

### It's All in My Head: Leveraging the Mind to Improve the VR Experience

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### Overview

- □ Where we are now.
- □ Where we want to go.
- □ Why we aren't there yet.
- □Some thoughts on what we can do.



### But First, Who Am I?

- B.A. in Computer Science from Brandeis University (1987)
- M.S. in Systems Management from University of Southern California (1992)
- □ Sc.D. in Computer Science from The George Washington University (1999)
- Non-tenure-track Ass. Prof. at GW (1999-2005)
- Tenure-track Ass. Prof. at WPI (2005-)



### What Else?

- 1987-1992 Project Manager repas GmbH
  - in Germany
    - Real-time factory automation systsms
    - User Interface designer
- Two big events in Germany during that time
  - Can you name them?



### Summer Collaborations

- 1997: NSF Summer Institute in Japan
   Dr. Yukio Fukui (AIST/Tsukuba University)
- 1998-2000: Naval Research Labs (DC)
   Dr. Jim Templeman
- 2002-2006: ATR International (Japan)
   Drs. Yasuyuki Yanagida & Haruo Noma
- 2008-2009: Osaka University (Japan)
   Drs. Yoshifumi Kitamura & Haruo Takemura











### Why I Got Into VR...

- □As a kid:
  - Loved science fiction
  - Optimistic
- □ As an adult
  - Took a chance

### Motivation: Late 1980s / Early 1990s



Interactive Media & Game Development

### Motivation: Late 1990s





### Motivation

- Much excitement (and hype) about how VR was going to change things
  - VR has not made inroads into everyday life
    - Lagging technology
    - Lack of understanding of usability issues
    - □ Lack of "killer app"
  - Still remains mainly in research labs
  - Video games show great promise
  - Training scenarios surgery, military, therapy
- Long-Term Goal of the HIVE
   Make VR more usable
- Human Interaction in Virtual Environments (HIVE) Lab
   We are interested in *all the senses in concert*

### Nothing New? SENSORAMA by Morton Heilig (1960)





### Background

- □ VR defined:
  - Fooling the senses into believing they are experiencing something they are not actually experiencing (Lindeman, 1999)
- □ Virtual reality systems consist of:
  - Graphical/audio/haptic/... rendering
  - Content
  - Tracking of people and objects
  - Collision detection
  - Interaction techniques
  - Optional, but common:
    - Networking
    - □ Autonomous agents



### Keys to Success

- □ High fidelity (or realism)
  - Graphics, audio, haptics, behaviors, etc.
- Low latency
  - Tracking
  - Collision detection
  - Rendering
  - Networking
- Ease of use
  - Low cumber for users
  - Easy integration for programmers
- Compelling Content
- Willing suspension of disbelief

### What About Cost?





SGI Onyx - 1992 (~US\$250,000)

Nvidia GTX 275 - 2009 (~US\$150)



### The Senses

- See (Visual Sense):
  Visuals are excellent!
- Hear (Aural Sense):
  Spatialized audio is very good!
- □ Smell (Olfactory Sense):
  - Very hard! Too many types of receptors.
- Touch (Haptic Sense): Application specific and cumbersome
- Taste (Gustatory Sense):
  We know the base tastes, but that is it!

### See: Head-Mounted Displays



### See: Projection-Based Environments

### See: Projection-Based Environments (cont.)





### Hear: Sound in VR

- Display techniques
  - Multi-speaker output (sound cube)
  - Headphones
  - Bone-Conduction
- Waveform filtering
  - Simple balance & volume control
  - Head-Related Transfer Functions
- Software "Standards"
  - OpenAL
  - A3D from Aureal (RIP!)
  - VRSonic.com



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# Smell: Air Cannon (Yanagida, WPI 2004)





### AirCannon Video



### Touch: Haptic Feedback in VR

#### Tactile: Surface properties

- Most densely populated area is the fingertip (okay, it's the tongue)
- Kinesthetic: Muscles, Tendons, etc.
   Also known as proprioception



8.17 Representation of the Body Surface in Somatosensory Cortex The homunculus (literally, "little man") depicts the body surface with each area drawn in proportion to the size of its representation in the primary somatosensory cortex.

### Touch: Desktop Haptics





### Touch: Exoskeletons





#### http://www.immersion.com/



**The HARP System: Haptic Augmented Reality Paddle for** Virtual Environments



### The TactaBoard 2.1 (2001)

#### DIC DIC

 16 individual PWM signals
 256 levels each
 RS-232
 Can drive many

devices



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### Touch: Wearable Vibrotactile Feedback





### HIVE: TactaCage (2007)





### HIVE: TactaCage (2009)





### So Now What?

### We have made good progress in the technology.

- Virtual actors are (almost) indistinguishable from real ones
- Virtual crowds show emergent behavior
- Interface devices and techniques are more natural
- Content creation tools allow us to be more expressive



### The Real World

- Fast update rate
- □ Integrated multi-modal rendering
- Really good physics
- □ Nearly infinite fidelity
- Can handle a massive numbers of objects and players
- □ Minimal lag
- Does this sound familiar?



### The Real World (cont.)

- We need to use everything we can from the real world.
  - Isn't this what AR does?
  - Dirk says VR is easier, but not in terms of fidelity.

#### Beyond *perceptual* things

- Anticipation
- Expectation
- Previous experience
- Tap into the experiences already anchored in the mind of the user

#### □ Or plant new ones!



### Creating the Experience

- Prime the user to expect what you are about to show them.
- Remove all distractions.
- Let's look deeper at these two.



### Priming the User

#### Can you name any examples of places where this is successful?



### **Removing Distractions**

Can you name some things that might prevent the user from believing what you are showing them?

### The Magic of Disney (and others)

- Well, it's not really magic, just careful planning and excellent execution!
- While you wait in line, you are brought into the story.
  - Learn about Buzz Lightyear
  - Spiderman back story (Universal Studios)
- It's night time, and you have the window open in your house while you read
   Ghost story vs. newspaper

### The Myth of Technical Immersion

- We do not need technology to achieve immersion
  - Other media do it all the time!
  - Books, music and film "transport" us to fantastic places.
- Since our tech is (relatively) low-fidelity, leverage the mind to fill in the blanks
   Ridley Scott's *Alien*



### **Digging Deeper**

### Dagstuhl Seminar on Virtual Realities June 1 - 6, 2008

Google: "Dagstuhl Virtual Realities" for more info



### Who Was There?





### Priming the Experience

- The VR experience starts long before the physical experience
- □ Example:
  - "Would you like to visit my VR lab?"
    - Vs.
  - "In my lab, I'm building the PlayStation 6. Would you like to visit?"

## Plant the seed for the experience you want to see grow.

□ Reduces the *variability* between users.



### Dagstuhl Approach

Group discussion: "What are some of the Magic Moments in your life?"

#### □ Answers:

- "For me, it usually has some element of surprise or novelty."
- "For me, memorable moments are those with high anticipation, followed by achievement of a goal (performance)."
- "Visiting the Oklahoma City bombing site was unforgettable, because of the weight of the event that happened there."
- "I had the good fortune of fulfilling a childhood dream of playing hockey in a famous stadium."

#### Common themes?



### Dagstuhl Approach (cont.)

#### □ More answers:

- "Achievement of flow (Csikszentmihalyi, 1991) constitutes magic moments for me."
- "For me, it is when I am so engaged in an activity that I lose track of time and space; my focus is drawn in to what I am doing."
- "Sometimes, though rarely, I experience a focus of consciousness and self-sense of the scale of things, extreme hypersensitivity, a heightened awareness and lack of distraction."

#### □ Sounds like the force, Luke!



### Dagstuhl Approach (cont.)

#### □ Still more answers:

- "I most remember full-body experiences, and living in the moment, such as sitting in a hot tub while really stressed, or standing in the rain and getting that full experience."
- "I was a spectator at a unique show that had a huge outdoor stage (2-3 km high) set up by a river. This was true full-sensory stimulation."
- "Doing "The Wave" at a stadium is an example of a large group engaged in a shared experience."

#### Multiple senses in concert



### Summary from Dagstuhl

- □ We should carefully design both firstand third-person experiences every time.
- □ First person is the user, third person is the next user waiting in line.
- 1. Plant the seed
- 2. Present the best VR experience you can
- 3. Remove distractions
- 4. Don't let the next participant watch



### So, How Do We Do This?

- □ As VR researchers, we are both
  - a) Technology providers, and
  - b) Content providers.
- For too long, we've been focusing on (a), and (greatly) ignoring (b).
- □ Arguably, we can do (a) pretty well.
- □ We need to learn to embrace (b).
- Successful game design teams marry technologists, artists, and designers to craft seamless, believable, compelling experiences.

### Summary of Effective VR Presentation



- Focus on building anticipation before the experience
- Provide a seamless transition from viewer to participant
- Improve the interactivity afforded to users
- Promote user engagement in the tasks at hand
- □ Increase the intimacy of shared experiences
- □ Insure the safety (worry) of the user
- Remove distractions
- Allow participants to let go of their sense of the real world



### **Final Thoughts**

- Achieving this is rooted in harnessing the power of human imagination.
- The creativity and processing power of the mind must be tapped to bring virtual worlds to a level that allows us to improve user effectiveness through *experiential fidelity*, rather than striving to match the *actual fidelity* of the real world.



### IEEE VR 2010!

- □ March 20-26, 2010
  - 3DUI/VR Tut./Wrk.: Sat-Sun (Mar. 20-21)
  - IEEE VR Main Conf.: Mon-Wed (Mar. 22-24)
  - Haptics Symposium: Thu-Fri (Mar. 25-26)
- Westin Waltham-Boston
  - Just West of Boston
  - In the heart of the Rt. 128 Tech corridor
  - Near to 3 major airports
    - Boston Logan, Manchester, NH & Providence, RI
  - Balance between cost & quality
    - □ Large, renovated meeting space



### Hotel Photos





### Local Culture/Attractions

- Birthplace of American Revolution
   Lexington & Concord
- Fenway Park
   Boston Red Sox Home
- Lots of local Colleges/Universities
- □ Great seafood
- □ Whale watching
- □ All of Boston!





### More Info

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Dhttp://www.cs.wpi.edu/~gogo/

Dhttp://www.cs.wpi.edu/~gogo/hive/