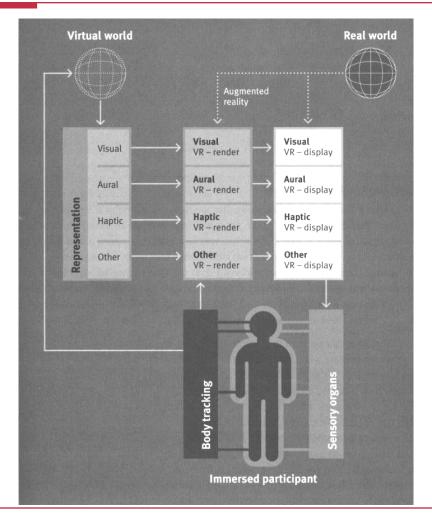# IMGD 5100:
Immersive HCI

Output Devices - Visual

Robert W. Lindeman

Associate Professor

Interactive Media & Game Development

Department of Computer Science

Worcester Polytechnic Institute

gogo@wpi.edu

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
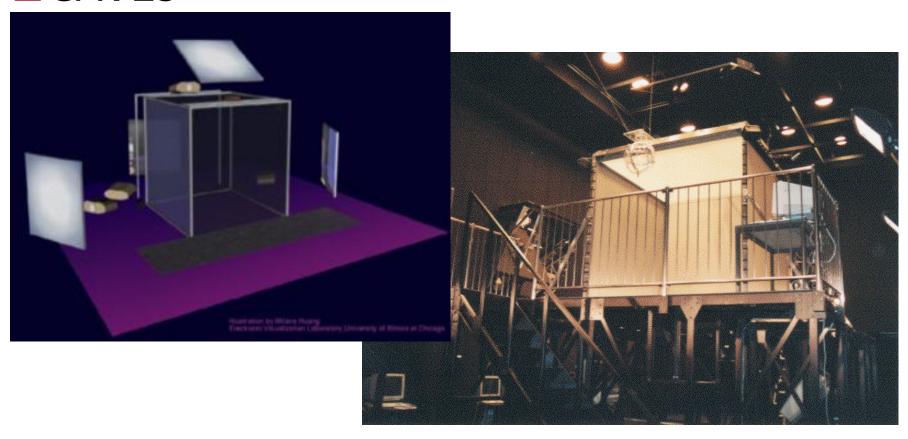- ■ Mobile devices

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

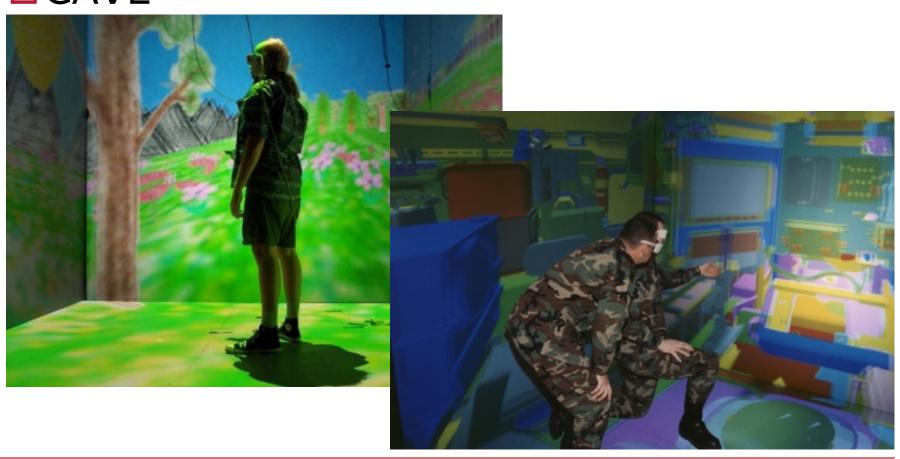- ☐ Autostereoscopic displays

- ☐ 3D displays

Visual Displays

☐ CAVEs

Visual Displays (cont.)

□ CAVE

Head-Mounted Displays (HMDs)

HMDs (cont.)

□ Oculus Rift

Augmented Reality Glasses

☐ Google Glass

Augmented Reality Glasses

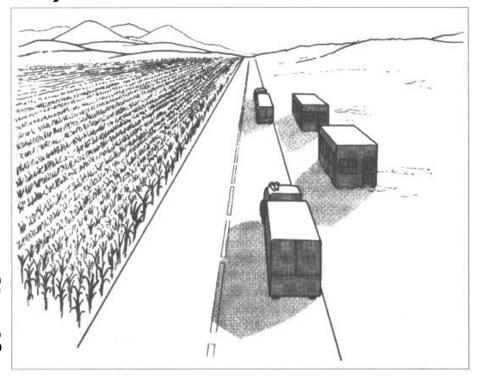☐ Epson Moverio

Augmented Reality Glasses

☐ Meta Glasses

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
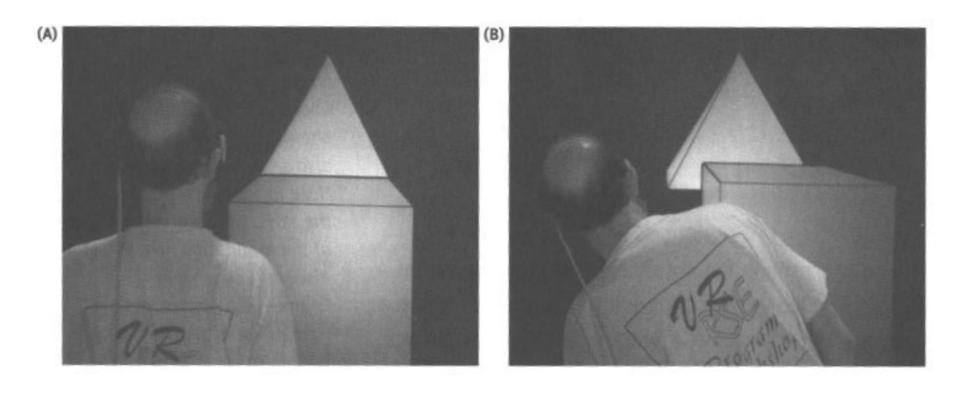
Motion Depth Cues

- ☐ 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&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)
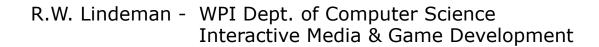
Nintendo DS Lite
(2006)

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

- 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*)
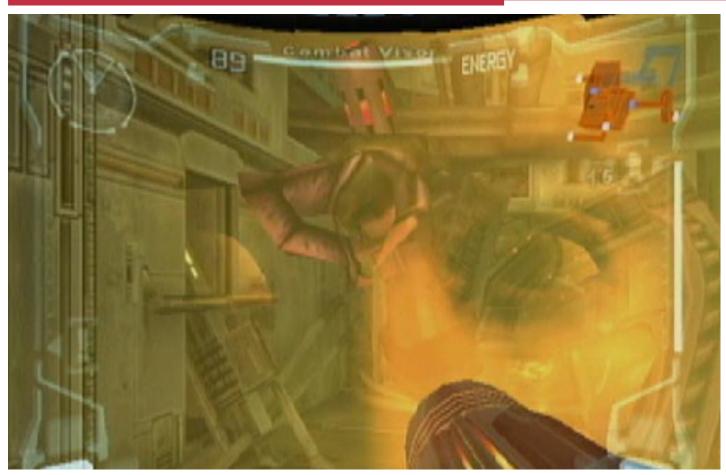
Semi-Opaic HUD

(*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