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
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
Cinerama

How the west was won, 1962 (John Ford)
Virtual reality and film

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

1982 - TRON
2009 - AVATAR
Avatar (2009)
The virtual reality triangle

Real-time

Immersion Interaction
Immersion

• 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

Virtual suturing
Source: Surgical Science
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

Source: Atticus Graybill of Virtually Better, Inc.
Head-mounted displays

Oculus Rift (Facebook)

Google Cardboard (Google)

HTC Vive (HTC and Valve)
Cave

• Project 3D CG into a cube with displays surrounding the viewer

• Coupled with head tracking systems (and other tracking systems e.g. hand)

• Usually surround audio feedback

• Viewer explores virtual world by moving and interacting in the virtual environment

Source: Dave Pape
Augmented reality

- Enhances your reality with graphics, haptics, sound

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

Source: VirtuSphere
Flight simulators

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

Source: NASA
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 $)

Thales flight simulator
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 medicine: Phobia treatment

Source: Virtually Better, Inc.
Application in TV and sports

First-down line
Source: SporTVision
Haptic interfaces

- hap·tic (ˈhap-tik) adj.
  Of or relating to the sense of touch; tactile.
Force-feedback rendering

Phantom 3-DoF device (Sensible)

Force-feedback mouse (Immersion)
Force-feedback rendering

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: appolonio&battista