

CSCI 480 Computer Graphics  
Lecture 25

## Virtual Environments


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 places.”




U.S. Navy personnel using a VR parachute trainer  
Source: Wikipedia

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## Virtual Reality

- One of the “hottest” R&D areas today
- Potential applications
  - medical imaging: training and diagnostic, future surgery?
  - interior design & architectural mock-up, civil engineering
  - videoconferencing
  - exploration of future worlds
  - ethics, philosophy, psychology, who am I, and what are we?
  - entertainment




Source: NASA


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## History of Virtual Reality

- 50+ years of history



Link Trainer, 1929  
(over 0.5 million pilots trained)




Source: Microsoft

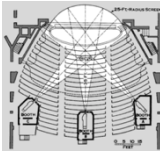
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## Cinerama

- 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




“The biggest new entertainment event of the year.” - LIFE  
1950s



Source: Wikipedia

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## Cinerama




How the west was won, 1962 (John Ford)


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### Virtual Reality and Film

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



1982

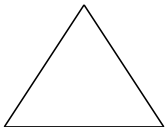


2009

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### The virtual reality triangle

Real-time




Immersion                      Interaction

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### 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



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### Interaction

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

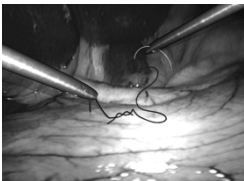


World of Warcraft

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### Real-time

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

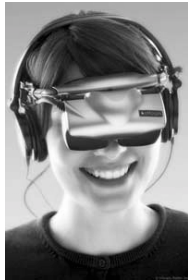


Virtual suturing  
Source: Surgical Science

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### Head-mounted displays

- Requires **rapid** update rates
- Very fast tracking and redisplay, preferably 60 fps, at the very least 30 fps
- 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.

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### Cave

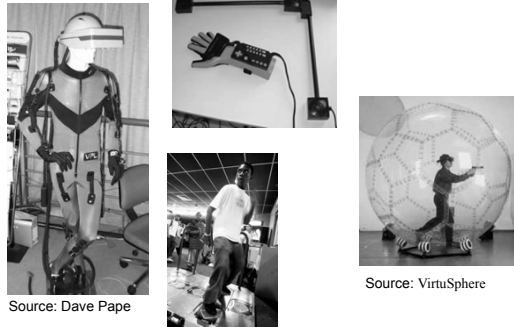
- Project 3D CG into a cube with displays surrounding the viewer
- Coupled with head tracking systems (and other tracking systems e.g. hand)
- Usually surround audio feedback
- Viewer explores virtual world by moving and interacting in the virtual environment



Source: Dave Pape

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### Virtual Reality "Hardware"



Source: Dave Pape


Source: Mario Tama, Getty Images

Source: VirtuSphere

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### Flight Simulators

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




Source: NASA

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### Flight Simulators

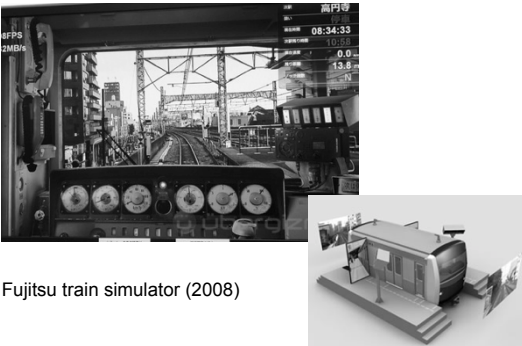
- Must render the virtual world
- Secondary visual cues
- Shadows and textures
- Motion and force feedback
- Techniques for management and efficient display of complex worlds
- Professional flight simulators are still very expensive (millions of \$)



Thales flight simulator  
Source: Wikipedia


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### Train simulation



Fujitsu train simulator (2008)

### Tank simulator

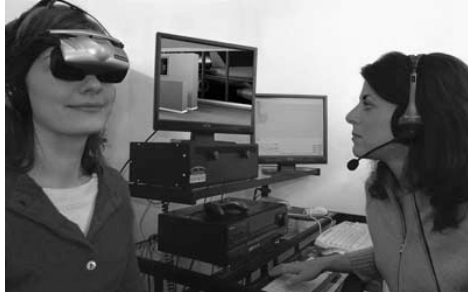


Stryker armored vehicle simulator

Source: Jason Kaye, U.S. Army

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### Application in medicine: Phobia treatment



Source: Virtually Better, Inc.

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### Application in medicine: Phobia treatment



Source: Virtually Better, Inc.

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### Application in TV and sports



First-down line  
Source: SporTVision

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### Haptic interfaces

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



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### Force-feedback rendering



Phantom 3-DoF device  
(Sensable)



Force-feedback mouse  
(Immersion)

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### Force-feedback rendering



Barbic and James 2007

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### Simulation in games



Silent Hunter 4 (Ubisoft)

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### Virtual reality in games



Source: Colin Anderson

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### Discussion

- Can we simulate anything?
- What is reality?



### Why virtual worlds?



Leontopodium alpinum  
Source: appolonio&battista

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