Winter 2013

CSE 190: 3D User Interaction

Lecture #5: Input Devices

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Announcements

- TA: Sidarth Vijay office hours in Sequoiah Hall lab 142:
  - Tuesday and Thursday 11am-1:30pm
- Homework project 2 due Friday February 8th at 1pm
- Webcam required for homework project
  - Who needs one?

Calit2 Free Monthly Tour

- Next tour Friday, December 8th, 1-2pm
- Conflicts with homework presentation!
  - On Feb 8th, we will begin grading at 12 noon
- Register at:
  - http://calit2.net/events/popup.php?id=2026

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)

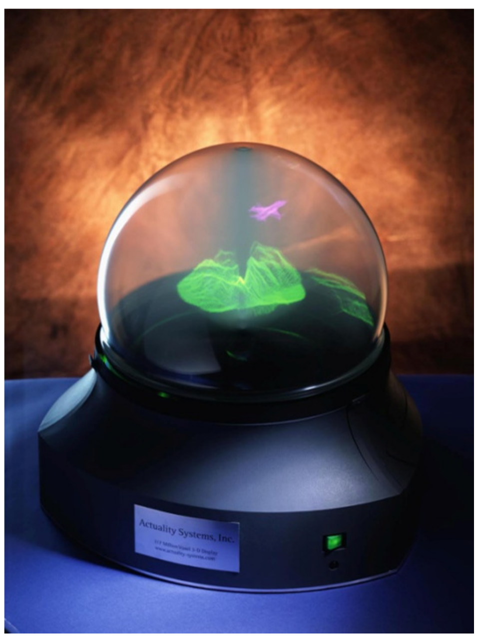
VRDs – Disadvantages

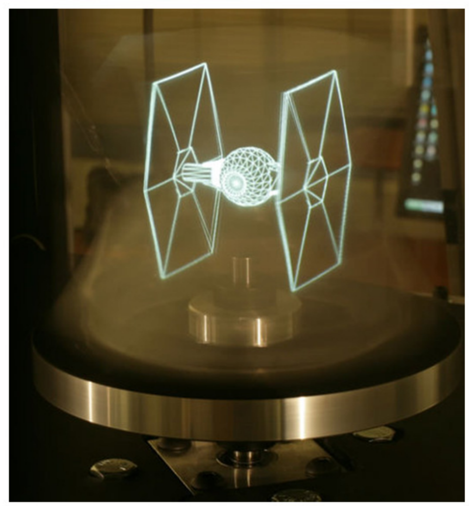
- In reality major deficiencies in many areas
- Low resolution and FOV is small
- Displays are monochrome (red only)
- Eye movement causes problems
- Technology was not commercially viable

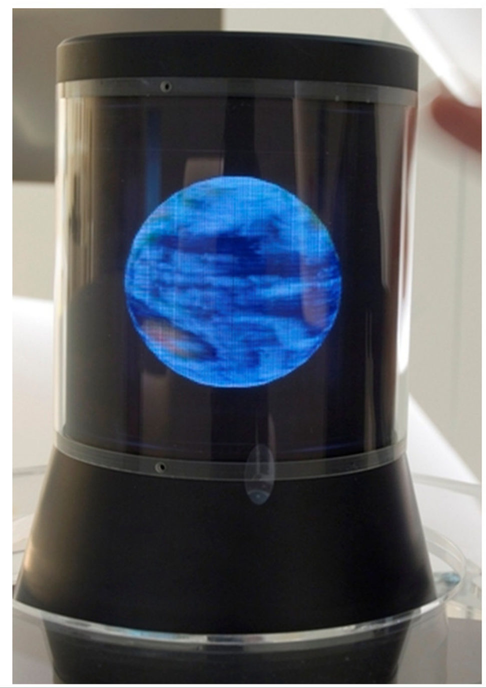
→ Other, theoretically inferior technologies took over in practice

Auto-Stereoscopic Displays

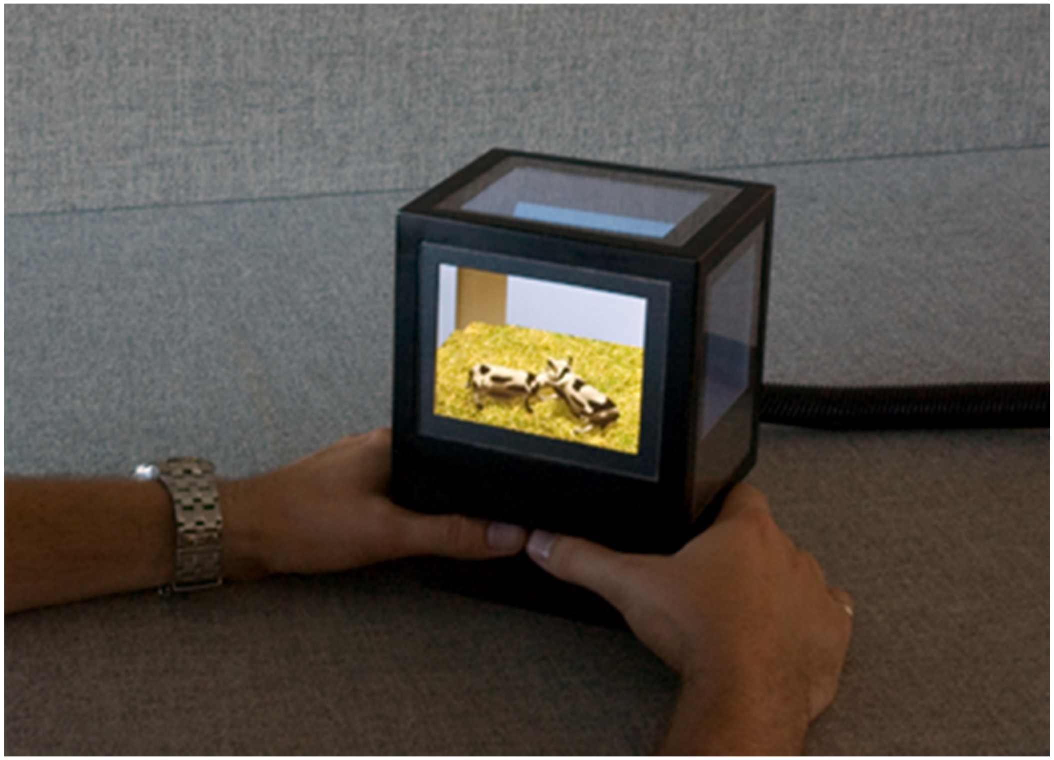
- Lenticular
- Volumetric
- Holographic





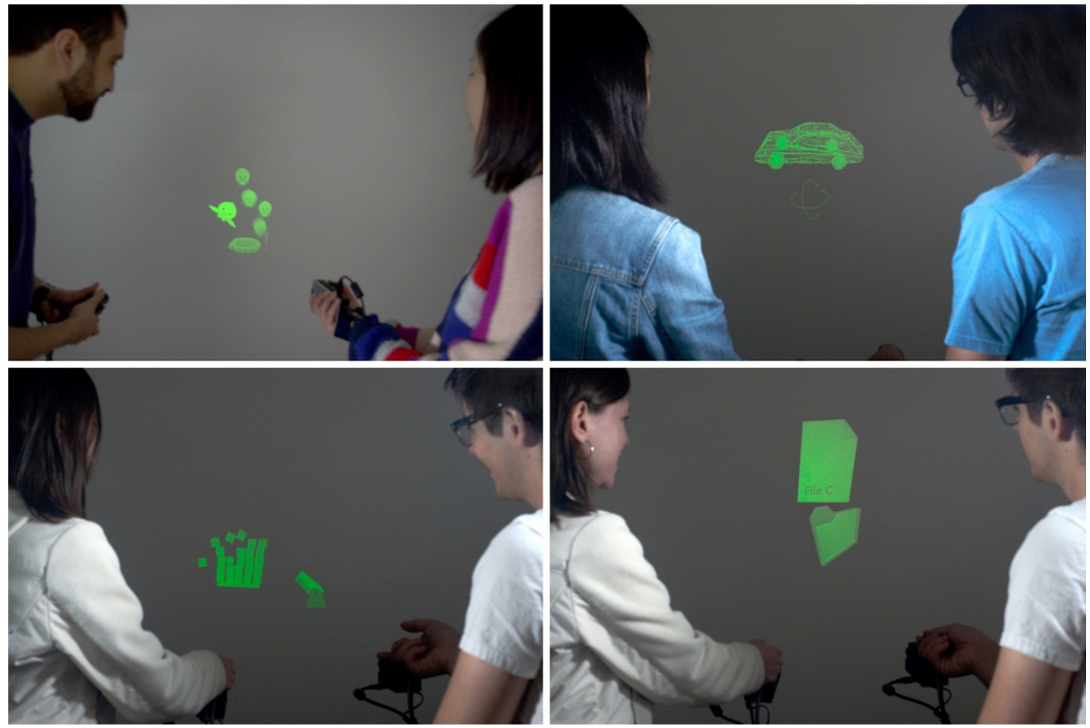


Simulated Autostereo – pCubee



University of British Columbia
http://hct.ece.ubc.ca/research/pcubee/

Other Display Technologies



SidebySide/Motion Beam
Disney Research, Pittsburgh

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

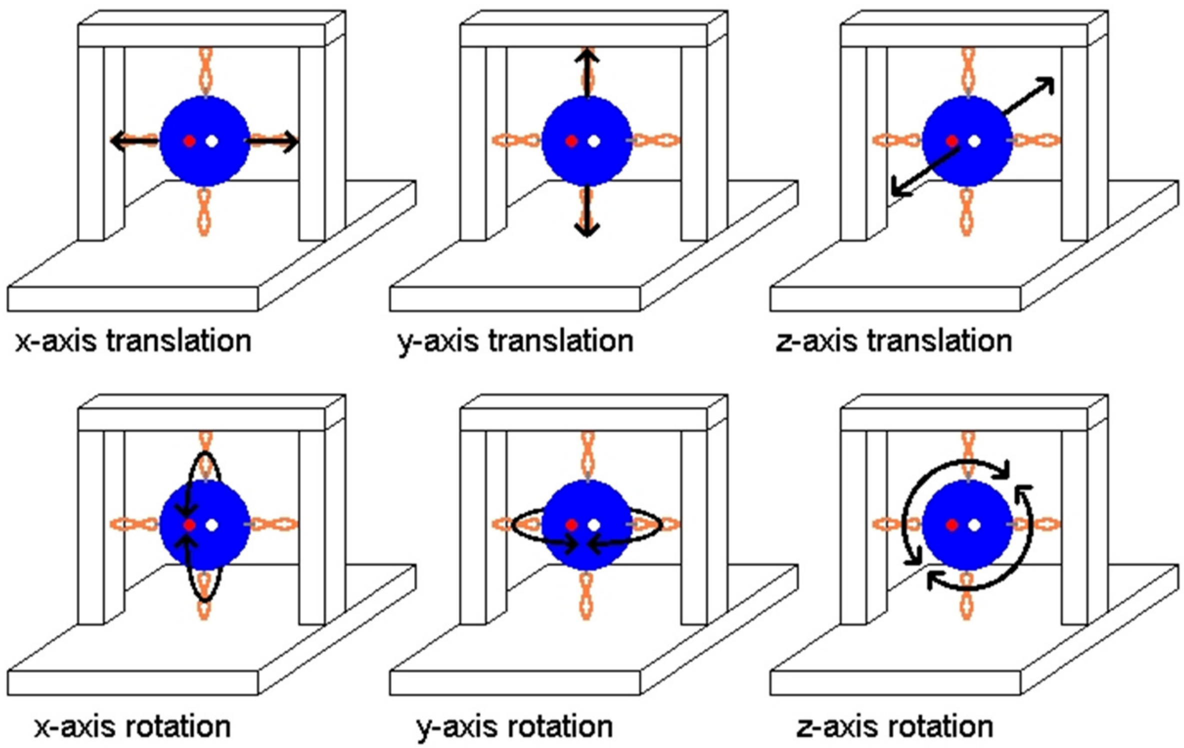
Overview

- 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

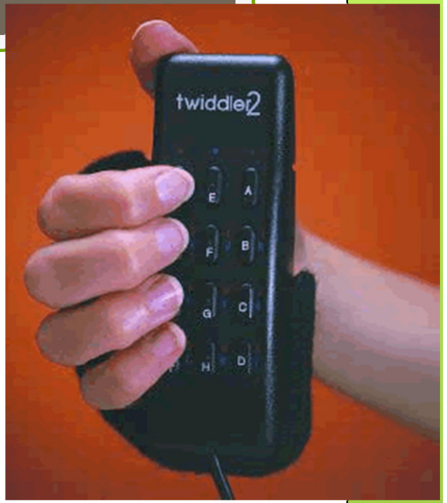
6 Degrees of Freedom



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

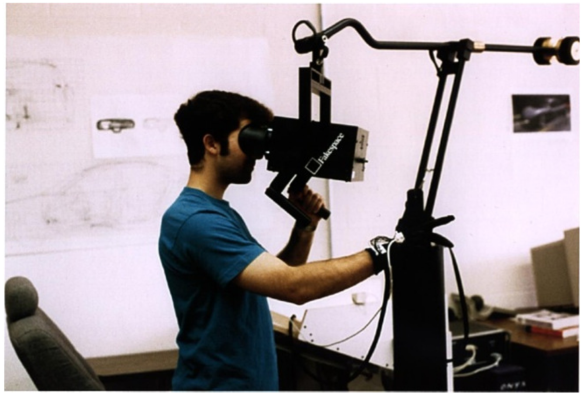
Spaceball 5000

Spaceball

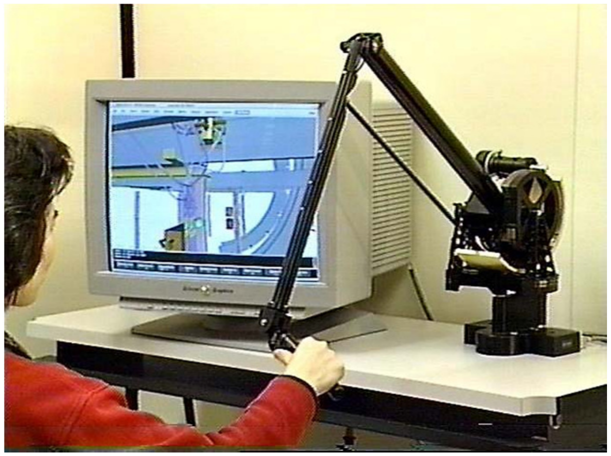
Space Navigator

Mechanical Tracking

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



Fakespace Boom



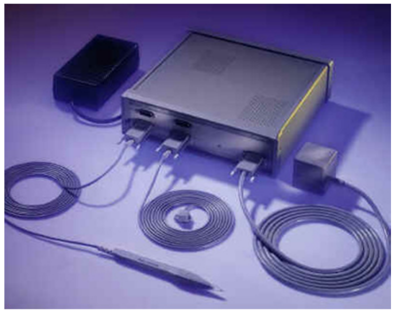
Sensable Phantom

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

Head/Eye Tracking



Polhemus Fastrak

Ascension Flock of Birds

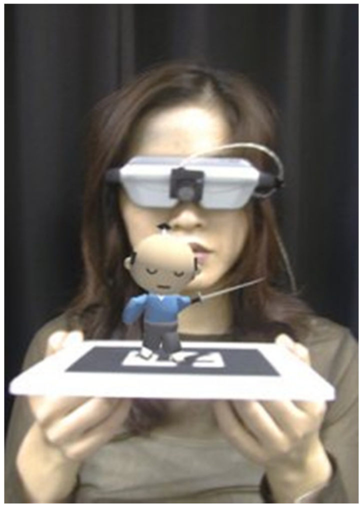
Inertial Tracking

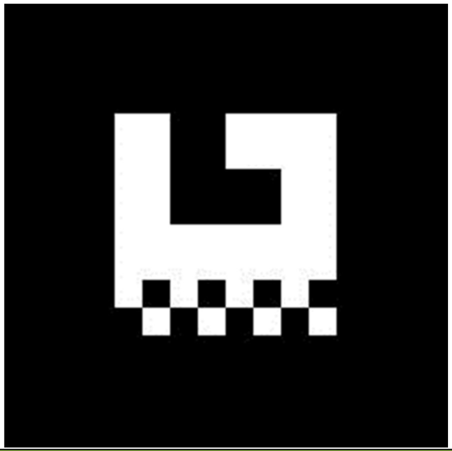
- Mechanical approach, relying on the principle of conservation of angular momentum.
- Trackers use miniature gyroscopes to measure orientation changes: 3-DOF.
- If full 6-DOF tracking ability is required, they must be supplemented by some position tracking device.
- Gyroscope consists of a rapidly spinning 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

ARToolkit Programming

- Required for homework assignment #2
- ARToolkit web site
  - http://www.hitl.washington.edu/artoolkit/
- OSGART: ARToolkit for OpenSceneGraph
  - https://www.artoolworks.com/community/osgart/