



CSE 165: 3D User Interaction

Lecture #7: Input Devices

Instructor:
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Announcements

- Homework Assignment #2
 - Due Friday, January 23rd at 1:00pm

Input Devices

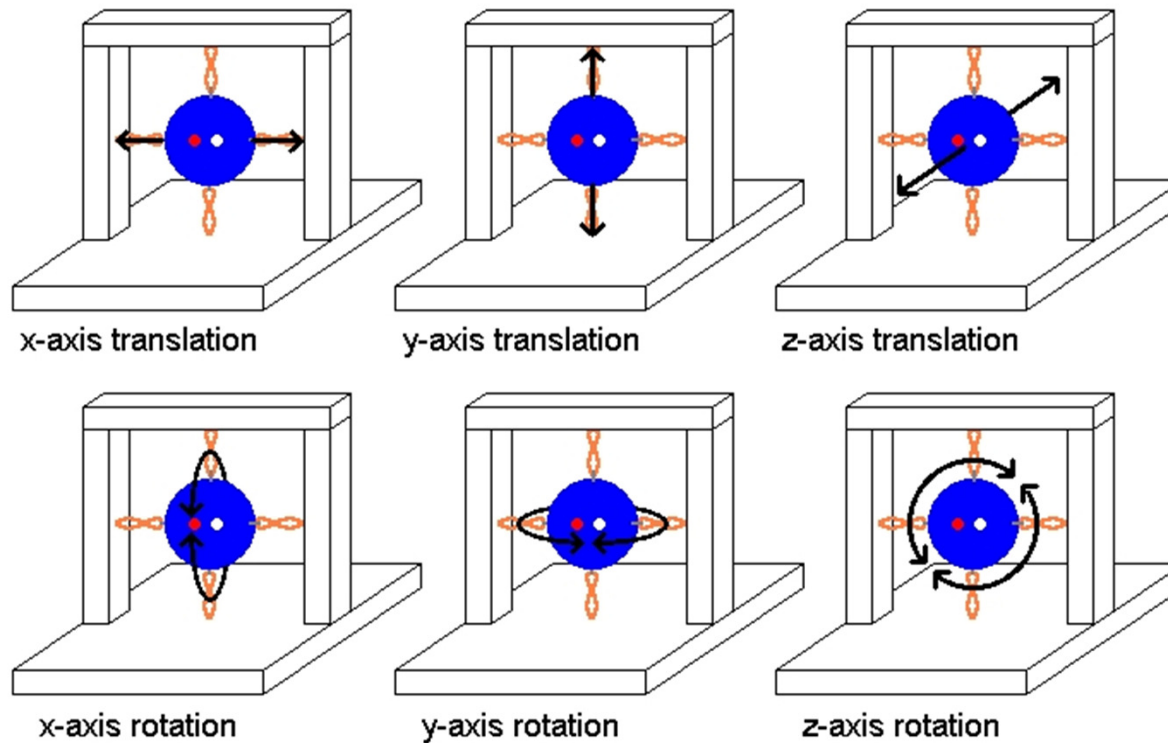
Overview

- 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



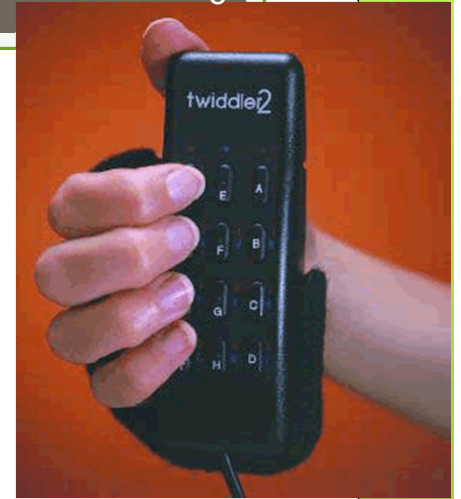
3 DOF: GPS

- 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

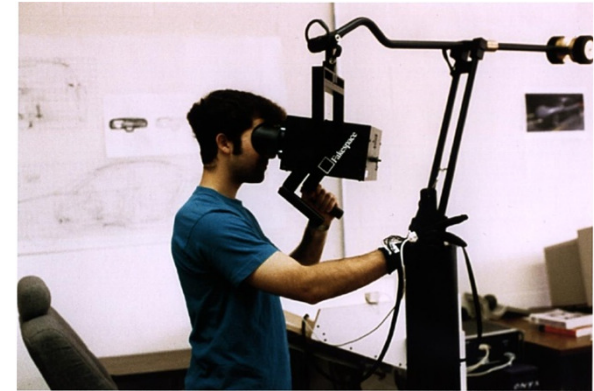


Space
Navigator

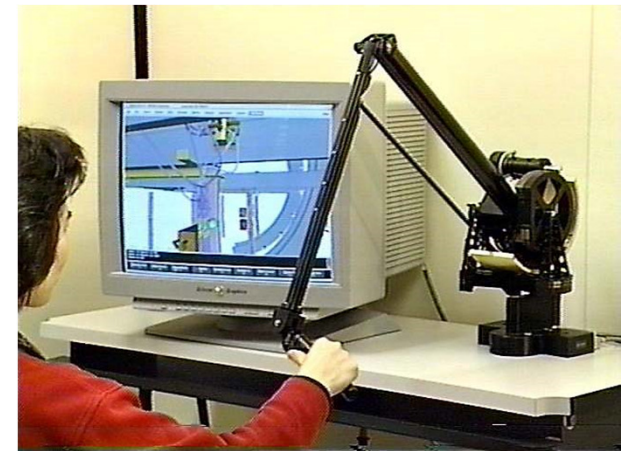


Mechanical Tracking

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



Fakespace Boom



Sensable Phantom

Electro-magnetic Tracking

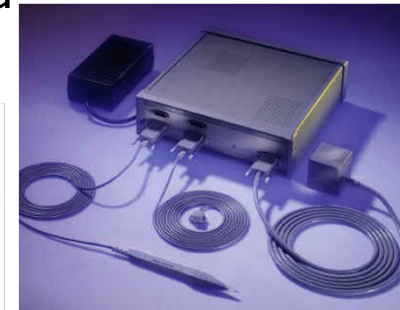
- Most commonly used technology
- Fixed transmitter generates low-level magnetic field from 3 orthogonal coils
- Fields generate current in smaller receiver unit(s) worn by user
- 6-DOF tracking achieved by analyzing signal strength in receiving coils
- Advantage: no line of sight restrictions
- Disadvantage: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



Wanda



Head/Eye Tracking



Polhemus Fastrak



Ascension Flock of Birds

Inertial Tracking

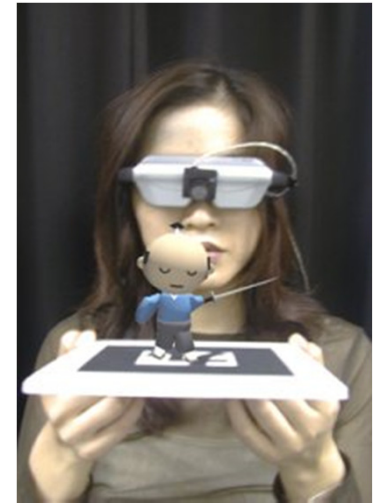
- Mechanical approach, relying on the principle of conservation of angular momentum.
- Trackers use miniature gyroscopes to measure orientation changes: 3-DOF.
- If full 6-DOF tracking ability is required, they must be supplemented by some position tracking device.
- Gyroscope consists of a rapidly spinning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



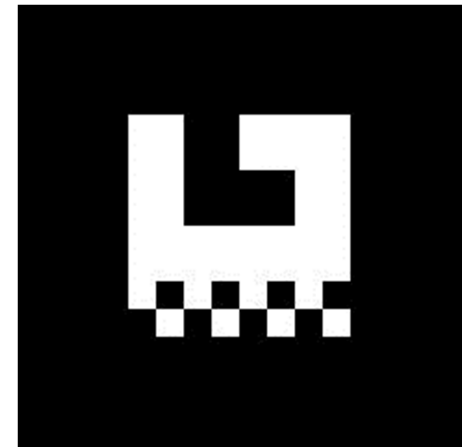
Intersense InertiaCube

Optical Tracking: ARToolKit

- Developed in 1999 by Hirokazu 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>



Optical Tracking: Mocap Devices

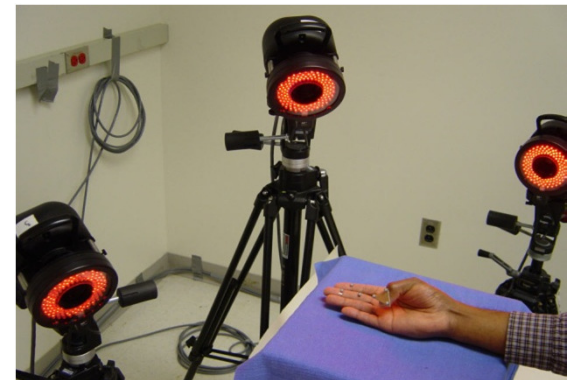
- Infrared (IR) cameras illuminate scene for easier detection of markers
- Multiple markers (highly reflective spheres) arranged in fixed, known configurations allow for 6 DOF tracking



ART Tracking System



Mosquito Aedes Aegypti,
carries the dengue virus



Vicon Tracking System