

Winter 2013

# CSE 190: 3D User Interaction

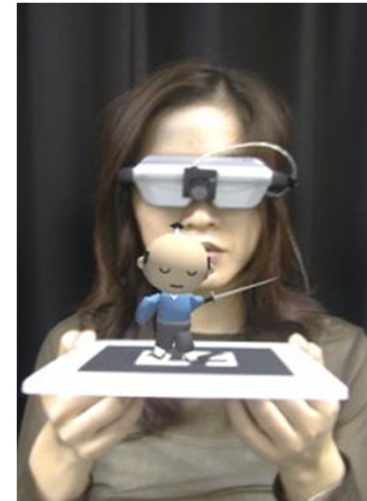
Lecture #6:  
Input Devices Part 2  
Jürgen P. Schulze, Ph.D.

# Announcements

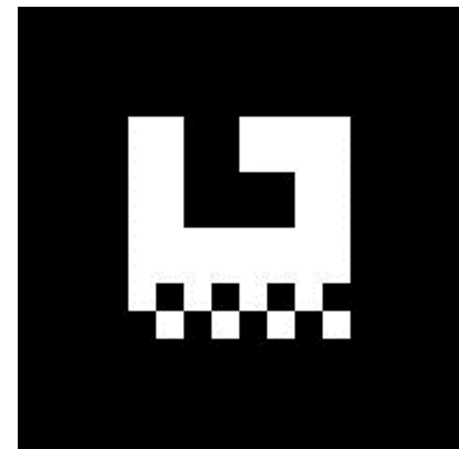
- Homework assignment #2 due Friday, February 8<sup>th</sup> at 1pm
- New, more detailed paper presentations section on course web site
- Schedule paper presentations

# 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

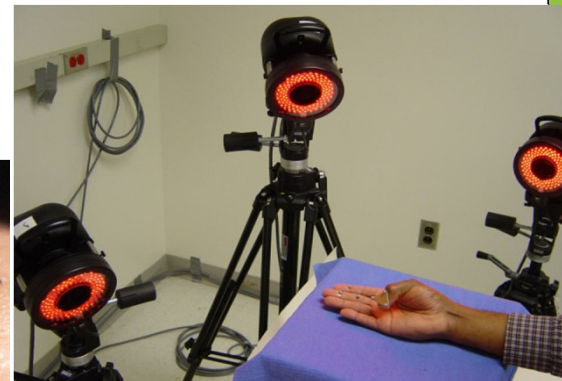
# Video

- 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



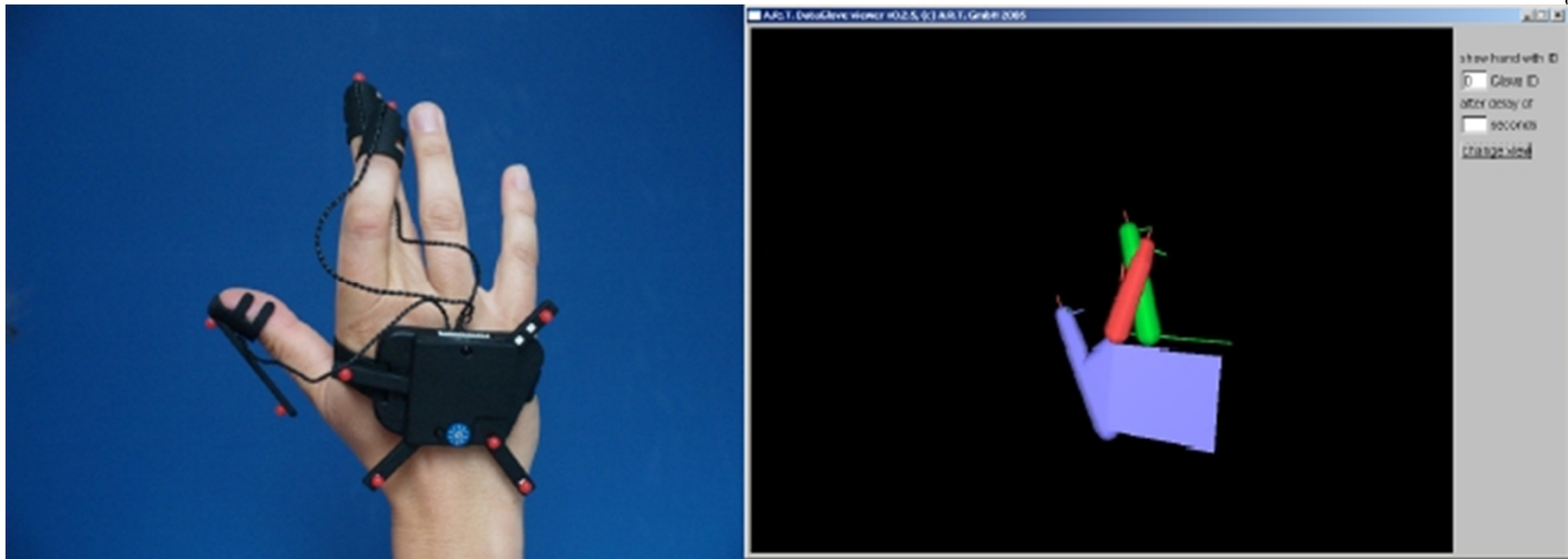
ART Tracking System

Mosquito *Aedes Aegypti*,  
carries the dengue virus

Vicon Tracking System

# Optical Finger Tracking

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



# 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

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



Logitech 3D Mouse



InterSense IS-900 tracker



InterSense IS-900 Wand



# Hybrid Devices: Haptic Feedback Devices

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



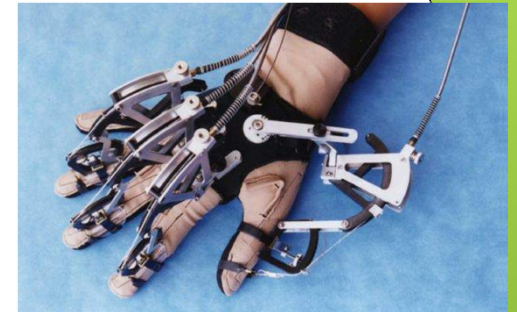
Microsoft force feedback joystick



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 Glove

- 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
  - Price at the time \$2000
  - Had problems with reliability

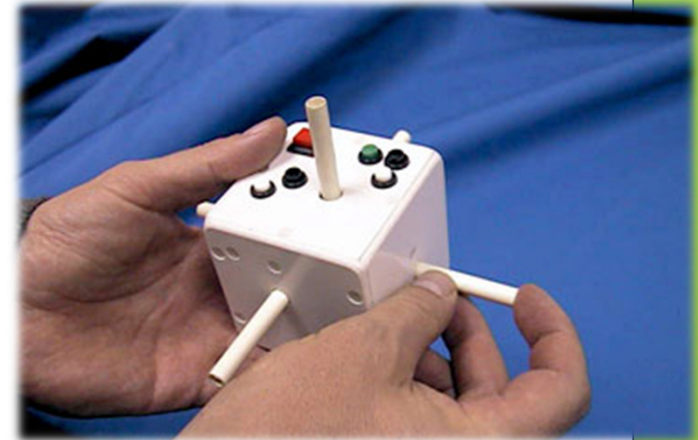


[www.fakespacelabs.com](http://www.fakespacelabs.com)



# Special Purpose Device: Cubic Mouse

- Developed 1999 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



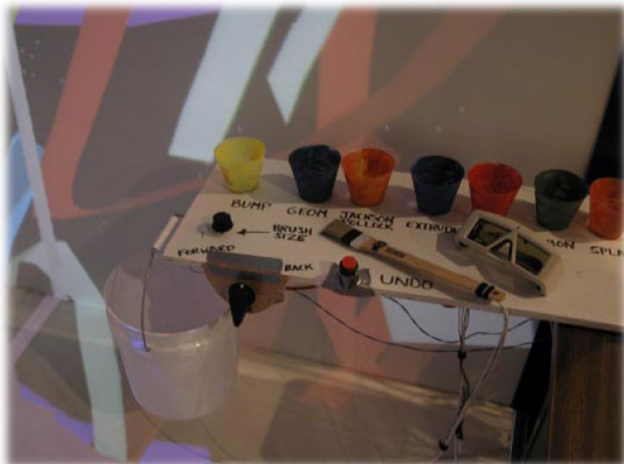
# Application-Specific Devices

- Virtual hang-gliding over Rio de Janeiro (L. Soares et 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)



# 3D Input Devices Today



Nintendo Wiimote



PlayStation Move



Microsoft Kinect



Leap Motion



Razer Hydra

Video game motion controllers at consumer prices!

# The Wiimote Device

- Uses Bluetooth for communication
- Senses acceleration along 3 axes
  - Used for sports games (tennis, bowling, etc.)
- 128x96 pixel monochrome camera with built-in image processing, requires sensor bar
  - Enables 2D on-screen pointer
- Standard buttons and trigger
- Provides audio and rumble feedback
- Up to 4 Wiimotes can be active simultaneously
- Connector for attachments
  - Nunchuck
  - Wii Zapper
  - Wii Wheel



Sensor Bar



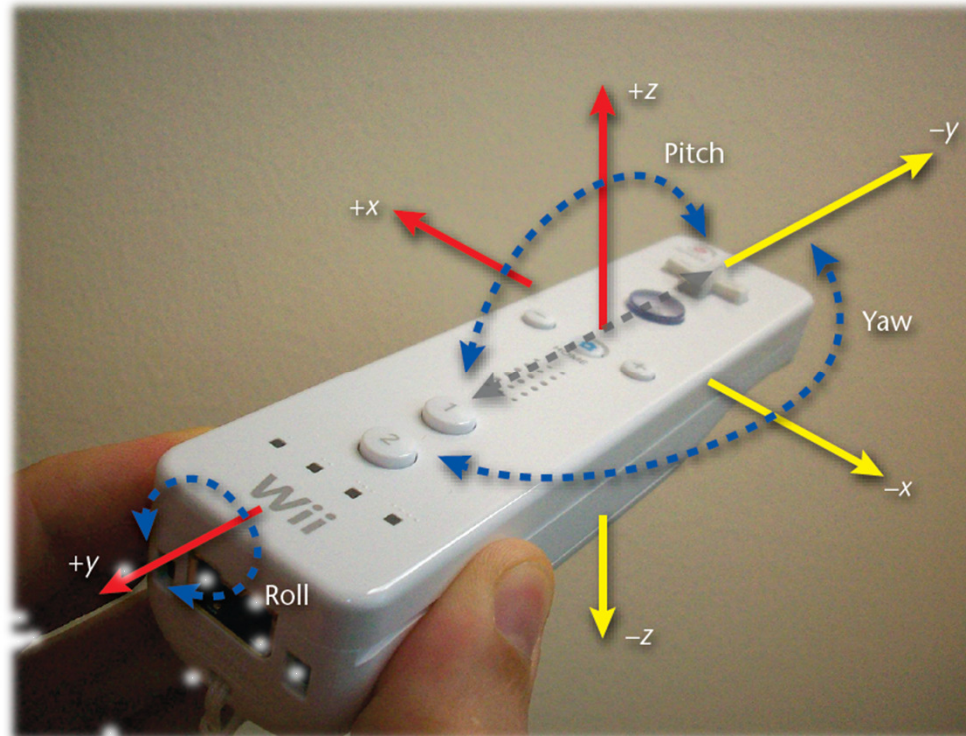
Wii Zapper



Wii Wheel



# The Wiimote – Coordinates



- Some data comes directly from physical sensors
- Some data mathematically derived from sensors

# The Wii Motion Plus

- Initially (June 2009) optional add-on, now built-in
- Uses 3-axis gyroscope
- Captures relative 3D orientation
- Improves pose and motion estimation
- Information captured by gyroscope can be used to distinguish true linear motion from accelerometer readings



# PlayStation Move

- Consists of
  - Playstation Eye camera
  - 1 to 4 motion controllers
  - Eye + 1 controller = ca. \$80
- Features
  - Combines camera tracking with motion sensing
  - 6 DOF tracking (position and orientation)
  - Several buttons on front of device
  - Analog button on back of device
  - Vibration feedback
  - Wireless and USB connectivity



# PlayStation Move – Hardware

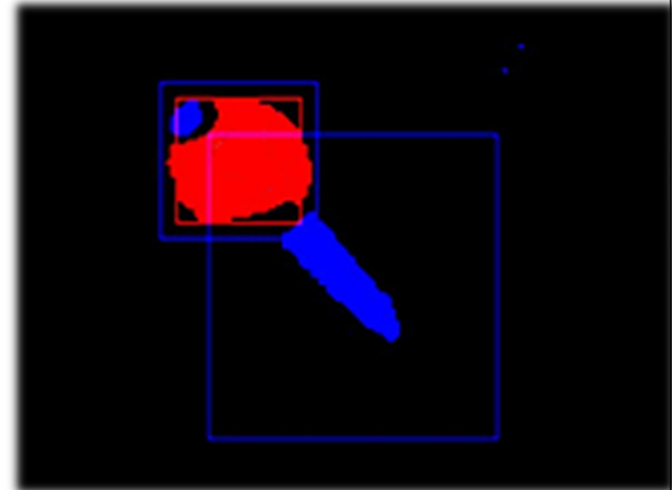
- PlayStation Eye
  - 640 x 480 (60Hz)
  - 320 x 240 (120Hz)
  - Microphone array
- Move Controller
  - 3-axis accelerometer
  - 3-axis angular rate gyroscope
  - Magnetometer: helps to calibrate and correct for drift
  - 44mm diameter sphere with RGB LEDs
    - Used for position tracking
    - Invariant to rotation
    - Provides own light source
    - Color ensures visual uniqueness



[www.hardwareSphere.com](http://www.hardwareSphere.com)

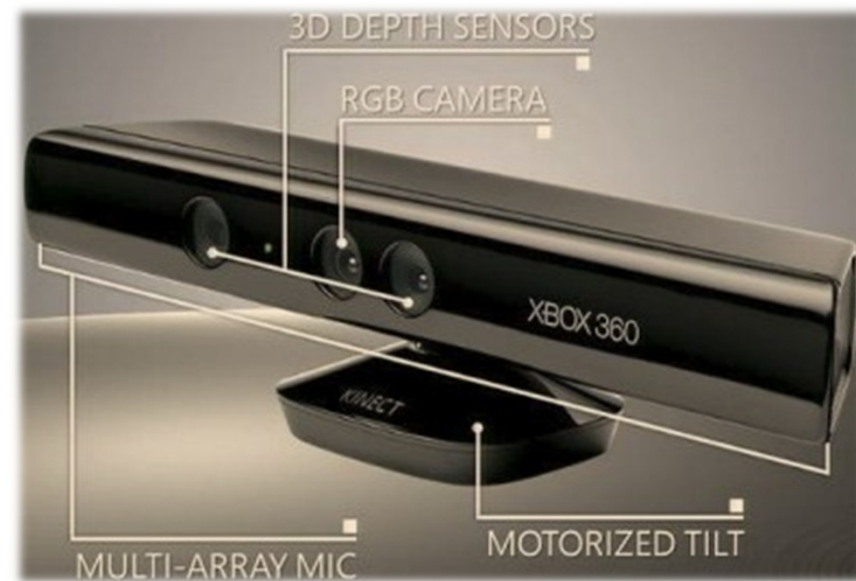
# PlayStation Move – 6 DOF Tracking

- Image Analysis
  - Find sphere in image with segmentation algorithm
  - Given focal length and size of sphere in image, calculate 3D position
- Sensor Fusion
  - Combines results from image analysis with inertial sensors
    - Accelerometer
      - Gives pitch and roll angles when controller is stationary
      - Gives controller acceleration when orientation is known
    - Gyroscope
      - Measures angular velocity and acceleration



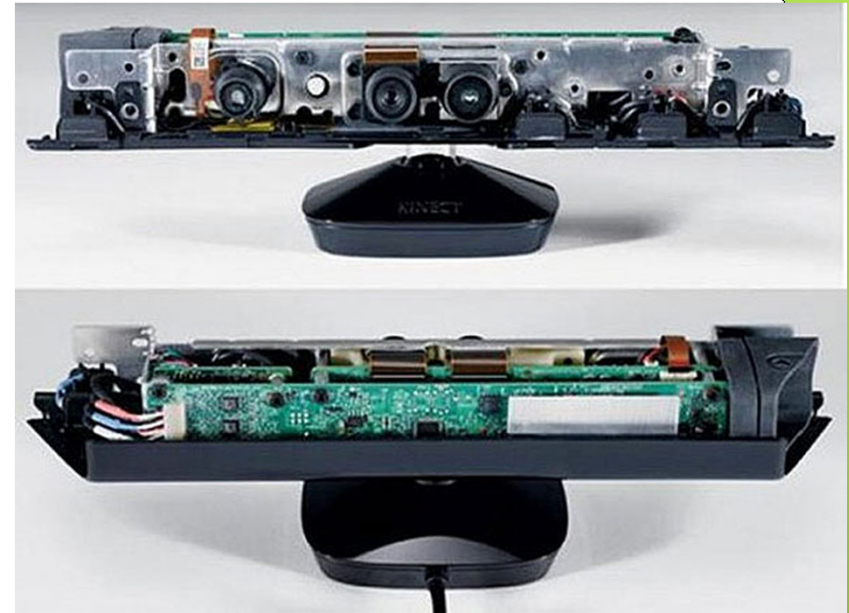
# Microsoft Kinect

- Microsoft sold 8 million units in first 60 days on market
  - Guinness World Record for “fastest selling consumer electronics device”
- Kinect features
  - RGB camera
  - Depth sensor
  - Microphone array
  - Motorized tilt
  - Connects via USB
- Enables controller-less user interface
- Full body tracking possible
- 2 versions:
  - Xbox (~\$100)
  - Windows PC (~\$250)



# Kinect – Hardware Details

- RGB Camera
  - 640 x 480 RGB pixels at 30Hz
- Depth Sensor
  - 640 x 480 monochrome pixels with 11-bit depth CMOS sensor at 30 Hz
  - Field of view: 57 ° horizontally, 43° vertically
  - Infrared laser projector
  - 4-11 feet range, down to 16 inches in near mode (Windows version only)
- Multi-array mic
  - Four microphones
  - Multi-channel echo cancellation
  - Sound position tracking
- Motorized tilt
  - 27° up or down



[www.hardware sphere.com](http://www.hardware sphere.com)

# Kinect – Extracting 3D Depth

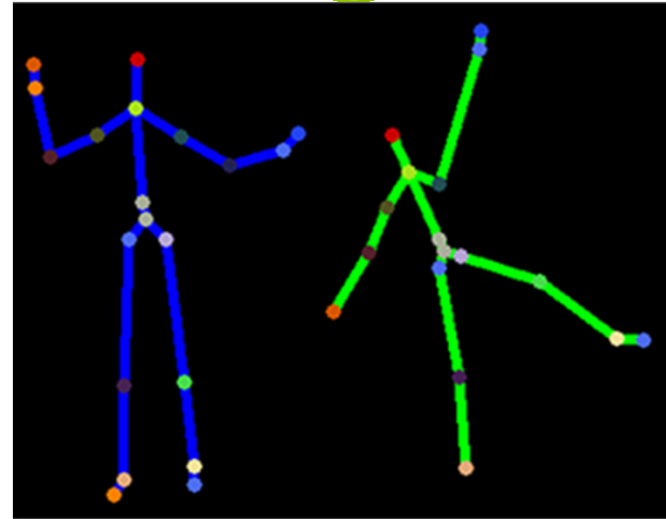
- Infrared laser projector emits known dot pattern
- CMOS sensor reads depth of all pixels
- Finds location of dots
- Computes depth information using stereo triangulation
  - Normally needs two cameras
  - Laser projector acts as second camera
- Depth image generation





# Kinect – Skeleton Tracking

- Combines depth information with human body kinematics
  - 20 joint positions
- Object recognition approach
  - per pixel classification
  - decision forests (GPU)
  - millions of training samples



# Kinect Programming

- Two approaches
  - Open NI and NITE
  - Microsoft Kinect SDK
- Skeleton extraction for full-body interaction

OpenNI™

