CSCI 480 Computer Graphics
Lecture 25

Virtual Environments

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

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http://www-bcf.usc.edu/~jbarbic/cs480-s11/

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

Virtual Reality

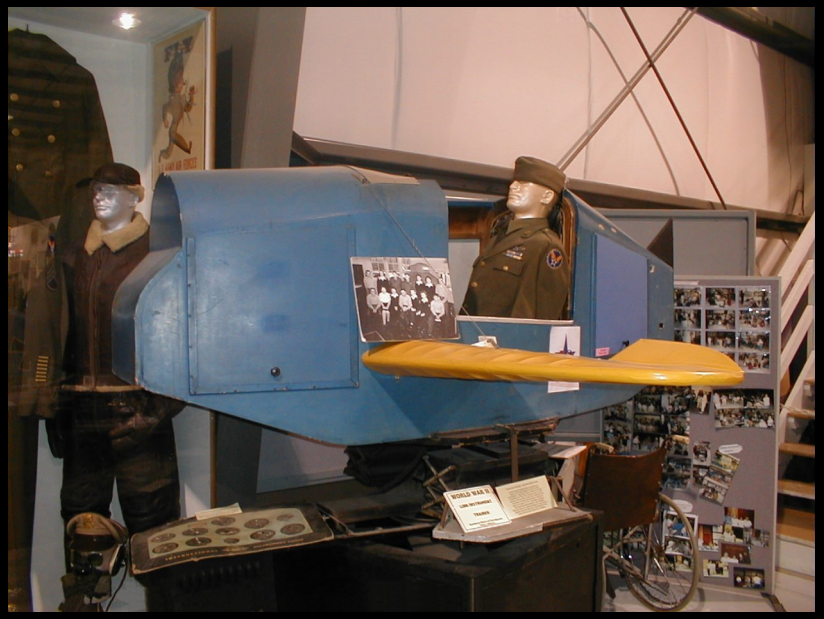
- One of the “hottest” R&D areas today

- 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

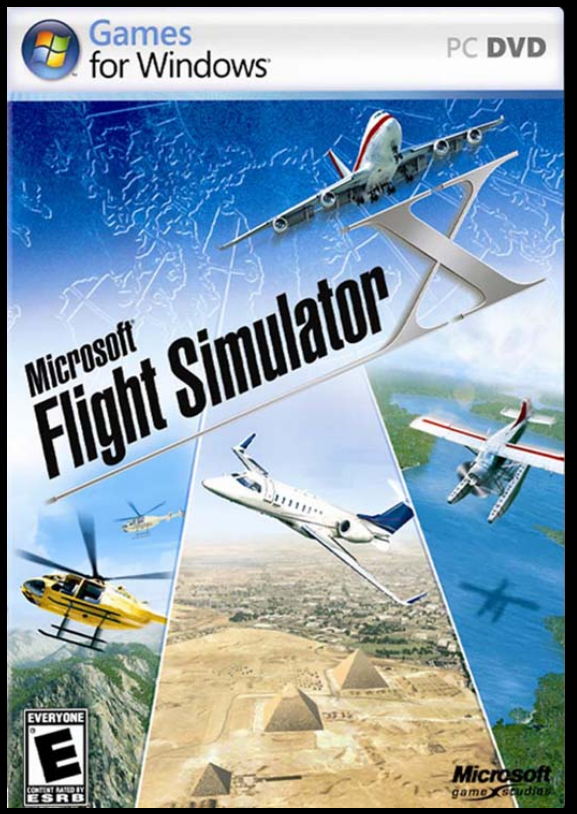
Source: NASA

History of Virtual Reality

- 50+ years of history



Link Trainer, 1929
(over 0.5 million
pilots trained)

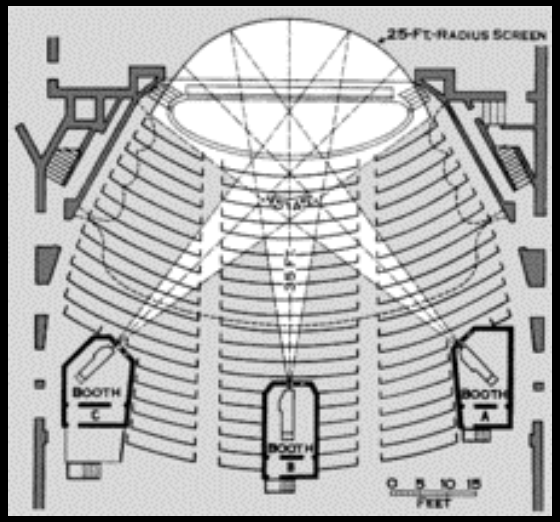


Source:
Microsoft

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

1950s



Source: Wikipedia

Cinerama

How the west was won, 1962 (John Ford)

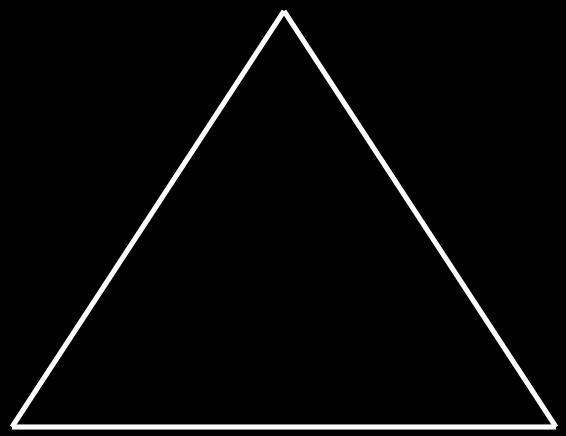
Virtual Reality and Film

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

1982

2009

The virtual reality triangle



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

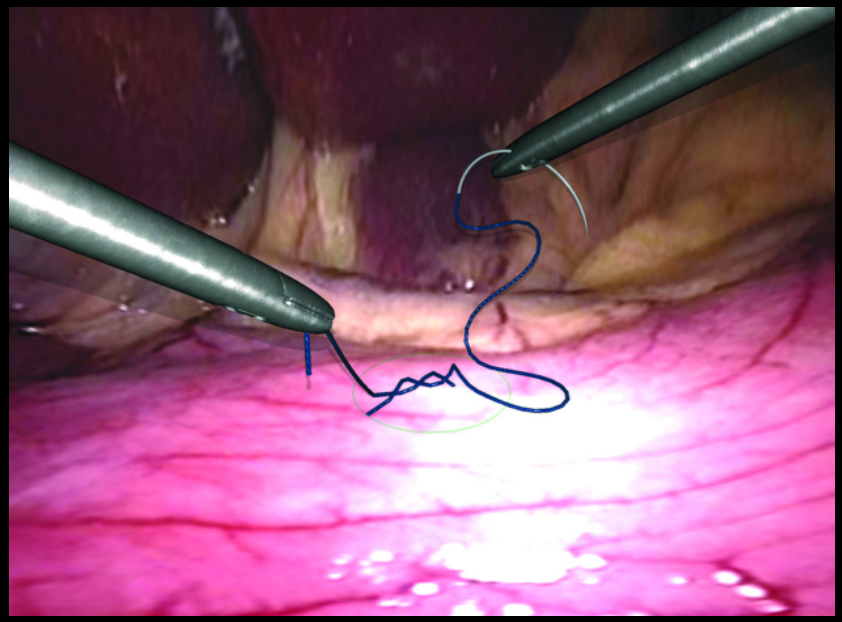
Interaction

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

World of Warcraft

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
- 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.

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

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

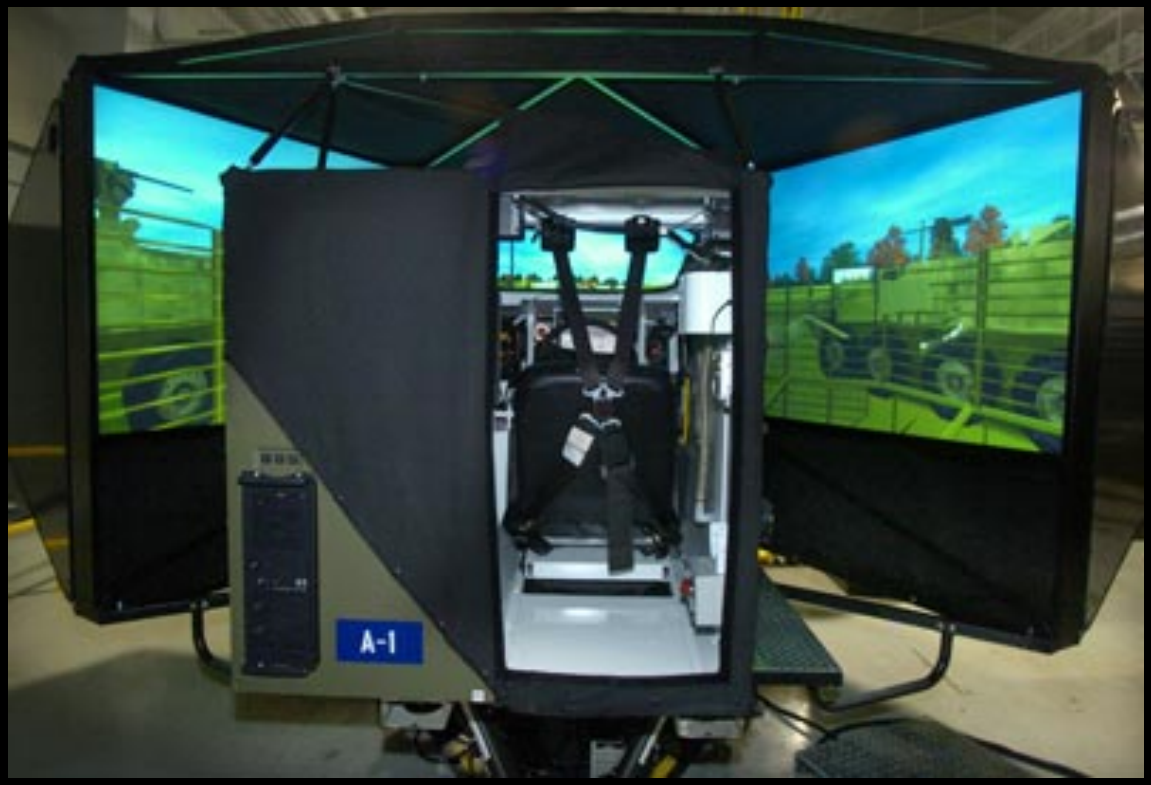
- Must render the virtual world
- Secondary visual cues
- Shadows and textures
- Motion and force feedback
- Techniques for management and efficient display of complex worlds
- Professional flight simulators are still very expensive (millions of $)

Thales flight simulator
Source: Wikipedia

Train simulation

Fujitsu train simulator (2008)

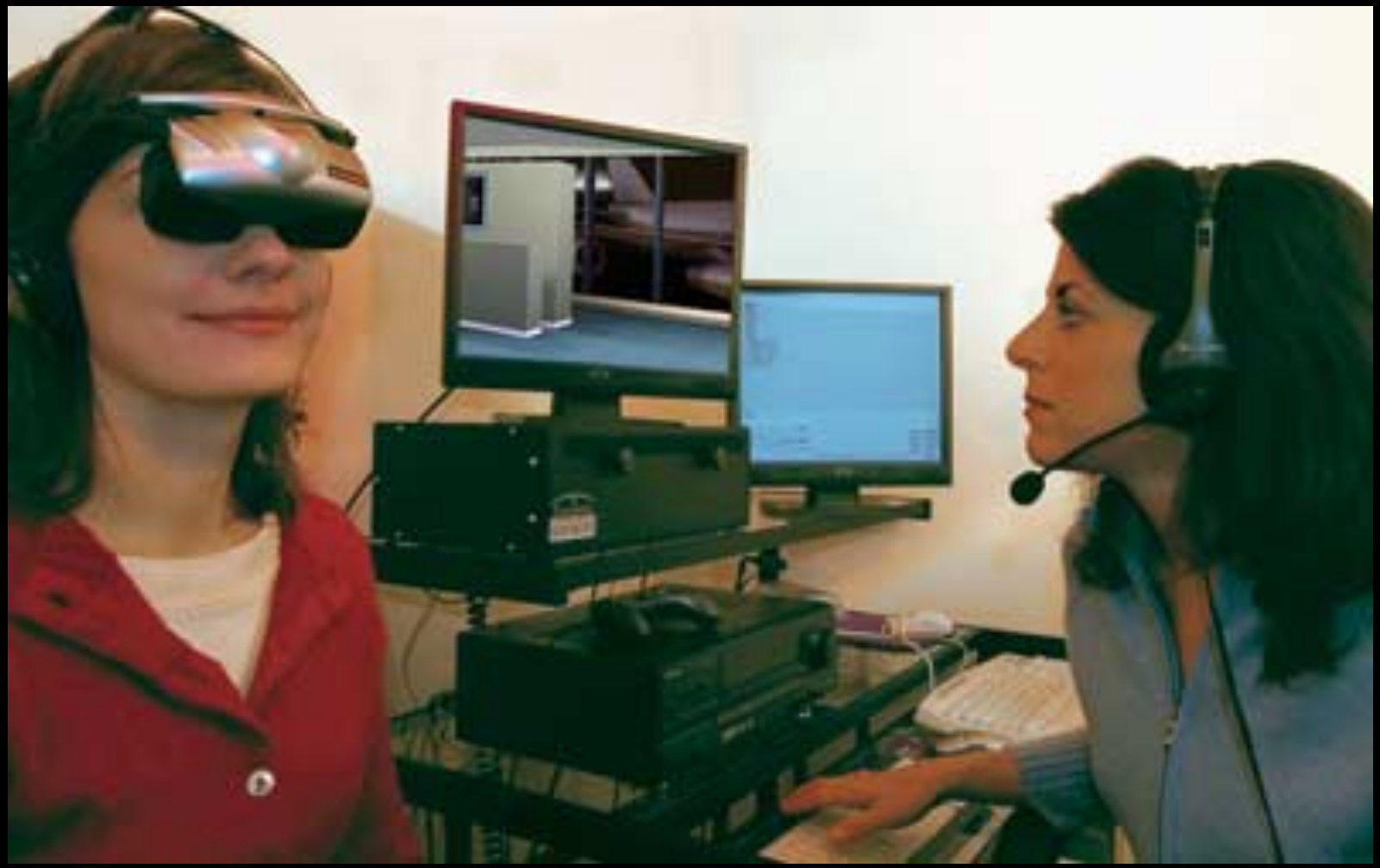
Tank simulator



Stryker armored vehicle simulator

Source: Jason Kaye, U.S. Army

Application in medicine: Phobia treatment



Source: Virtually Better, Inc.

Application in medicine: Phobia treatment

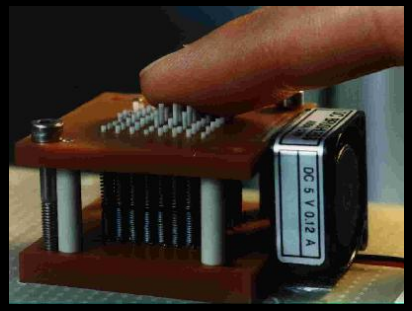
Source: Virtually Better, Inc.

Application in TV and sports

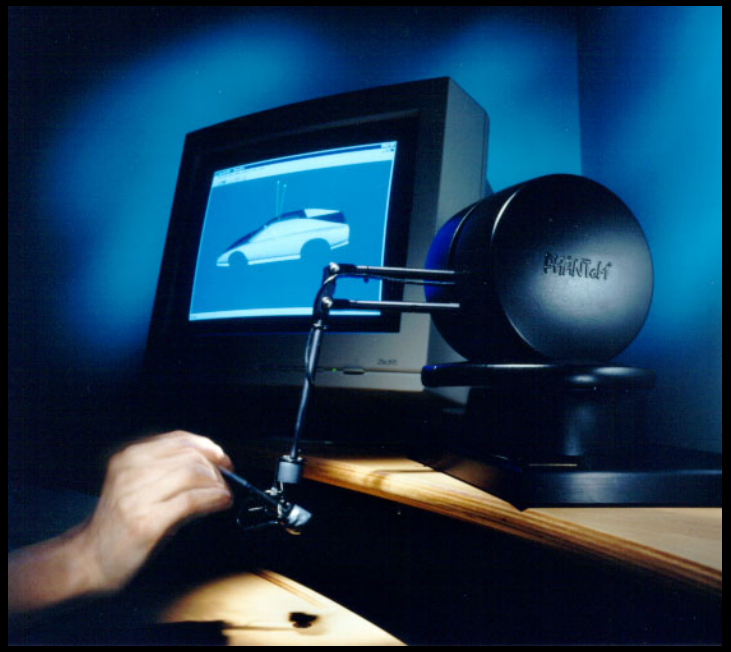
First-down line
Source: SporTVision

Haptic interfaces

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



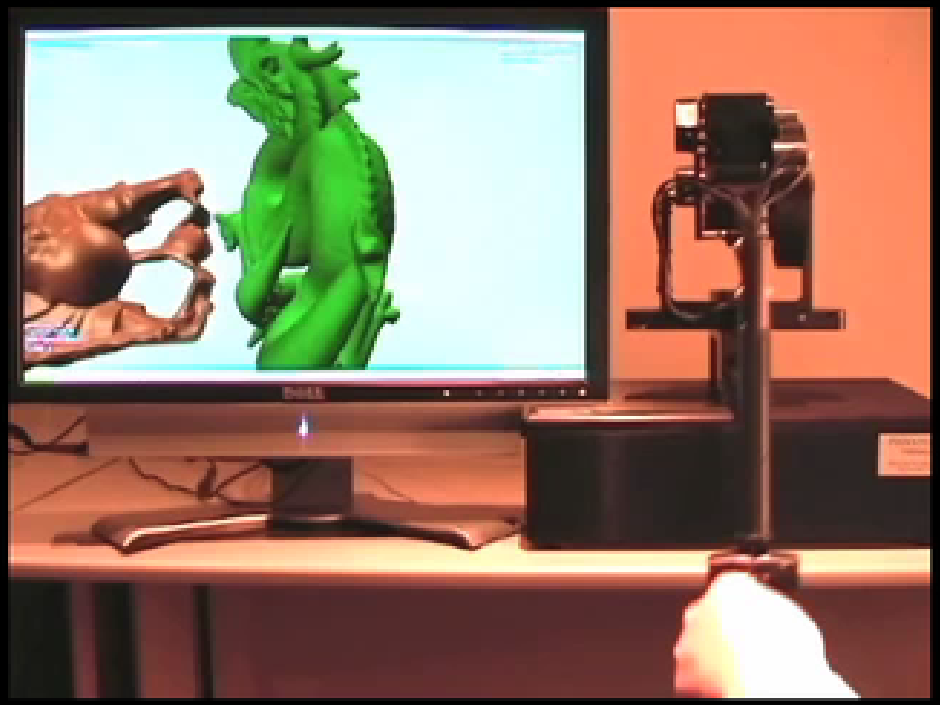
Force-feedback rendering



Phantom 3-DoF device
(Sensable)

Force-feedback
mouse
(Immersion)

Force-feedback rendering



Barbic and James 2007

Simulation in games

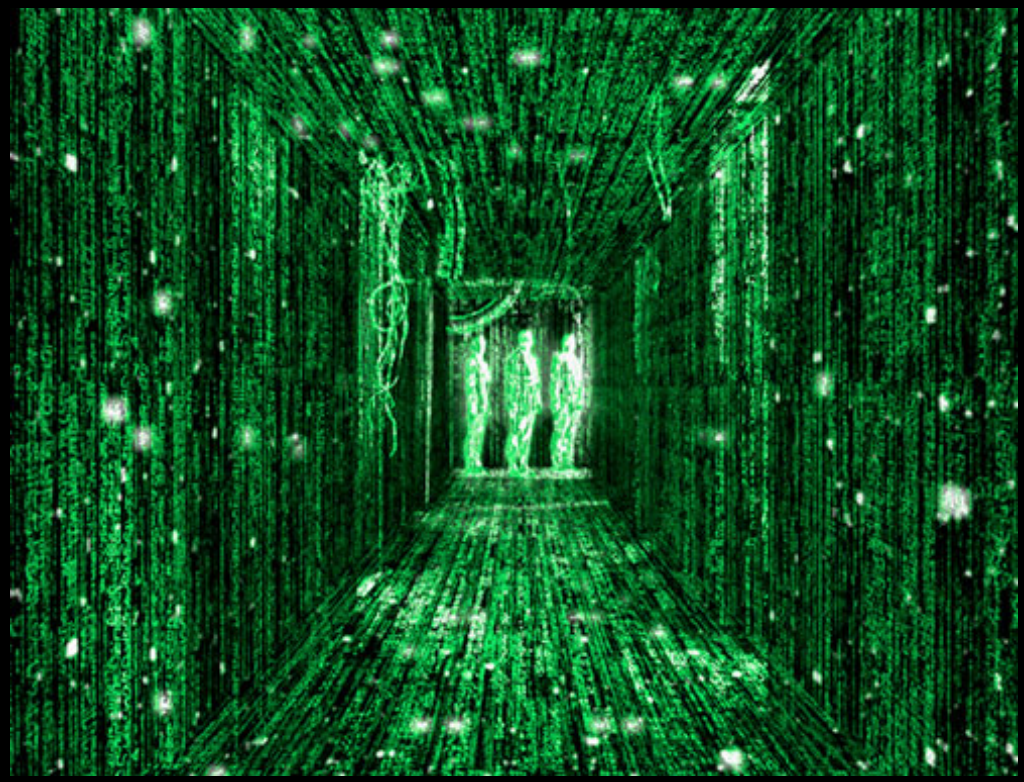
Silent Hunter 4 (Ubisoft)

Virtual reality in games

Source: Colin Anderson

Discussion

- Can we simulate anything?
- What is reality?



Why virtual worlds?

Leontopodium alpinum
Source: appolonio&battista