CSCI 420 Computer Graphics
Lecture 25

Virtual Reality

History of Virtual Reality
Flight Simulators
Immersion, Interaction, Real-time
Haptics

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Virtual reality

“computer-simulated environments that can simulate physical presence in places in the real world, as well as in imaginary worlds”

U.S. Navy personnel using a VR parachute trainer


Virtual reality

• One of the “hottest” R&D areas today

• Applications
  – medical training, future surgery?
  – interior design, civil engineering
  – videoconferencing
  – exploration of future worlds
  – ethics, philosophy, psychology, who am I, and what are we?

Source: NASA

Virtual reality is a “hot” topic today

• Many startup companies
  • Games
  • Film
  • Design (create 3D models, animations in VR)
  • Social networks

Virtual reality

14 grand challenges in engineering (by the US National Academy of Engineering)

• Make Solar Energy Economical
• Provide Energy from Fusion
• Develop Carbon Sequestration Methods
• Manage the Nitrogen Cycle
• Provide Access to Clean Water
• Restore and Improve Urban Infrastructure
• Advance Health Informatics
• Engineer Better Medicines
• Reverse-Engineer the Brain
• Prevent Nuclear Terror
• Secure Cyberspace
• Enhance Virtual Reality
• Advance Personalized Learning
• Engineer the Tools of Scientific Discovery

History of virtual reality

• 50+ years of history

Link Trainer, 1929
(over 500,000 pilots trained)

Source: Microsoft
**Cinerama**

- Expand movie-going experience by filling a larger portion of the audience's visual field
- Required special cameras to film
- Proved too costly to be embraced by most commercial theaters

*Source: Wikipedia*

**Virtual reality and film**

- VR heavily influenced by film techniques
- Hollywood, from early 1950s

**Avatar (2009)**

**The virtual reality triangle**

- The feeling of “being there”
- User becomes part of the simulated world
- Rather than the simulated world being a feature in the user's world
**Interaction**

- Possibility of moving in the virtual space and manipulate objects
- Without it, illusion breaks down quickly

**Real-time**

- Actions should immediately affect the world
- Computers must simulate the world
- Huge computational burden
- Large computer science challenges

**Head-mounted displays**

- Requires rapid update rates (min 30 fps, preferably 60 fps)
- Very fast tracking and redisplay
- Short lag times
- No noticeable delay between movement and production of correct visuals
- If these are not satisfied => simulator sickness

**Augmented reality**

- Enhances your reality with graphics, haptics, sound

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**Head-mounted displays**

- Oculus Rift (Facebook)
- HTC Vive (HTC and Valve)
- Google Cardboard (Google)

**Augmented reality**

- Source: bestofmicro.com, cultofandroid.com
Augmented reality headsets

- Microsoft HoloLens (Microsoft)
- Magic Leap (Magic Leap, Google)

Virtual reality “hardware”

- Source: Dave Pape
- Source: Mario Tama, Getty Images

Flight simulators

- Key driving force of virtual reality technologies
- US Air Force, NASA
- Friend/foe identification
- Targeting/threat information
- Optimal flight path

Flight simulators

- Must manage and render the virtual world
- Shadows and textures
- Motion and force feedback
- Professional flight simulators are still very expensive (millions of $)

Train simulation

- Fujitsu train simulator (2008)

Tank simulator

- Stryker armored vehicle simulator
  - Source: Jason Kaye, U.S. Army
Application in medicine: Phobia treatment

Source: Virtually Better, Inc.

Application in TV and sports

First-down line
Source: SporTVision

Haptic interfaces

- hap-tic (hap-tik) adj.
  Of or relating to the sense of touch; tactile.

Force-feedback rendering

Phantom 3-DoF device (Sensable)

Barbič and James 2007
Simulation in games

Silent Hunter 4 (Ubisoft)

Virtual reality in games

Source: Colin Anderson

Discussion

• Can we simulate anything?

• What is reality?

Why virtual worlds?

Leontopodium alpinum
Source: appoloniobattista