IMGD 3xxx - HCI for Real, Virtual, and Teleoperated Environments:

The Human Visual System and Visual Display Techniques

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Introduction

- Vision is the most dominant sense
  - Though other senses are better at certain things, like smell for memory recall
- What types of visual elements are common to interactive experiences?
- How can we leverage the visual sense to promote efficiency and effectiveness?

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
- For gaming, low-cost is important

Some Things to Remember

- Humans are animals, and hence, have evolved over time.
- Evolutionary forces have guided the development of our senses.
- Displays and cues 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
  - Body-worn displays
  - Hand-held displays

Visual Display Anchoring Points

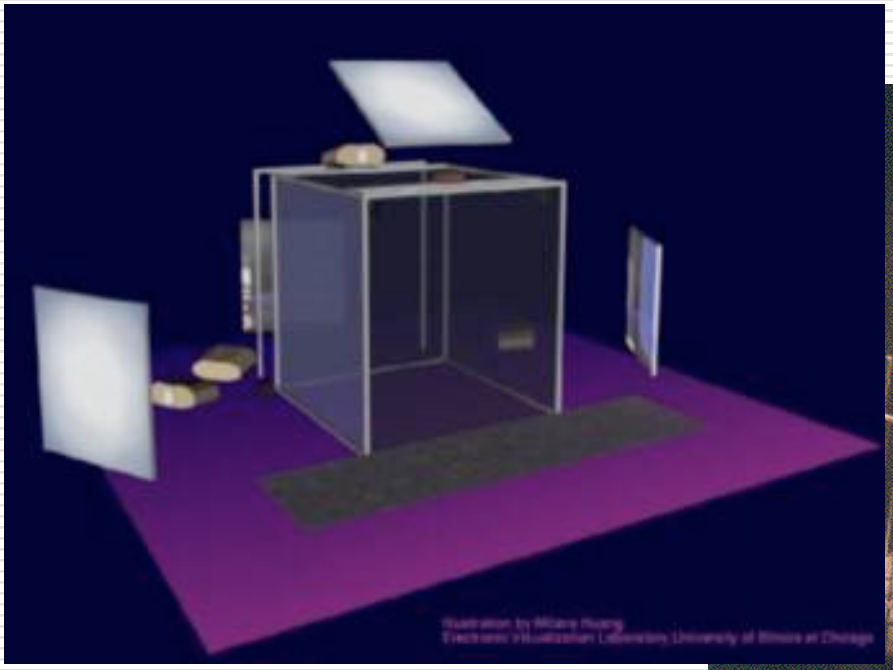
- World-fixed displays
  - Fishtank VR
  - Projection VR
- Body-worn displays
  - Opaque HMDs
  - Transparent HMDs
- Hand-held displays
  - Palm VR
  - Boom-mounted screens

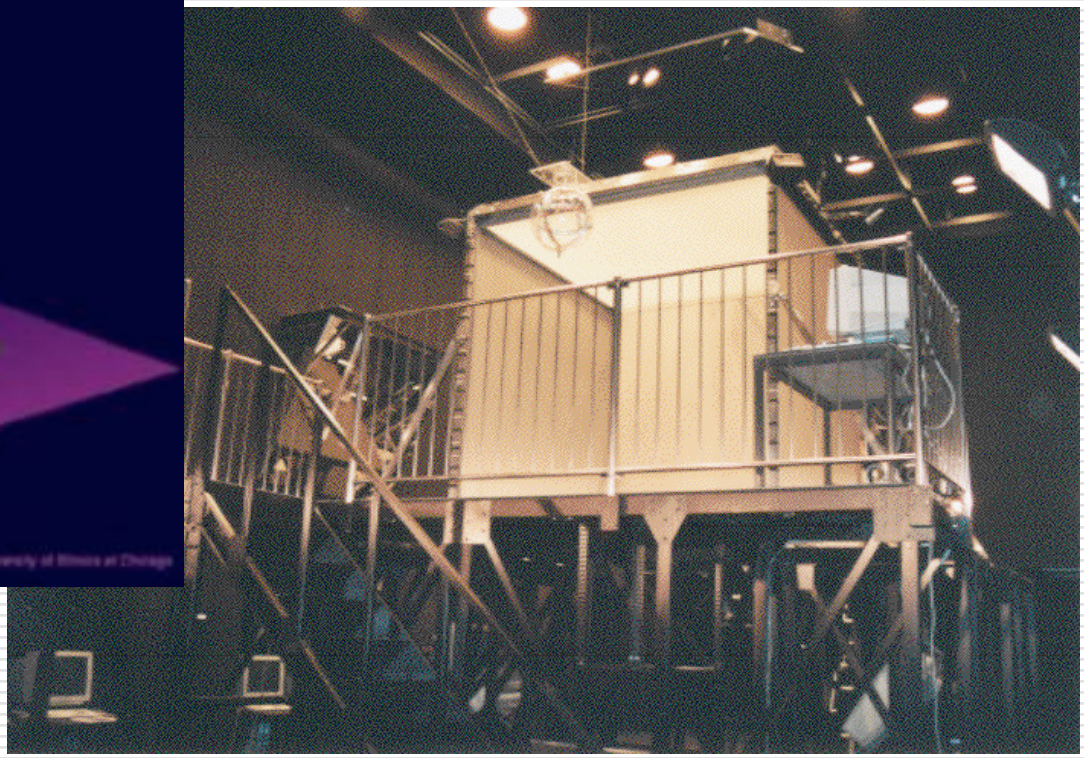
Visual Display Types

- 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

Surround Screens

- CAVEs

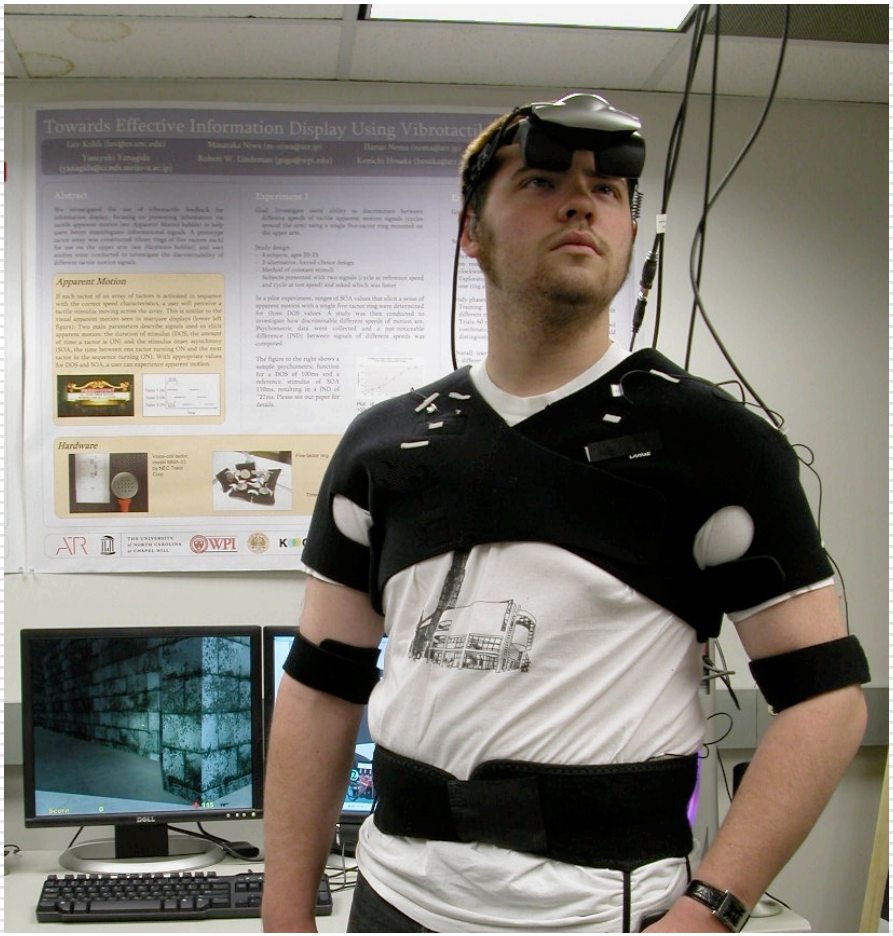




Surround Screens (cont.)

- CAVE

Head-Mounted Displays (HMDs)

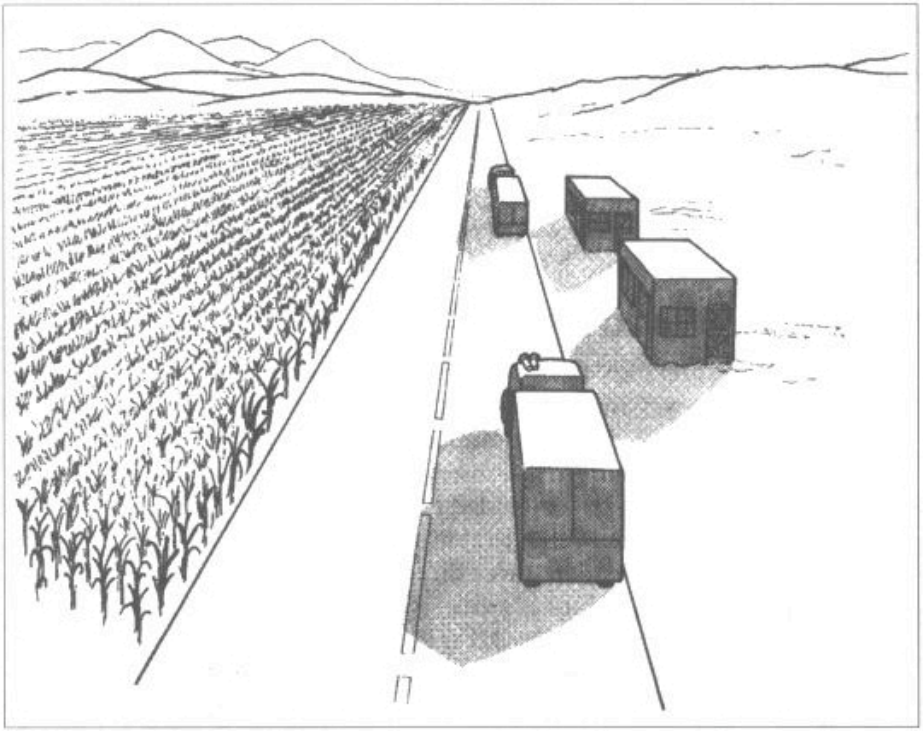


Visual Cues

- 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

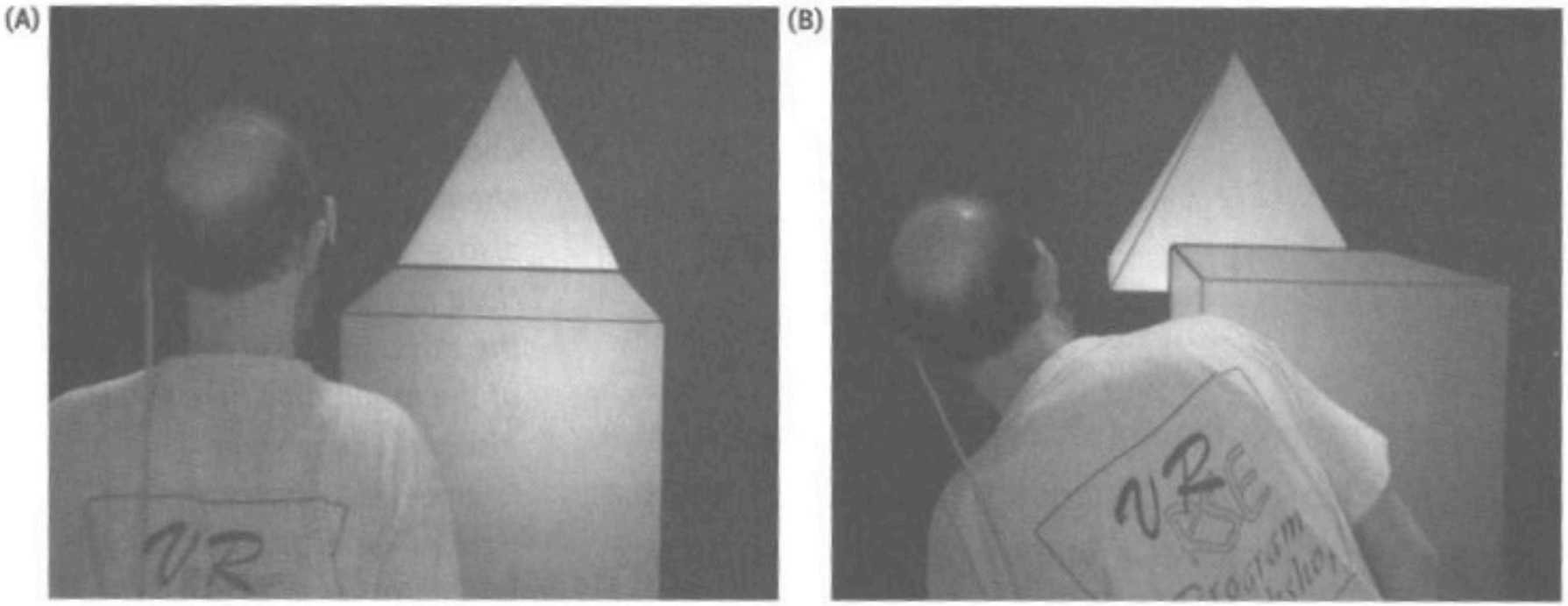
Motion Depth Cues

- 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



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

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 currently surrounding the user
- Examples
  - CAVE: 200° FOV facing forward, 75% FOR
  - HMD: 100° FOV, 100% FOR

Hand-Held VR

- PDAs are becoming more powerful
  - Can track a tablet PC, and use as VR display
- Call phones have cameras
  - Can do AR

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
- A public service announcement:
  - http://www.youtube.com/watch?v=Ahg6qcgoay4&NR=1
- Next example from:
  - http://www.psych.ubc.ca/~rensink/flicker/
  - Show Movie

Change Blindness

Change Blindness (answer)

Change Blindness (answer)

Visuals in Games

- Two main kinds
  - Visuals for representing the world (player)
  - Visuals for representing the state of the game (player)
- Usually for the first type, more is better
- Usually for the second type, less is better

Heads-Up Displays (HUDs)

- What is a HUD?
  - "A collection of persistent on-screen elements whose purpose is to indicate player status."

  (Greg Wilson, Gamasutra: http://www.gamasutra.com/features/20060203/wilson_pfv.htm)
- Are HUDs good?

Creating an Effective HUD

- How can we minimize HUD elements?
- Decide what information the player needs, and what he/she doesn't.
- Put as much of that information into the game
  - E.g., speedometer in car, ammo count on weapon
- Off-load from visuals to something else
  - Examples for what would work?
- Blink-in changes, then fade them out
- Make things configurable
  - View point, map type, transparency
- Camouflage the HUD using themes

HUD-less

(*Peter Jackson's King Kong*)

Integrated HUD Info

(*Doom 3*)

Integrated HUD Info

(*Project Gotham Racing 3*)

Semi-Opaic HUD

(*Deus Ex: Invisible War*)

Themed HUD

(*Metroid Prime*)

Need For Speed HUD Elements

Need For Speed HUD Elements

Good Readings

- "Learn Faster to Play Better"
  - http://www.gamasutra.com/view/feature/3392/learn_faster_to_play_better_how_.php
- "Off with their HUDs"
  - http://www.gamasutra.com/features/20060203/wilson_01.shtml