual
  - Auditory
  - Haptic
  - Olfactory
  - Gustatory

- Display anchoring
  - World-fixed displays
  - View-fixed displays
  - Body-worn displays
  - Hand-held displays
Visual Display Types

- World-fixed displays
  - Fishtank VR
  - Projection VR

- Body-worn displays
  - Opaque HMDs
  - Transparent HMDs

- Hand-held displays
  - Palm VR
  - Boom-mounted screens
  - Mobile devices
Visual Display Types

- Monitors
  - CRT, Plasma, LCD
- Surround-screens (e.g., CAVEs)
- Tabletops
- Hemispheric displays
- Head-mounted displays (HMDs)
- Arm-mounted displays
- Virtual retinal displays
- Autostereoscopic displays
- 3D displays
Visual Displays

- CAVEs
Visual Displays (cont.)

- CAVE
Head-Mounted Displays (HMDs)
Visual Cues

- Depth is the main thing added by VR to more-traditional displays
  - How do we perceive depth?

- Monoscopic cues
- Stereoscopic cues
- Motion-depth cues
- Physiological cues
Monoscopic Cues

- Overlap (Interposition)
- Shading & shadows
- Size
- Linear perspective
- Texture gradient
- Height in the image
- Atmospheric effects
- Brightness
Stereoscopic Cues

- This is based on the *parallax* of objects appearing in two images.
- Camera 1 / camera 2 effect
- Only good within about 5 meters of viewer
Motion Depth Cues

- Changing relative position of head and objects
- Can be user and/or object moving
  - Train leaving a station
  - Use proprioception to disambiguate

http://www.youtube.com/watch?v=1AZAbSXmeoI
Motion Depth Cues (cont.)

- Head movement

(A) [Image of person facing a triangle]

(B) [Image of person facing a cube]

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Physiological Cues

- The eye changes during viewing
- Accommodation
  - Muscular changes of the eye
- Convergence
  - Movements to bring images to same location on both retinas
Properties of Visual Displays

☐ Color
☐ Spatial resolution
☐ Contrast
☐ Brightness
☐ Number of channels
☐ Focal distance
☐ Opacity
☐ Masking
☐ Field of view
☐ Field of Regard

☐ Head position info
☐ Graphics latency
☐ Frame rate
Number of Display Channels

- **Spatial multiplexing**
  - Different image in front of each eye

- **Temporal multiplexing (time interlacing)**
  - Use shutter glasses

- **Polarization multiplexing**
  - Use polarized glasses

- **Spectral multiplexing**
  - Red/blue left-eye/right-eye images

- **Binocular monoscopic**

**Stereo takes twice the resources!**
Masking

- How physical objects block virtual ones
- CAVE: Hands can break effect
- HMD: Not at all
- Fishtank: Display edges/bezel can break effect

http://www.youtube.com/watch?v=Jd3-eiid-Uw&fmt=18
Field of View vs. Field of Regard

- Field of view (FOV)
  - How much of the scene (in degrees) is visible at any given time

- Field of regard (FOR)
  - Amount of space (in percent) of the virtual world is currently surrounding the user

- Examples
  - CAVE: 200° FOV facing forward, 75% FOR
  - HMD: 100° FOV, 100% FOR
Hand-Held Displays

- Mobile devices are more powerful
- Cell phones have cameras
  - Can do AR

Apple iPhone 4 (2010)

Apple iPad (2010)

Motorola DROID (2009)

Nintendo DS Lite (2006)

Sony PlayStation Portable (2004)
Change Blindness

- There is so much information for the brain to process, we need to filter.
- Change blindness is when we miss things that change from one instant to another.
  - [http://www.youtube.com/watch?v=mAnKvo-fPs0](http://www.youtube.com/watch?v=mAnKvo-fPs0)
- A public service announcement:
  - [http://www.youtube.com/watch?v=Ahg6qcgoyoay4&NR=1](http://www.youtube.com/watch?v=Ahg6qcgoyoay4&NR=1)
- Next example from:
  - Show Movie
Change Blindness
Change Blindness (answer)
Change Blindness (answer)