CSCI 420 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 worlds"



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
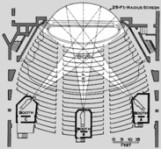
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## Cinerama

• Expand movie-going experience by filling a larger portion of the audience's visual field



"The biggest new entertainment event of the year." - LIFE

1950s

• Required special cameras to film

• Proved too costly to be embraced by most commercial theaters



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
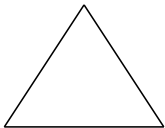
• Hollywood, from early 1950s



1982          2009                    7

## 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
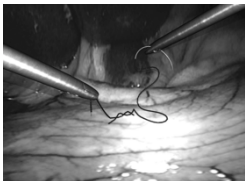• Without it, illusion breaks down quickly



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
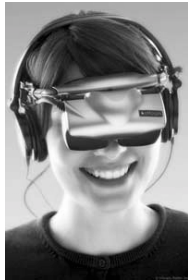
Virtual suturing
Source: Surgical Science

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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

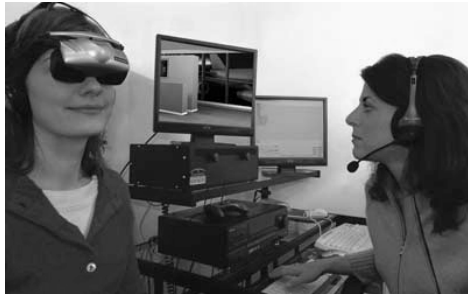Stryker armored vehicle simulator

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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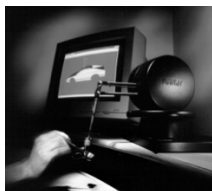## Application in TV and sports



First-down line
Source: SporTVision

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## Haptic interfaces

- hap·tic ('hap-tik)
  a*dj.*
  Of or relating to the sense of touch; tactile.



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## Force-feedback rendering



Force-feedback
mouse
(Immersion)

Phantom 3-DoF device
(Sensable)

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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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