CSE 165: 3D User Interaction

Lecture #6: Input Devices

Announcements

- Homework Assignment #2
  - Due Friday, January 29th at 2pm

Engineers for Exploration

Hi Jurgen,

As you may know, Albert, Ryan Kastner and I run this undergraduate research program called Engineers for Exploration: http://e4e.ucsd.edu/. We basically build technologies to help archaeologists, environmentalists, explorers, etc. It's a bit like the undergraduate wing of CISA3. Most students work on these for free.

We actually have some ongoing projects that have a need for GUI design and playing around with 3D reconstruction algorithms/devices (Google Tango tablet). If you know some motivated students, maybe from the VR club, who would be interested, feel free to pass this along to any and all who might be interested in this kind of stuff. We are always looking for more students.

(on a separate note, we also run a paid 10-week summer program for engineers for exploration that might be of interest to the students http://reumanager.com/efore)

Thanks,

Curt

Input Devices

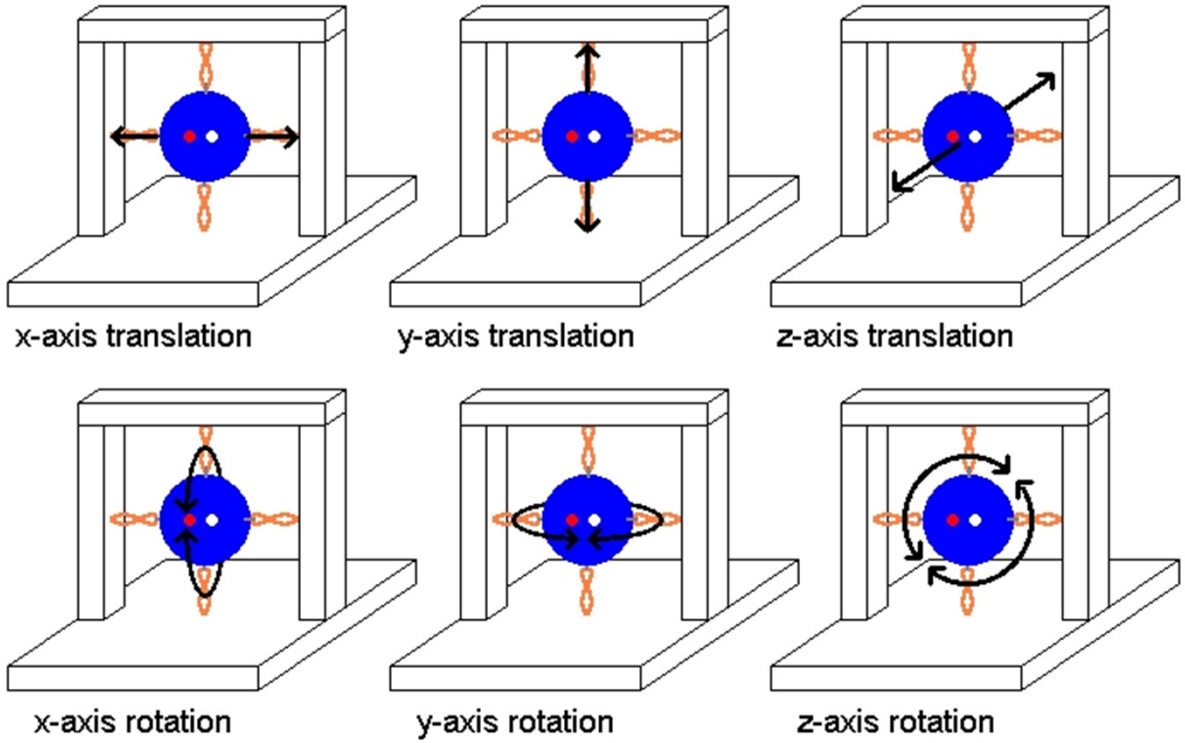
Overview

- 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)

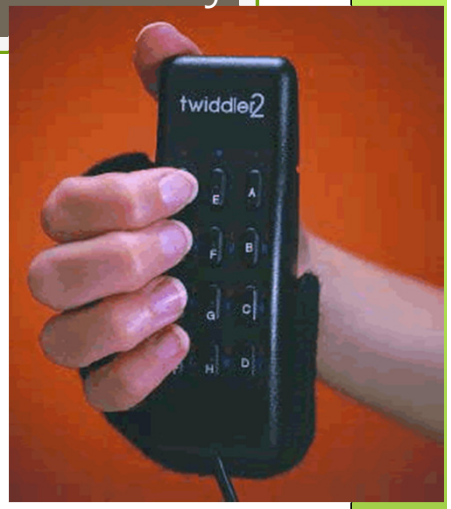
- DOF: Set of independent displacements that specify completely the displaced or deformed position of a body or system.
- 3 DOF for position:
  - Moving up and down (heaving)
  - Moving left and right (swaying)
  - Moving forward and backward (surging)
- 3 DOF for orientation:
  - Tilting up and down (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

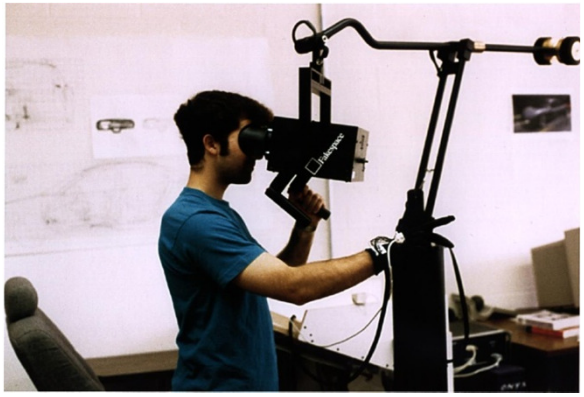
Spaceball 5000

Spaceball

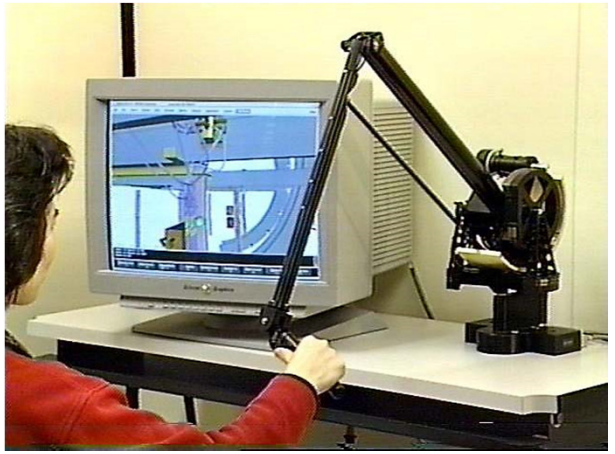
Space Navigator

Mechanical Tracking

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



Fakespace Boom

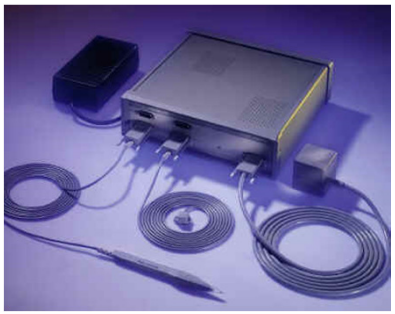


Sensable Phantom

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

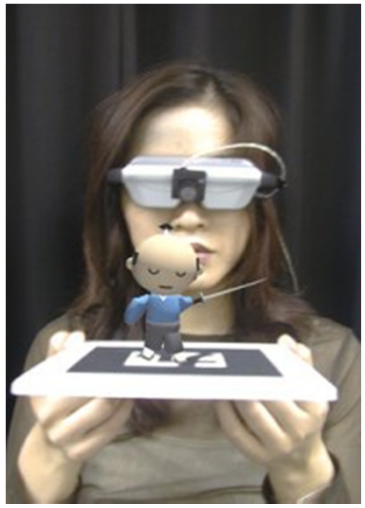
Inertial Tracking

- 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.

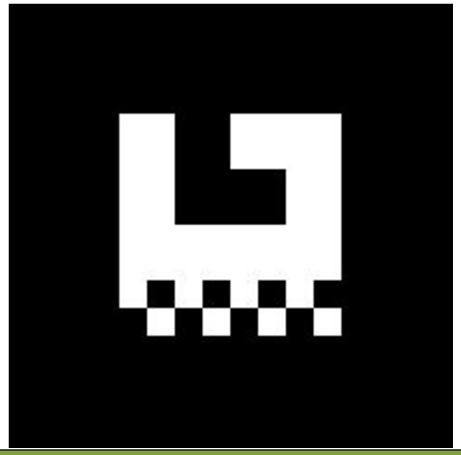
Intersense InertiaCube

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



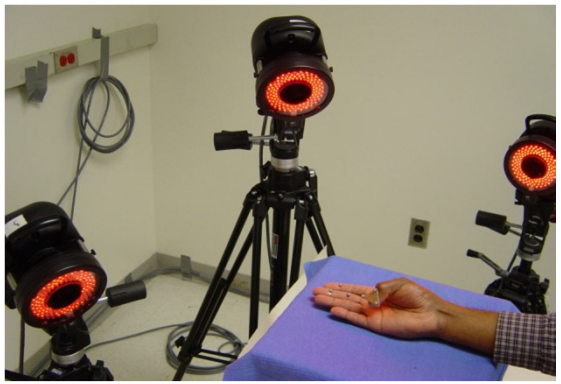
ARToolKit marker

Video

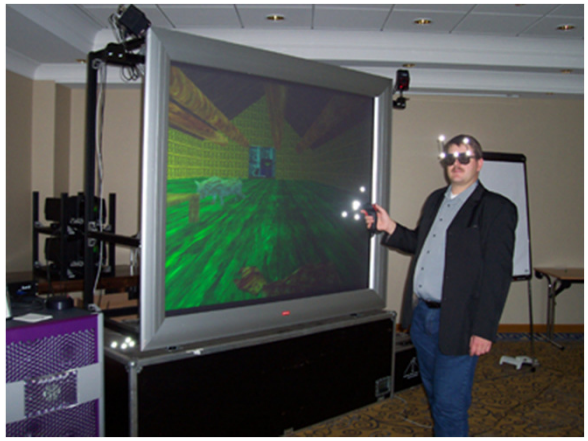
- Augmented Reality by Hitlab
  - http://www.frequency.com/video/augmented-reality-by-hitlab/2556268

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



Vicon Tracking System

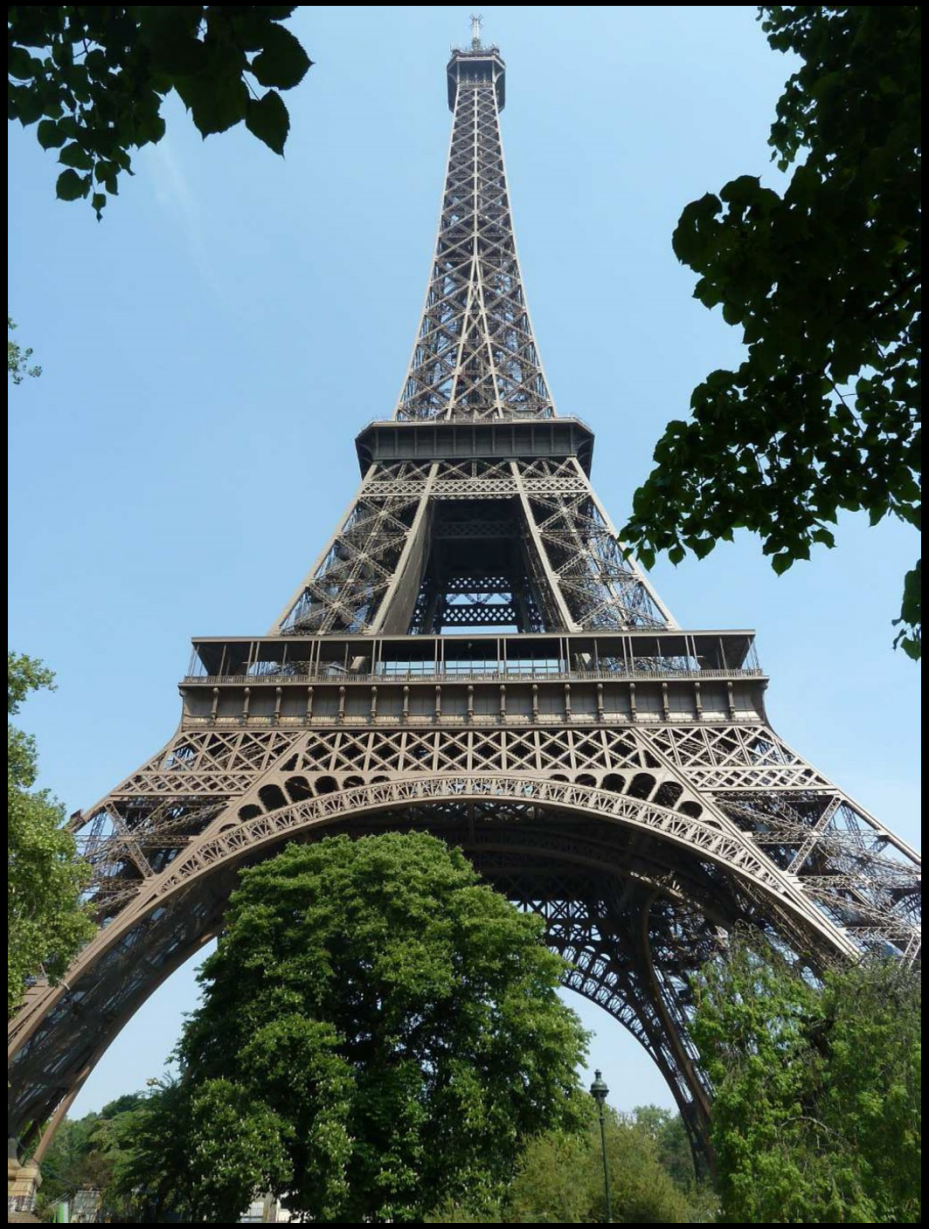


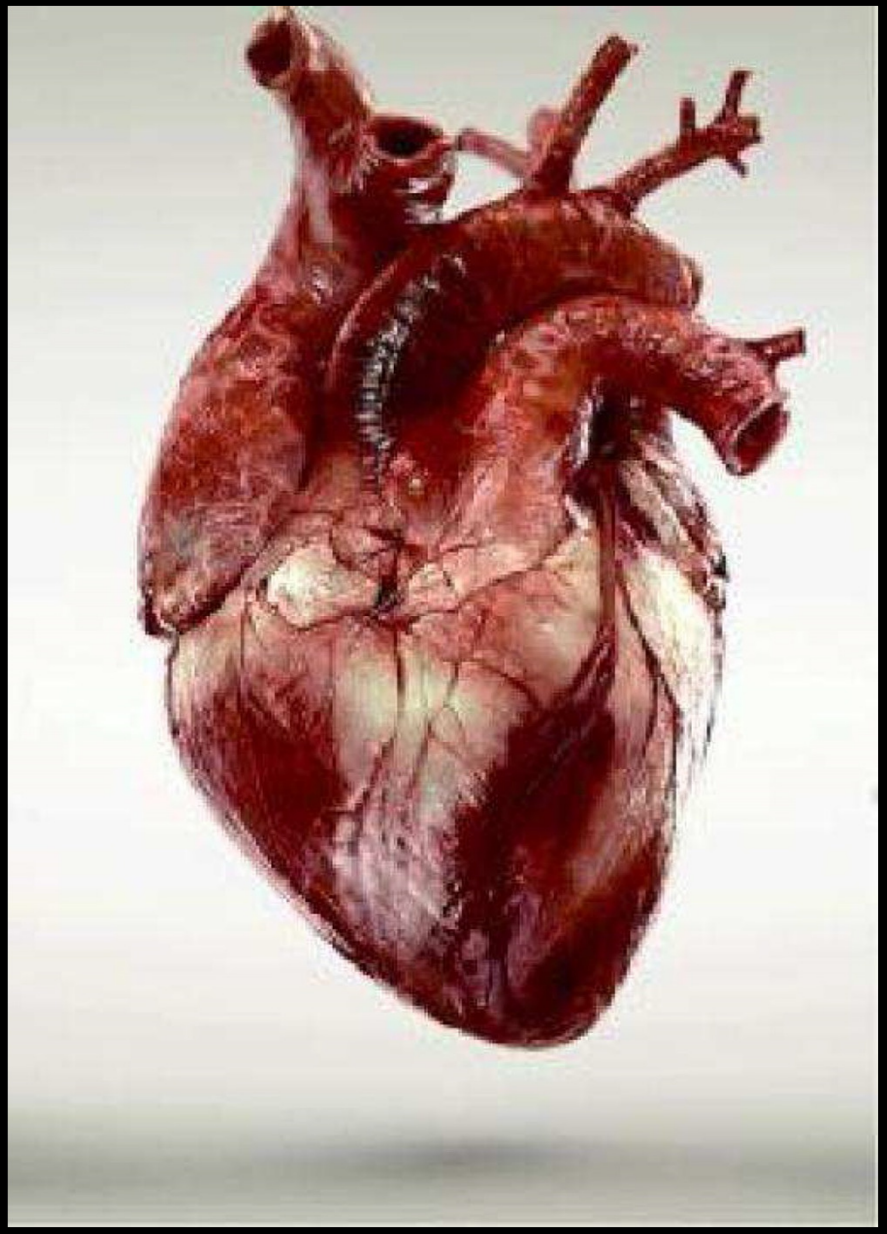
ART Tracking System

Mosquito Aedes Aegypti, carries the dengue virus

Augmented Reality

- Android app:
  - Download "Augmented Reality Try it Free" by CreativiTIC from Google Play Store
  - App uses Vuforia from Qualcomm for image recognition
- Then point at images on next slide





Optical Tracking: HiBall

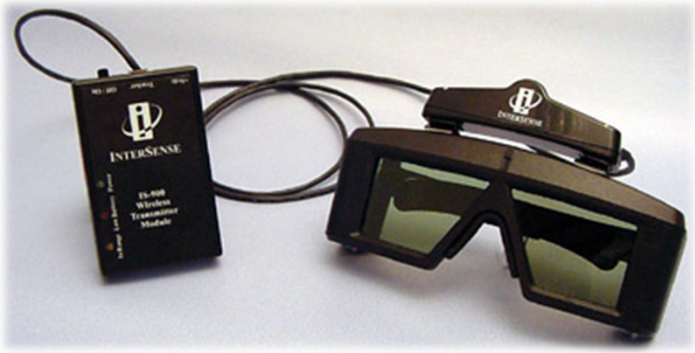
- HiBall-3100 tracker system, distributed by 3rd Tech
- Developed within wide-area tracking research project at UNC Chapel Hill
- System is composed of:
  - HiBall Optical Sensor
    - Views infrared LEDs in beacon arrays on ceiling with 6 lenses and photodiodes
    - Ceiling beacon arrays
- Tracker update rate: 2,000 Hz
- No metal or sound interference

HiBall beacon array

Ultrasonic Tracking

Logitech 3D Mouse

- Systems measure duration of an ultrasound signal to reach microphones.
- InterSense system uses combination of ultrasound and gyroscope.



InterSense IS-900 tracker

InterSense IS-900 Wand

Hybrid Devices: Haptic Feedback Devices

- PHANToM haptic device
- Force feedback joystick
- Exoskeleton-like devices

Microsoft force feedback joystick

LEXOS: Frisoli et. al., Italy

Immersion CyberForce

SensAble PHANToM

Tracking Devices: Bend-Sensing Gloves

- CyberGlove, 5DT
- Reports hand posture
- Gesture:
  - single posture
  - series of postures
  - posture(s) + location or motion

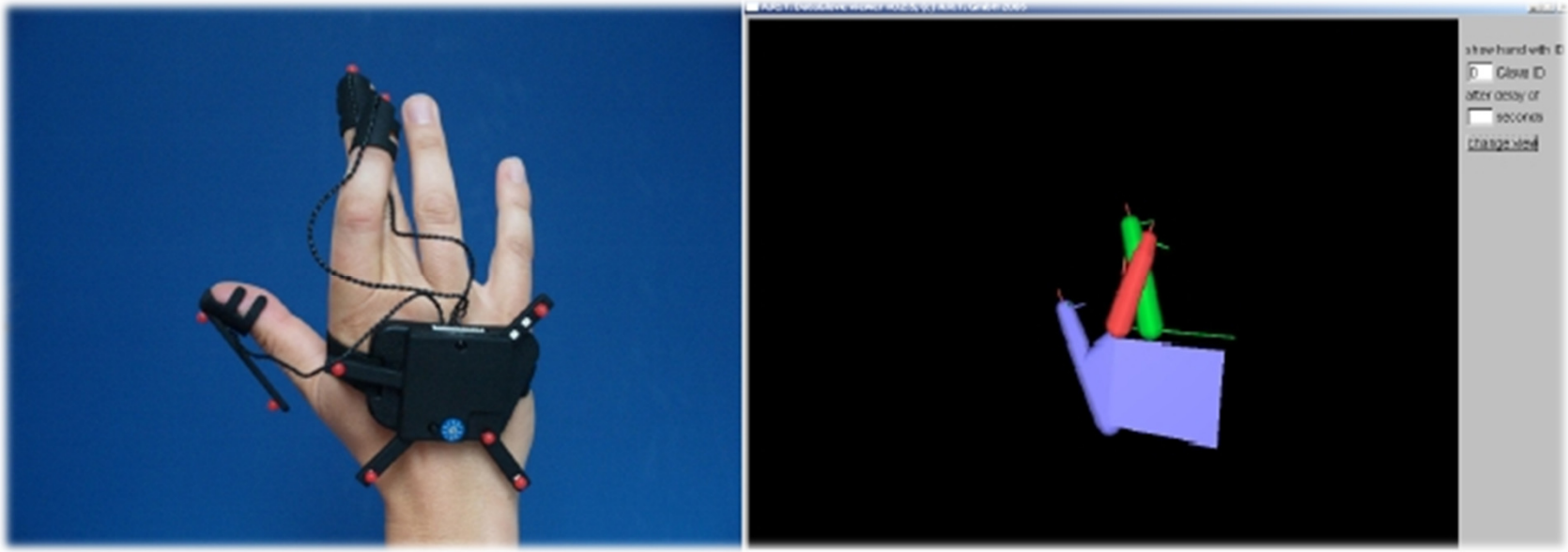
Pinch Gloves

- Determine if two or more fingertips are touching
- Use conductive cloth to close circuit
- Tethered to controller box
- Designed for pinching and grabbing gestures
- Recognize any gesture of 2 to 10 fingers touching, plus combinations of gestures
- Had problems with reliability

www.fakespacelabs.com

Optical Finger Tracking

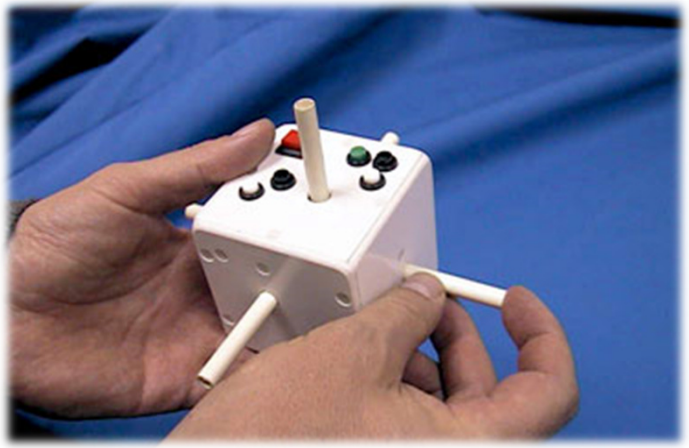
- Extension of ART system
- Tracks three fingers and the hand



Optical Finger Tracking

- Oblong Industries g-speak
  - Video: http://www.youtube.com/watch?v=9OpmxbPzDM0

Special Purpose Device: Cubic Mouse



- Developed at Fraunhofer Institute by B. Frohlich and J. Plate
- Cube shaped box with three rods represents a physical coordinate system
- 6DOF tracker is inside cube
- Rods used to manipulate x-, y-, and z- coordinates of an object (built for controlling cutting planes)
- Target application area: volume rendering for oil and gas industry

Cubic Mouse Video

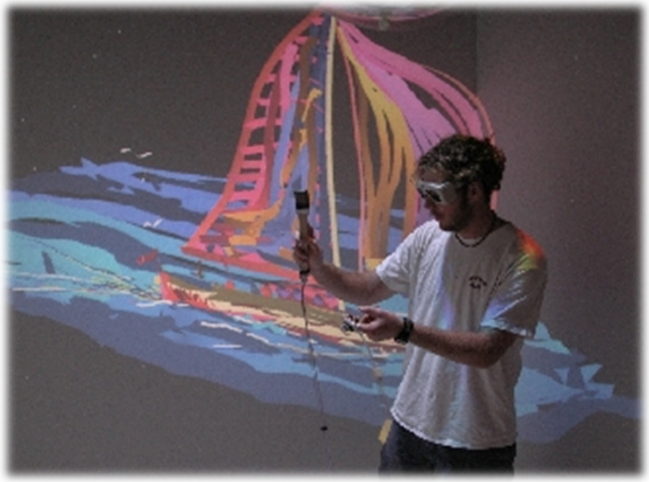
- http://www.youtube.com/watch?v=1WuH7ezv_Gs

Application-Specific Devices

- Virtual hang-gliding over Rio de Janeiro (L. Soares at. al.)
- Virtual canoe, Siggraph 2005
  - Real-time water simulator with pre-computed 3D fluid dynamics
  - Creates realistic wakes and force feedback of water resistance

Cave Painting

- Physical props (brush, color palette, bucket) allow intuitive painting
- System created by Daniel Keefe at Brown University (now Prof. at Univ. of Minnesota)



Cave Painting Video

- http://www.youtube.com/watch?v=WQv-LnHrmwU