CSCI 480 Computer Graphics
Lecture 25

Virtual Environments

History of Virtual Reality

Flight Simulators

Immersion, Interaction, Real-time

Haptics

April 23, 2012
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http://www-bcf.usc.edu/~jbarbic/cs480-s12/

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
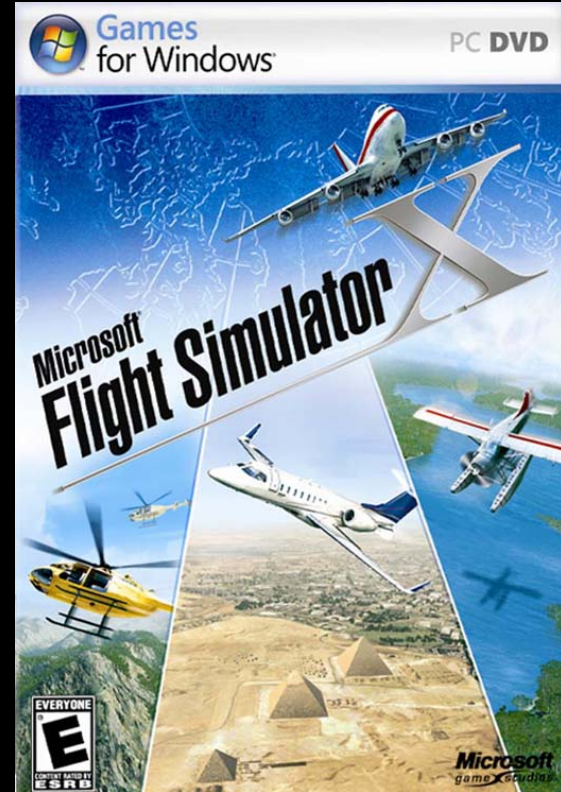 - ethics, philosophy, psychology, who am I, and what are we?
  - entertainment

Source: NASA

History of Virtual Reality

- 50+ years of history
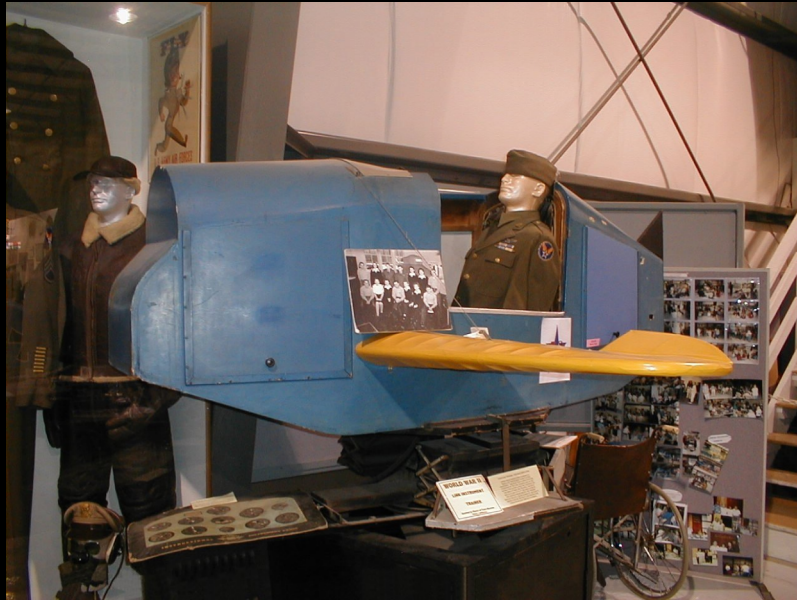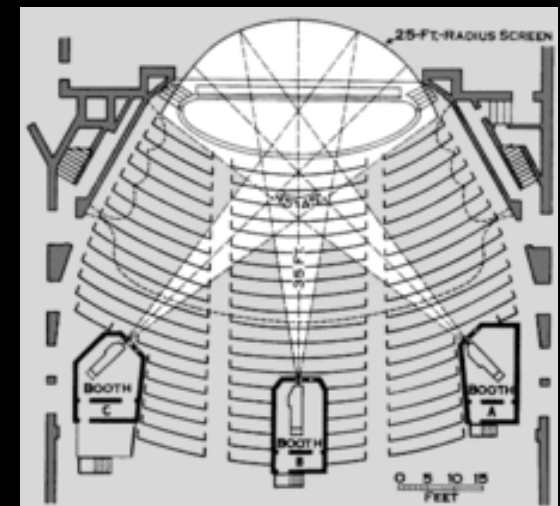

Link Trainer, 1929
(over 0.5 million
pilots trained)

Source:
Microsoft

Cinerama

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

1950s

- 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

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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
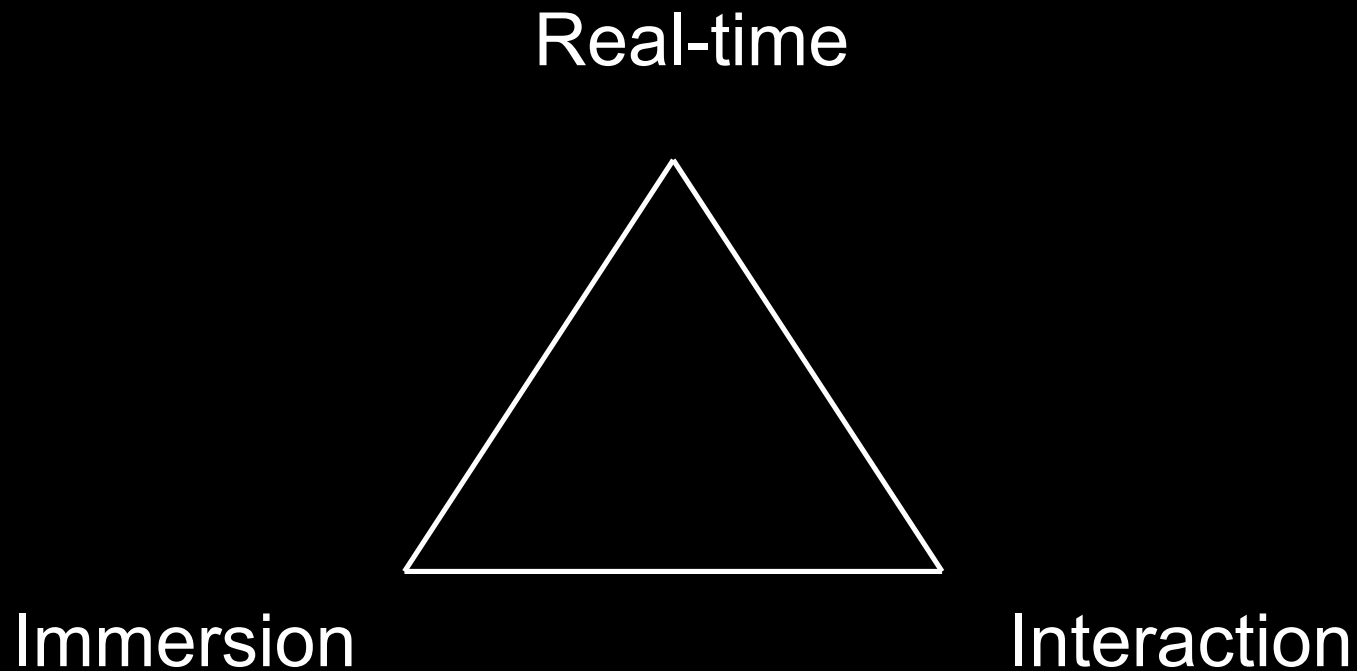
- Hollywood, from early 1950s

1982

2009

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
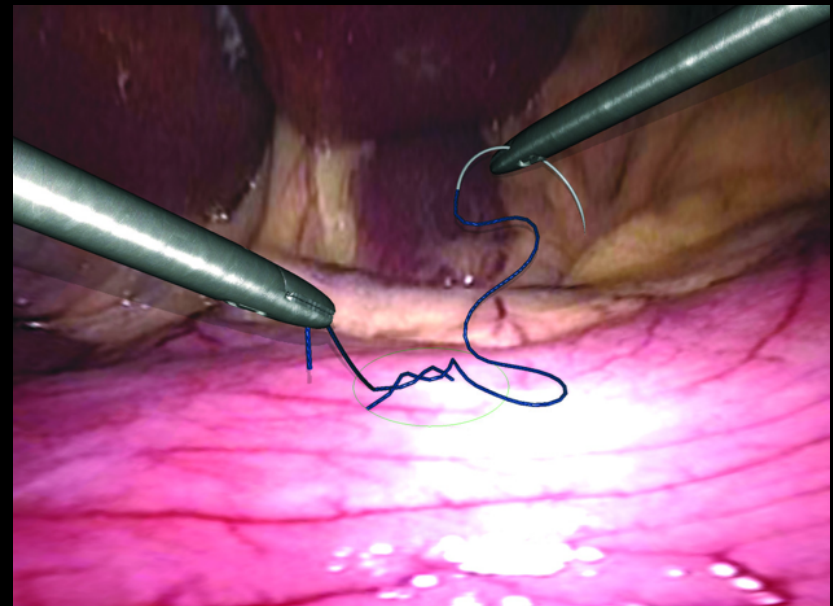
Interaction

- Possibility of moving 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

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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

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 $)
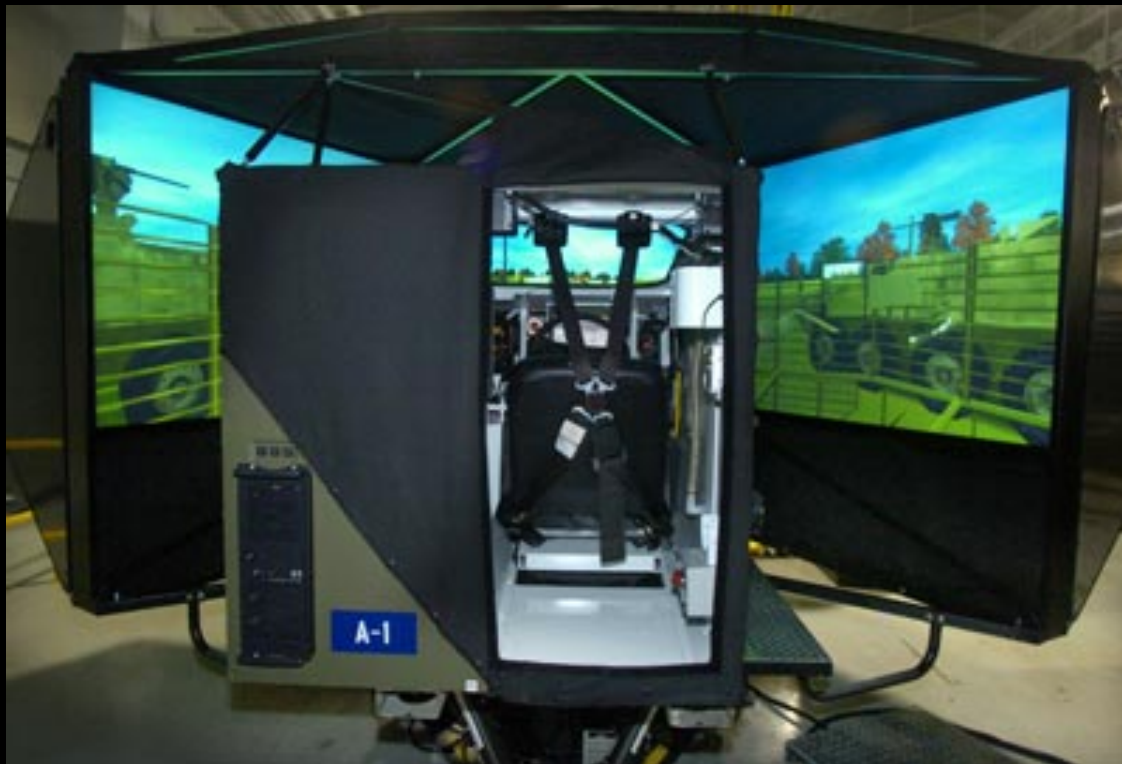

Thales flight simulator
Source: Wikipedia

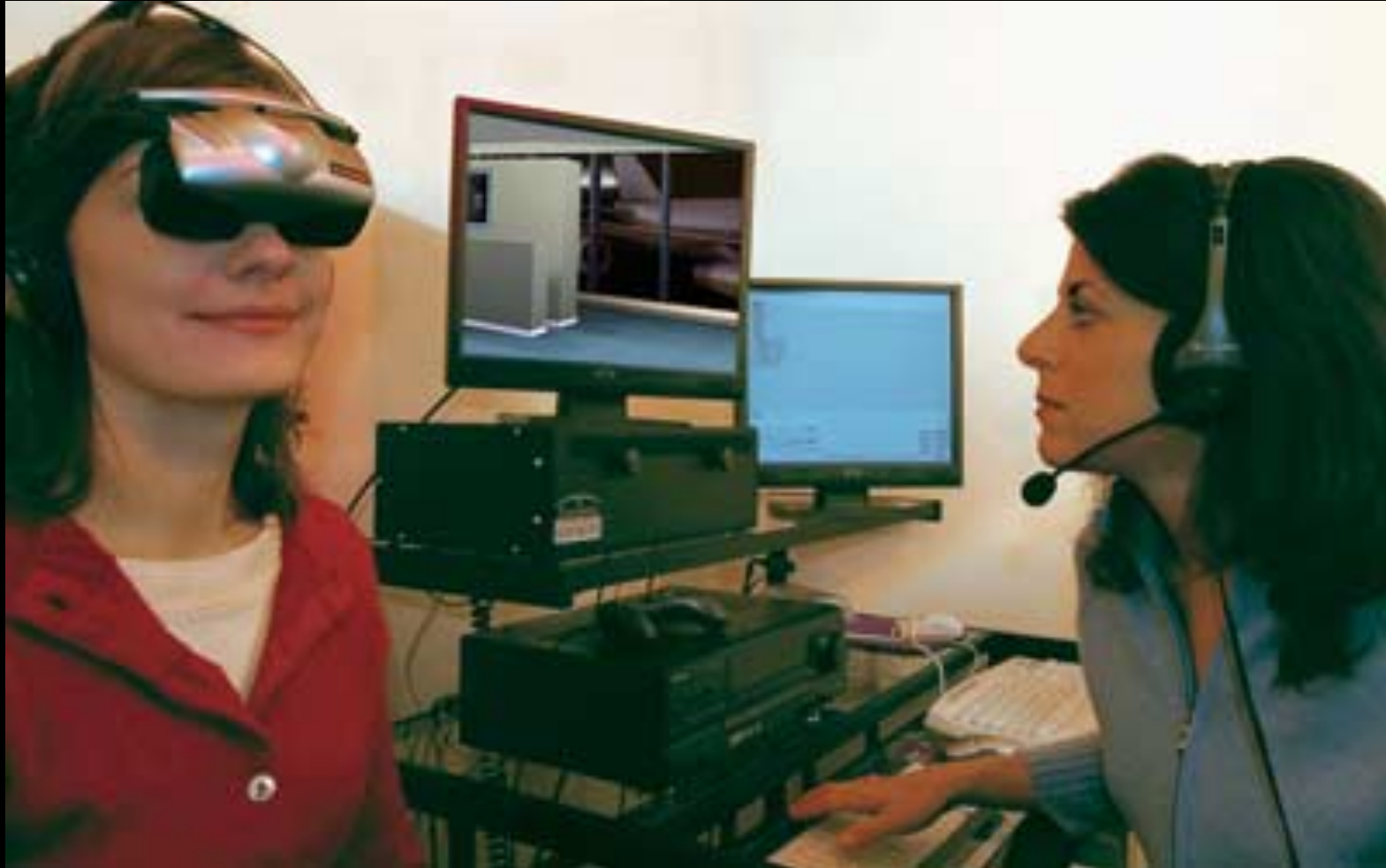# Train simulation

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.

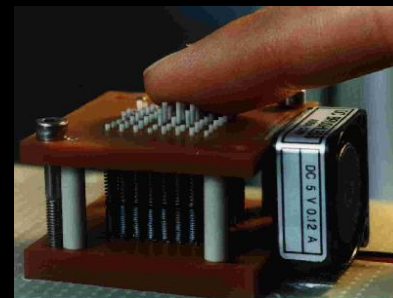# Application in medicine: Phobia treatment

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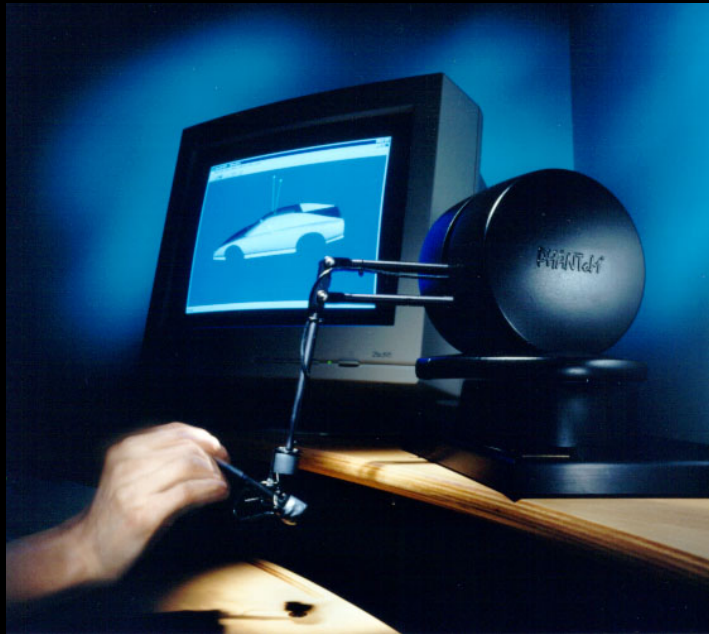
Application in TV and sports

First-down line
Source: SporTVision

Haptic interfaces

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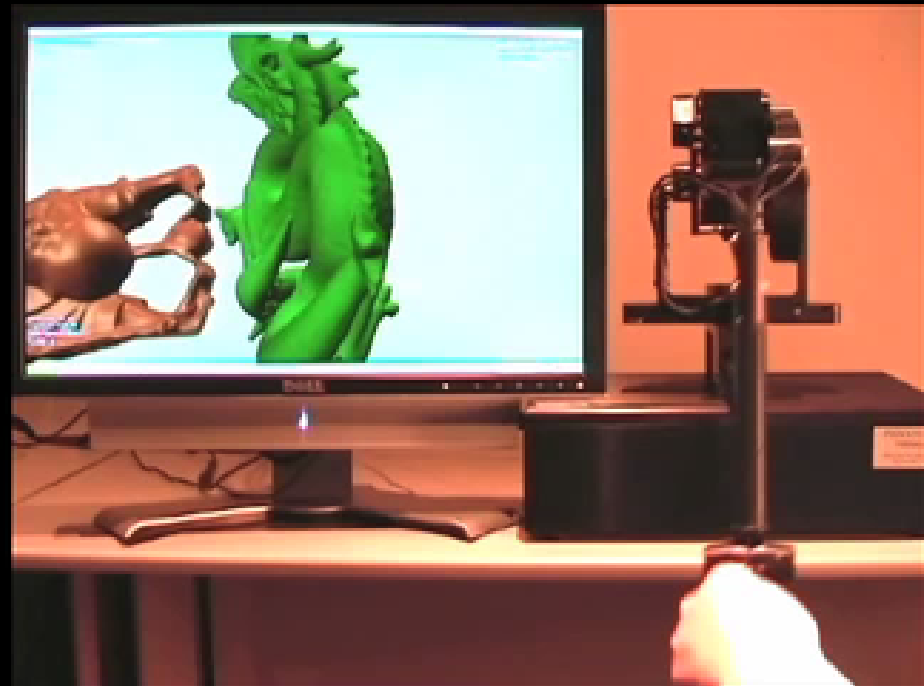
Force-feedback rendering

Phantom 3-DoF device
(Sensable)

Force-feedback
mouse
(Immersion)

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Force-feedback rendering

Barbic and James 2007

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Simulation in games

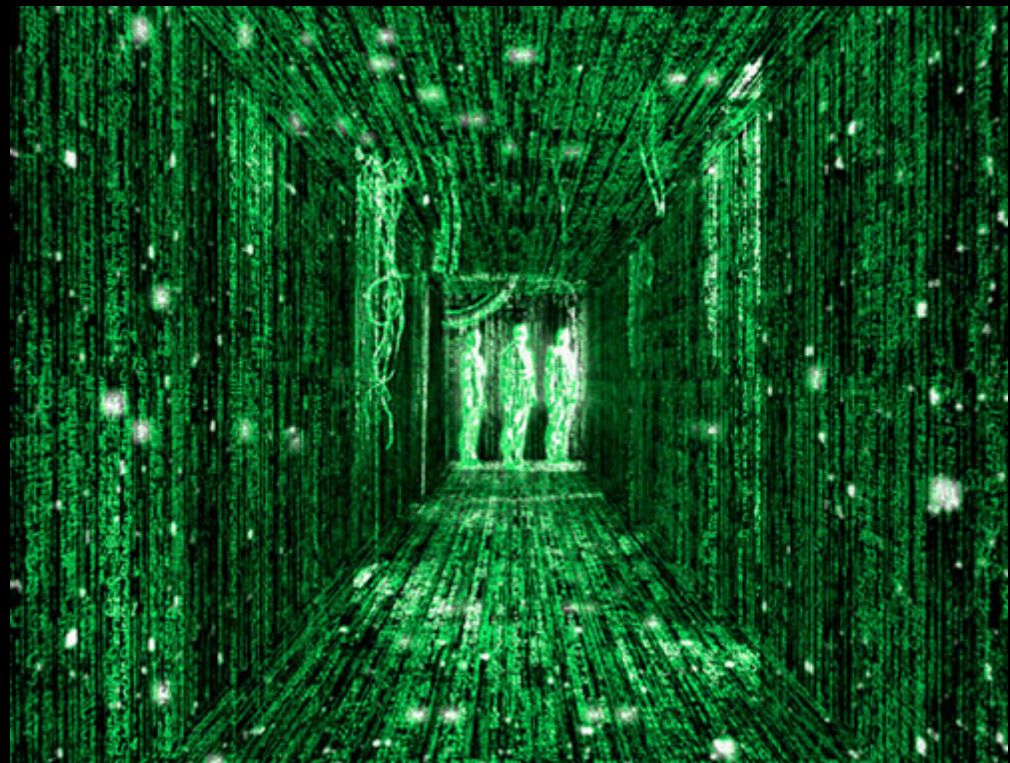
Silent Hunter 4 (Ubisoft)

Virtual reality in games

Source: Colin Anderson

Discussion

- Can we simulate anything?

- What is reality?

Why virtual worlds?

Leontopodium alpinum
Source: appolonio&battista