IMGD 5100: Immersive HCI

Introduction

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Course Goals

- Learn about designing, building, and evaluating immersive interfaces
- Look at how humans function
- Look at application areas
- Look at usage environments
- Understand the main problems/sub-fields
- Build something cool!
Assignments

- 2-3 Assignments
  - Each uses different technologies

- Paper summaries
  - You will write short summaries for several papers

- Final Project
  - Done in groups of two/three
  - Go deeper into one application/technology
  - Evaluate your system with a user study
Final project

☐ Choose
  ■ User population
  ■ Application
  ■ Usage environment (e.g., mobile)

☐ Choose I/O devices/techniques

☐ Design the application

☐ Design the interface & interaction

☐ Build the system

☐ Assess the result
Assignments

- Can be done in teams
  - Clearly define what each member will be responsible for

- Can use any software/language you like

- Samples
  - OpenGL, DirectX, Java3D, OpenSceneGraph, OpenSG, FreeVR, Android, iphone
  - Game-engine code (Unity, UE4, C4)

- Resources
  - HIVE has many devices for you to use.
  - Field trip later in the semester
  - (old) Android phones
What is Virtual Reality?

☐ You tell me!
Virtual Reality Systems

- 1929 – Link Flight Simulator
- 1946 – First computer (ENIAC)
- 1956 – Sensorama
- 1960 – Heileg’s HMD
- 1965-68 – The Ultimate Display
- 1972 – Pong
- 1976 – Videoplace
- 1977 – Apple, Commodore, and Radio Shack PCs
- 1979 – First Data Glove [Sayre] (powerglove -89)
- 1981 – SGI founded
- 1985 – NASA AMES
- 1986-89 – Super Cockpit Program
- 1990s – Boom Displays
- 1992 – CAVE (at SIGGRAPH)
- 1995 – Workbench
- 1998 – Walking Experiment
Link Flight Simulator

- 1929 - Edward Link develops a *mechanical flight simulator*
- Train in a synthetic environment
- Used mechanical linkages
- Instrument (blind) flying

http://www.wpafb.af.mil/museum/early_years/ey19a.htm
Sensorama

Morton Heilig, 1956

Motorcycle simulator - all senses
- visual (city scenes)
- sound (engine, city sounds)
- vibration (engine)
- smell (exhaust, food)

Extend the notion of a ‘movie’
Heilig's HMD (1960)

Simulation Mask from Heilig’s 1960 patent

- 3D photographic slides
- WFOV optics with focus control
- Stereo sound
- Smell
Ivan Sutherland

- The Ultimate Display (FIPS 1965)
  - Data Visualization: “A display connected to a digital computer...is a looking glass into a mathematical wonderland.”
  - Body Tracking: “The computer can easily sense the positions of almost any of our body muscles.”
Ultimate Display (cont.)

- Virtual Environments that mimic real environments: “A chair display in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal.”
- VEs that go beyond reality: “There is no reason why the objects displayed by a computer have to follow ordinary rules of physical reality with which we are familiar.”
First HMD-Based VR

1965 - The Ultimate Display paper by Sutherland
1968 - Ian Sutherland’s HMD
Molecular Docking Simulator

- Incorporated force feedback
- Visualize an abstract simulation
Data Gloves

- Light, electrical or metal detectors compute “bend”
- Electrical sensors detect pinches
- Force feedback mechanical linkages
1985 - NASA Ames HMD

- McGreevy and Humphries
  - Wearable immersive HMDs
  - LCD “Watchman” displays
  - LEEP Optics

- Led to VIVID, led by Scott Fisher
FakeSpace Boom Display: Early 1990s
CAVE - 1992
Virtual Workbench-1995
(Responsive Workbench, Immersidesk, etc.)
Excellent VE

- UNC Pit Experiment
- Fear of Heights a Strong Response
- Thousands of visitors
- Compelling Experience
  - Haptics
  - Low Latency
  - High Visual Quality
VPL Founded - 1985

- First VR Company
- VPL Research by Jaron Lanier and Thomas Zimmerman
  - Data Glove
  - Term: Virtual Reality

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1995 - Effectiveness of computer-generated (VR) graded exposure in the treatment of acrophobia in *American Journal of Psychiatry*
Major Reinvigoration: Hardware Evolution

- High expense
- PC performance surpasses Graphics supercomputers
  - SGI RealityEngine (300k tris – 1993)
  - XBOX (150 mil tri/sec - 2001)
  - XBOX360 (500 mil tri/sec - 2005)
  - WiiMote/MotionPlus
  - Sony MOVE (SHOW MOVIE!)
  - MS Kinect (SHOW MOVIE!)
- Large LCDs are “cheap”
- 3D displays are here
- Low-cost Head Mounted Displays (HMDs)
Why Study Immersive HCI?

- Relevant to real-world tasks
  - Can use familiarity to ease adaptation
  - Can increase realism of experience

- Mature technology
  - Cheap, robust solutions
  - Need to create interface mappings

- 3D interaction is difficult
  - Many VR/gaming systems lack necessary cues
  - Adapting WIMP techniques is not adequate
Why Study Immersive HCI? (cont.)

- Current approaches are either too simple or unusable
  - Since users have problems, dumb it down!
  - Need to be able to perform all actions though!

- Ripe area for study
  - Very hot area of HCI
  - We know a lot about doing things in 2D
  - And also about doing things in the real world
  - Mobile wearable systems emerging
A Brief History (cont.)

- HCI draws on
  - Perception
  - Cognition
  - Linguistics
  - Human factors
  - Ethnography
  - Graphic design
  - Computer science
  - ...

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Interactive Media & Game Development
A Brief History (cont.)

- Technology developments also drive growth
  - Flight simulators
  - 3D Graphics
  - Augmented Reality (AR)
  - Virtual Reality (VR)
  - Immersive Gaming
Basic Interaction Tasks in VR (Bowman et al.)

- Object Selection & Manipulation
  - What do I want to manipulate?
  - How can I manipulate it?

- Navigation
  - Wayfinding: How do I know where I am, and how to get where I am going?
  - Travel: How do I get there? (locomotion)

- System Control
  - How do I change system parameters?

- Symbolic Input
  - Inputting text and numbers

- Avatar Control
  - How do you control you?
World Builder (Bruce Branit)

- Concept film
- Can you spot the different tasks?
Dealing with Objects

- Problems
  - Ambiguity
  - Distance

- Selection Approaches
  - Direct / enhanced grabbing
  - Ray-casting techniques
  - Image-plane techniques

- Manipulation Approaches
  - Direct position / orientation control
  - Worlds in miniature
  - Skewers
  - Surrogates

Courtesy: D. Bowman
Navigation: Wayfinding

- People get lost/disoriented easily
- Traditional tools
  - Maps (North-up vs. Forward-up)
  - Landmarks
  - Spoken directions
- Non-traditional
  - Callouts
  - Zooming

Images: http://vehand.engr.ucf.edu/handbook/Chapters/Chapter28/Chapter28.html
Navigation: Travel

- Problems
  - Limited physical space, unlimited virtual space
  - Cables

- Approaches
  - Fly where you point/look
  - Treadmills
  - Walking in place
  - Big track ball

Image: www.virtusphere.com
System Control

☐ Need to manipulate widgets
  ■ Lighting effects
  ■ Object representation
  ■ Data filtering

☐ Approaches
  ■ Floating windows
  ■ Hand-held windows
  ■ Gestures
  ■ Menus on fingers
System Control Examples

Courtesy: R. Lindeman

Courtesy: D. Bowman
User, Task & Environment

- The "optimal" interface will depend on the capabilities of the user, the nature of the task being performed, and the constraints of the environment.

- User
  - Dexterity, level of expertise

- Task
  - Granularity and complexity of task

- Environment
  - Stationary, moving, noisy, etc.
Direct Manipulation
Can We Do WIMP in VR?

specifications

- Shell5, IBeam: 15' x 15'
- Space (x x y x h): 29.3, 13.8, 9.7
- Copies x(-2- 4) y(0- 4) z(-1- 4)
- Obj: X(4.3) Y(4.6) Z(4.8)
Desktop Interaction: SensAble PHANToM

http://www.sensable.com/
Wearable Interaction with Haptics: Immersion CyberGrasp
Wearable Interaction:
Rob's *Hand-Held Windows*
How Do We Do Menus?

Courtesy: Virginia Tech
Interface Devices

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Augmented Reality (AR)
AR (cont.)

- Wearable mobile systems emerging
  - Google Glass
    - [https://www.google.com/glass/start/](https://www.google.com/glass/start/)
  - Epson Moverio
  - Meta
    - [https://www.spaceglasses.com/](https://www.spaceglasses.com/)
  - CastAR
    - [http://technicalillusions.com/](http://technicalillusions.com/)
  - Just Android phones with special modifications
Google Project Glass

- Concept videos
- How does the user interact?
What Can We Take From Sci-Fi?

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Iron Man Interaction

- What can we take from this?
Sight Video