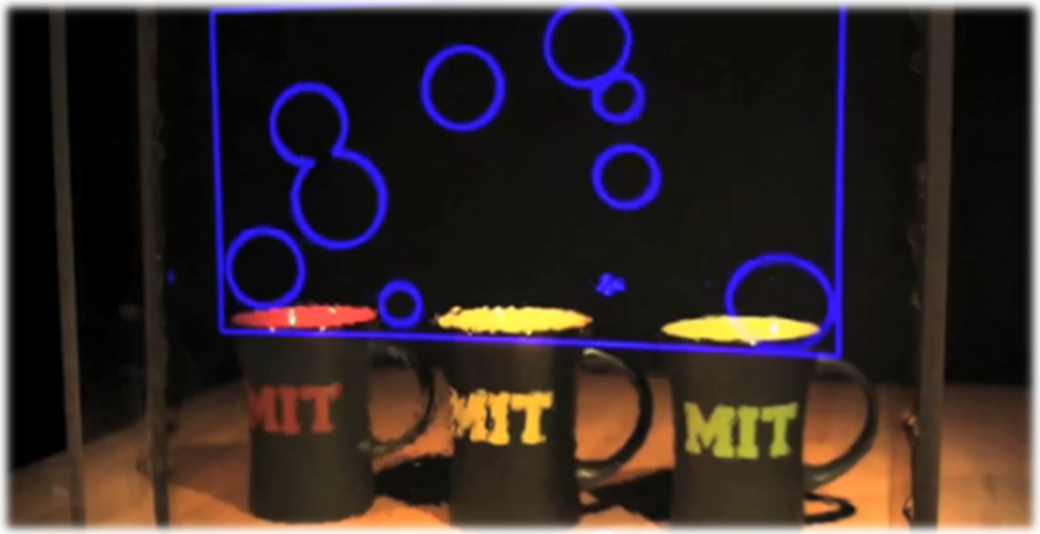
CSE165 3DUI
- Winter 2014

CSE 165: 3D User Interaction

Lecture #5: Input Devices

Jürgen Schulze

News Flash: MIT's Transparent Display



http://www.youtube.com/watch?v=0aw58MUciWw

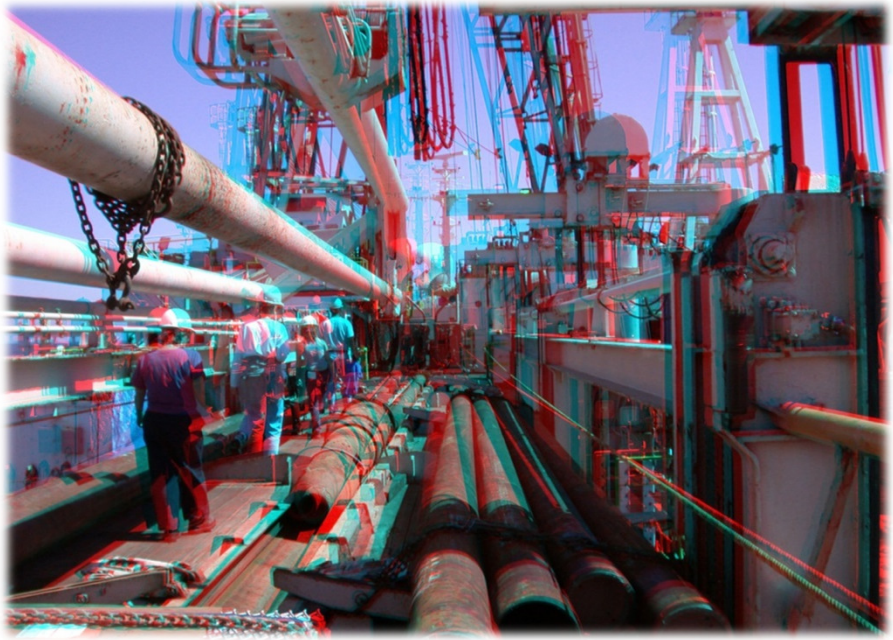
Announcements

- Homework project 1 due this Friday at 1:30pm in CSE basement lab 260
- In today's office hour (after class):
  - Razer Hydra sign out
- On Feb 4th: guest lecture by Dr. Thomas DeFanti, co-inventor of the CAVE
  - Demonstration of new WAVE in SME building
- Research paper presentations
  - Discuss schedule
  - See discussion board for Matteo's slides from last year

Stereo Display Techniques

Stereo Imaging: Anaglyphic

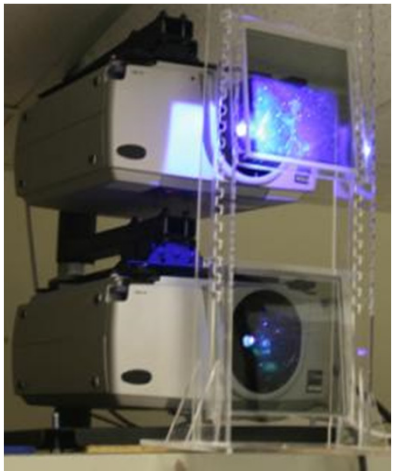
- Anaglyphic
  - requires red/blue, red/green glasses
  - color is lost (intensity only)



Core drilling ship (Andy Johnson, UIC/EVL)

Stereo Imaging: Polarizing Filters

- Linear polarization
- Circular polarization: creates circularly polarized light by adding a quarter-wave plate after a linear polarizer
- Polarizing glasses are inexpensive (from $2)



Stereo projectors

Polarizing glasses

Stereo Imaging: Active Stereo

- Display alternates between images for left and right eyes at 120+ Hz
- Shutter glasses are synchronized to display
- Shutter glasses require batteries
- Initially only CRT and DLP were fast enough, today LCD also works
- Shutter glasses used to be expensive ($1000+) but are now ~$30 for home 3D TVs

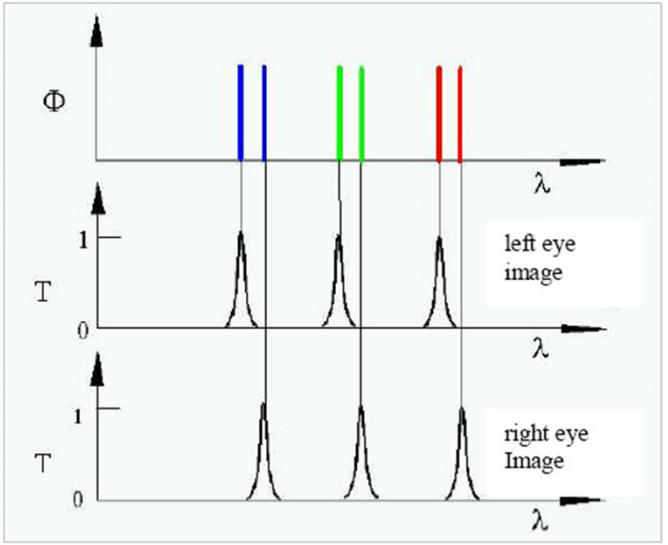
CrystalEyes shutter glasses

Stereo Imaging: Infitec

- Technology based on wavelength multiplexing
- Two separate primary color triplets are filtered by glasses to generate two sets of primary colors
- Infitec resulted from a research project of DaimlerChrysler

Projectors with Infitec filters

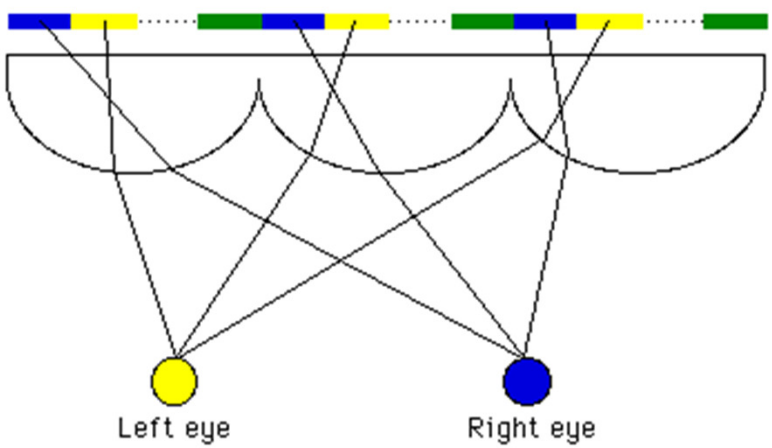
Infitec glasses



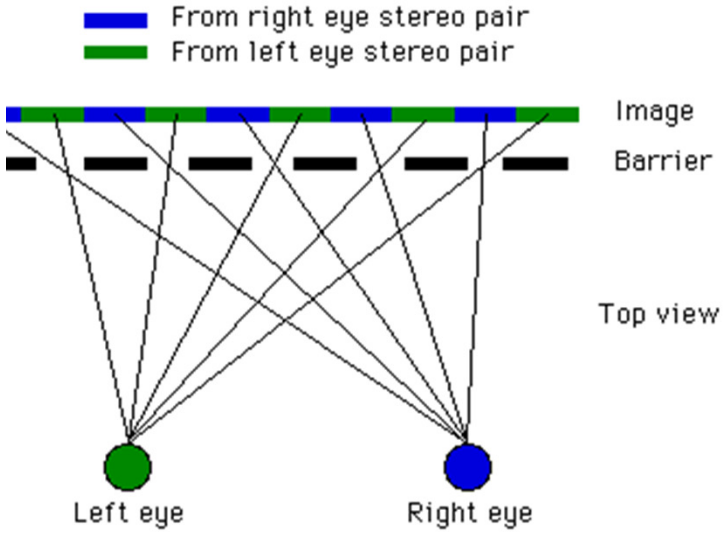
Primary color triplets

Autostereoscopic Displays

- Light sent separately to each eye from a monitor
- No headgear required
- Tracked (dynamic) vs. non-tracked (static, sweet spot)
- Approaches:
  - Lenticular screen
  - barrier



Lenticular screen



Barrier

Displays Continued

Google Glass

- Small display in front of one eye
- Not designed for VR
- Explorer Edition available for selected users ($1,500)
- Built-in Android 4
- 640x360 pixels
- Built-in 5 MP camera
- Wi-Fi, Bluetooth
- 16GB RAM
- Gyroscope, accelerometer, compass, light sensor

Virtual Retinal Displays (VRD)

- Send images directly onto the retina
- First invented at the HIT Lab in 1991
- In 1990s, commercially available from Microvision, Inc.
- In principle ideal for many applications

VRDs – Advantages

- Relatively lightweight
- Potential for high resolution
- Potential for complete visual immersion
- Can achieve good stereo quality (no ghosting)

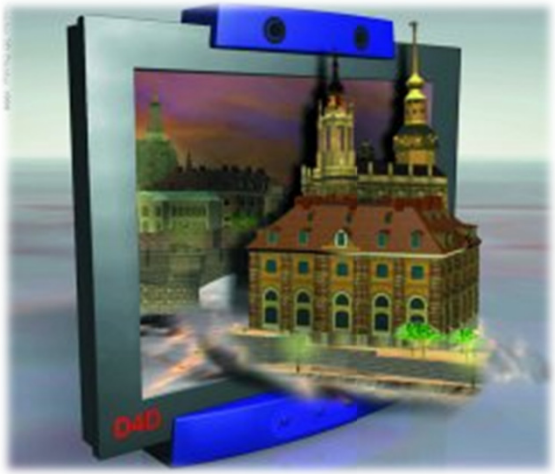
VRDs – Disadvantages

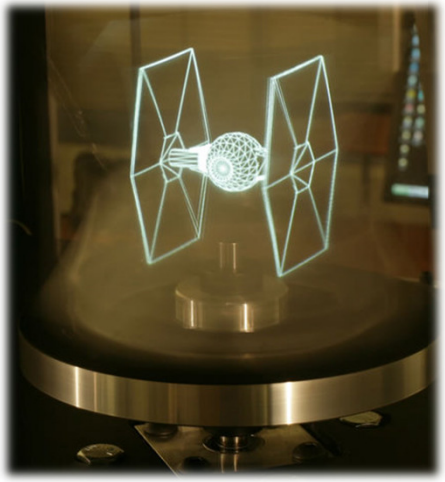
- In reality major deficiencies in many areas
- Low resolution and FOV is small
- Displays are monochrome (red only)
- Eye movement causes problems
- Technology was not commercially viable

→ Other, theoretically inferior technologies took over in practice

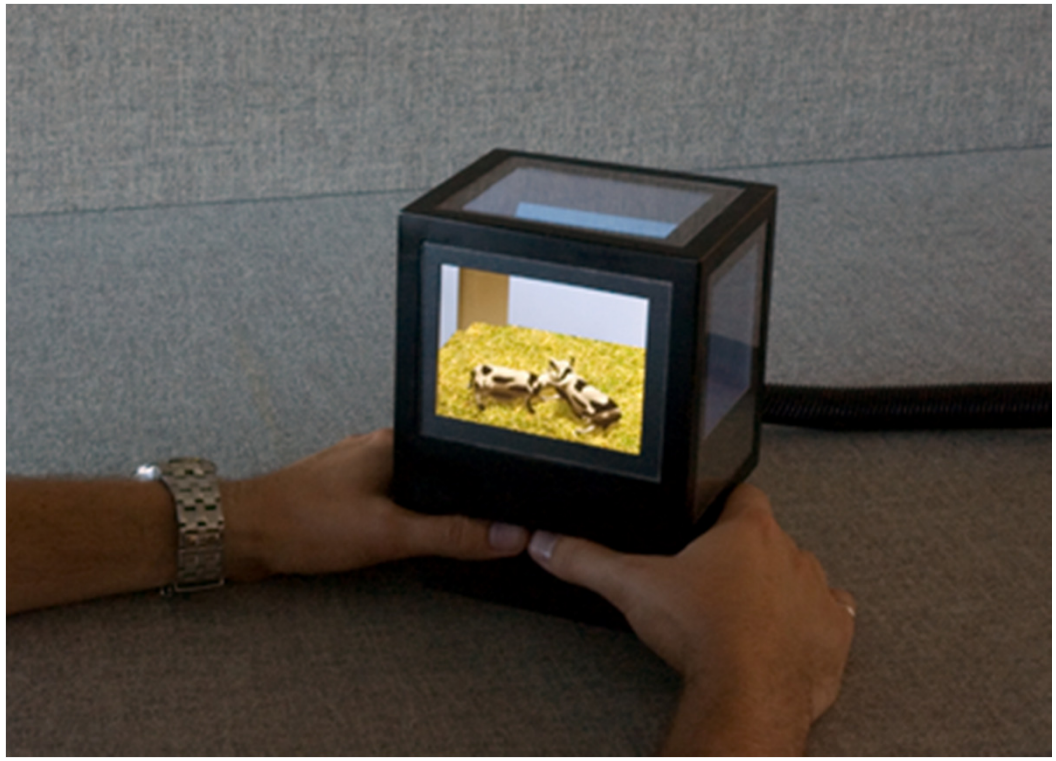
Auto-Stereoscopic Displays

- Lenticular
- Volumetric
- Holographic



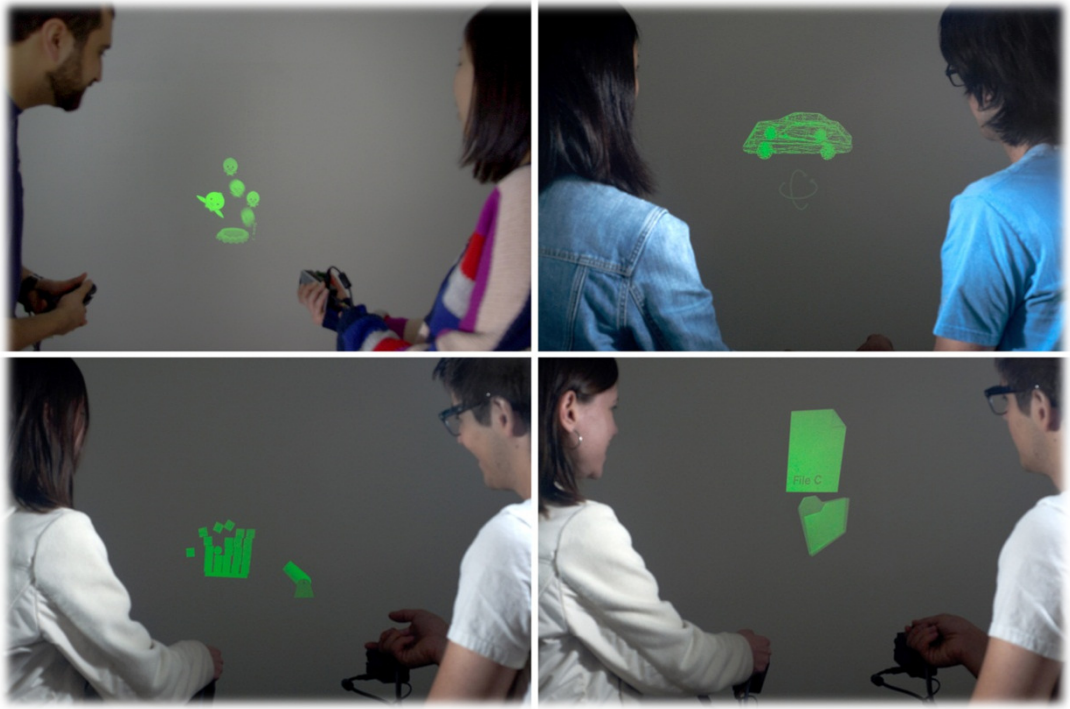


Simulated Autostereo – pCubee



University of British Columbia

Portable Pico Projectors



SidebySide/Motion Beam (Disney Research)

Which Visual Display to Use?

- Consider lists of pros and cons
- Consider depth cues supported
- Consider level of visual immersion
- This is a very hard question to answer empirically

Input Devices

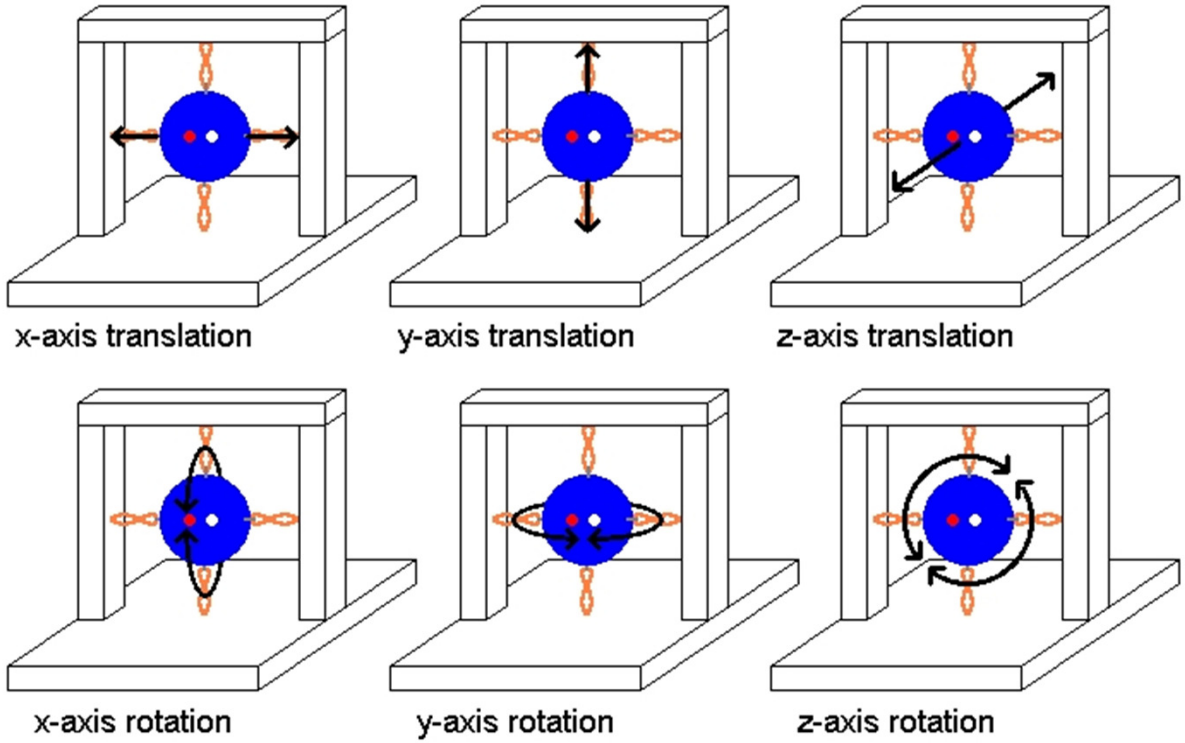
Overview

- Degrees of freedom
- 2-DOF devices
- Relative 6-DOF devices
- Absolute 6-DOF devices
  - mechanical
  - electromagnetic
  - inertial
  - optical
  - ultrasound
  - hybrid
  - special purpose

Degrees of Freedom (DOF)

- DOF: Set of independent displacements that specify completely the displaced or deformed position of a body or system.
- 3 DOF for position:
  - Moving up and down (heaving)
  - Moving left and right (swaying)
  - Moving forward and backward (surging)
- 3 DOF for orientation:
  - Tilting up and down (pitching)
  - Turning left and right (yawing)
  - Tilting side to side (rolling)
  - See also: Euler angles

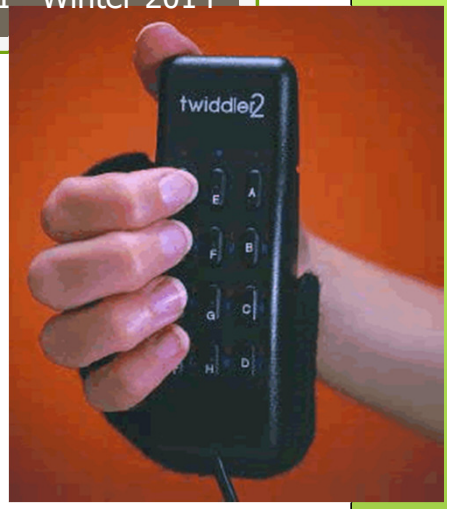
6 Degrees of Freedom



3 DOF: GPS

- GPS = Global Positioning Satellite system
- 24 satellites constantly transmit microwave signals of their location
- GPS receivers determine exactly how long it takes for the signals to travel from each satellite
- Receiver needs a signal from at least 3 satellites for accuracy of +/- 100 feet
- Many GPS receivers can improve accuracy by extrapolating additional information
- Tracking accuracy insufficient for VR user interfaces
- Works only outdoors

Keyboard (binary n-DOF) and Mouse (2-DOF)



- Most popular interaction devices for virtual environments
- Many VR installations are used only with keyboard and mouse. Works well for walk/fly-through presentations to groups

Desktop Devices: Pen-based Tablets

- Absolute 2D device
- Either direct or indirect

6-DOF Relative Devices

- Relative position and orientation
- 3dconnexion/Logitech

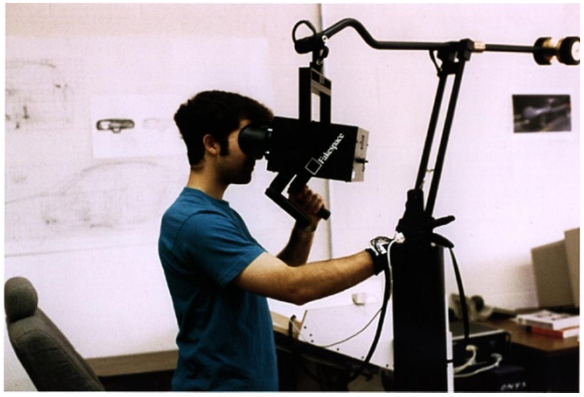
Spaceball 5000

Spaceball

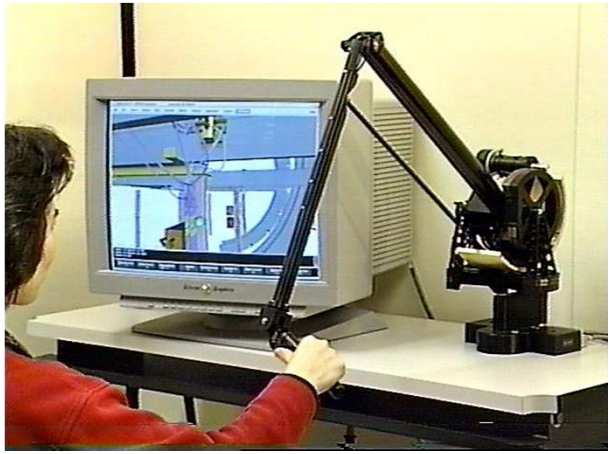
Space Navigator

Mechanical Tracking

- Fakespace Boom: doubles as a stereo display
- Sensable Phantom: doubles as a haptic feedback device



Fakespace Boom

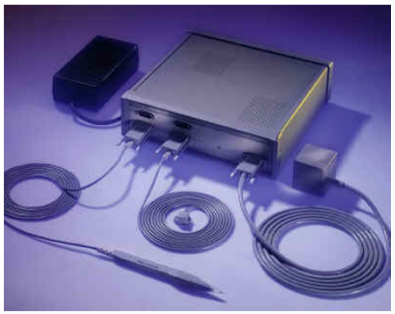


Sensable Phantom

Electro-magnetic Tracking

- Most commonly used technology
- Fixed transmitter generates low-level magnetic field from 3 orthogonal coils
- Fields generate current in smaller receiver unit(s) worn by user
- 6-DOF tracking achieved by analyzing signal strength in receiving coils
- Advantage: no line of sight restrictions
- Disadvantage: metal in environment can cause interference

Wanda



Polhemus Fastrak

Head/Eye Tracking

Ascension Flock of Birds

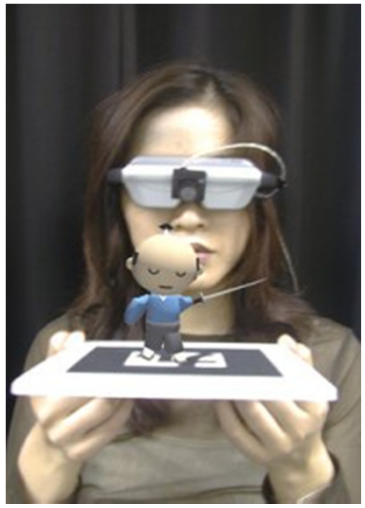
Inertial Tracking

- Mechanical approach, relying on the principle of conservation of angular momentum.
- Trackers use miniature gyroscopes to measure orientation changes: 3-DOF.
- If full 6-DOF tracking ability is required, they must be supplemented by some position tracking device.
- Gyroscope consists of a rapidly spinning wheel suspended in a housing. Resistance can be measured and converted into yaw, pitch, and roll.
- Inertial tracking devices are fast and accurate, range only limited by length of cable to control computer. Main disadvantage is drift between actual and reported values that is accumulated over time.

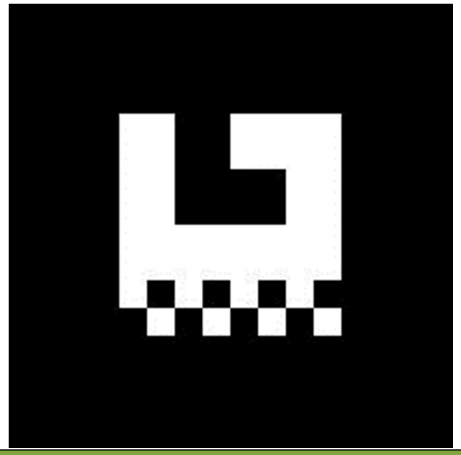
Intersense InertiaCube

Optical Tracking: ARToolKit

- Developed in 1999 by Hirokazo Kato, HITLab, University of Washington
- Printable markers
- Camera based (webcam sufficient)
- Flexible marker design
- Simple programming interface
- 6 DOF tracking possible



ARToolKit



ARToolKit marker

Video

- Augmented Reality by Hitlab
  - http://www.frequency.com/video/augmented-reality-by-hitlab/2556268