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Motion Capture

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MoCap Technologies

Instrument the *talent* to facilitate tracking feature points on the human figure

Need some kind of sense-able markers from which positional and possibly rotational status can be recorded

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"Traditional" MoCap Technologies

- **Optical – uses video capture**
  - **passive – markers just reflect light**
  - **active – markers emit light**

- **Magnetic – markers sense their status in magnetic field**

- **Electro-Mechanical – rotors connected to limb-aligned rods record their status – for hands, optical sensors used sometimes**

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Optical - Active

PhoeniX Technologies
www.ptiphoenix.com

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Magnetic

Ascention technology
http://www.ascension-tech.com/

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Electro-Mechanical

MetaMotion
www.metamotion.com/metamotion.htm

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Newer MoCap Technologies

- **Inertial systems (similar to Wii technology)**
- **Make-up**
- **Semi-passive imperceptible markers**
- **Markerless systems**

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Inertial

Moven
www.moven.com/en/home_moven.php

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Make-up

Mova

www.mova.com/

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Lighting- aware

SIGGRAPH 2007 paper
http://www.merl.com/people/raskar/LumiNetra/

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Markerless

Organic Motion

www.organicmotion.com/

www.image-metrics.com/

Motion Tracking

Mechanical Tracker

- A simple mechanical tracker can take the form of mechanical arm attached to the tracked object
- Very useful when integrated with a hand-held device
- High accuracy and low latency due to its electromechanical nature
- Restricted active volume (movement)

Phantom Omni (Sensable)

Motion Tracking

Optical Tracker

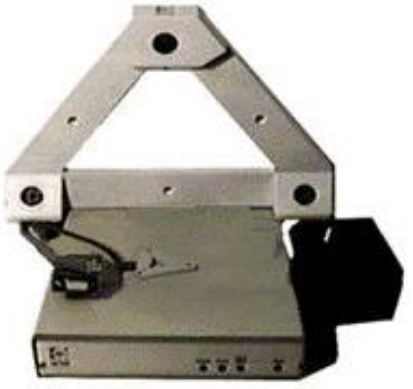
- Infrared video cameras that record the movement of a person
  - Attached to the person is a collection of markers in the form of small marker spheres fixed to a critical joints
  - When the moving person is illuminated with infrared light the marker balls are readily detected within the video images
- Fast and low latency
- The system depends on the line-of-sight, so the orientation of the cameras must ensure that the markers are always visible
- Often prone to interference caused by ambient lighting conditions

ARTTrack1 and ARTTrack2, by Advanced Realtime Tracking Inc. (http://www.ar-tracking.de)

Motion Tracking

Ultrasonic Tracker

- Ultrasonic sound waves are used to locate the user's position and orientation
- Usually used for fishtank VR in which the ultrasonic tracker is placed on the top of the monitor and records the user's head movements
- Simple and low cost
- Slow, restricted active volume, sensitive to temperature and depends on the line-of- sight



Logitech Ultrasonic Head Tracker
(http://www.i-glassesstore.com/logtractracs.html)

Motion Tracking

Electromagnetic Tracker

- Employ a device called a source that emits an electromagnetic field, and a sensor that detects the radiated field
  - The source, which can be no bigger than a 2-inch cube, can be placed on a table or fixed to a ceiling
  - The sensor is even smaller and is readily attached to an HMD or fitted within a 3D mouse
- Fast and very low latency; no light-of-sight restriction
- Restricted active volume and are prone to interference of metallic objects

miniBIRD, by Ascension Technology Corp. (http://www.ascension-tech.com/products/minibird.php)

Motion Tracking

Other game-type devices can also be used for tracking purposes, such as:

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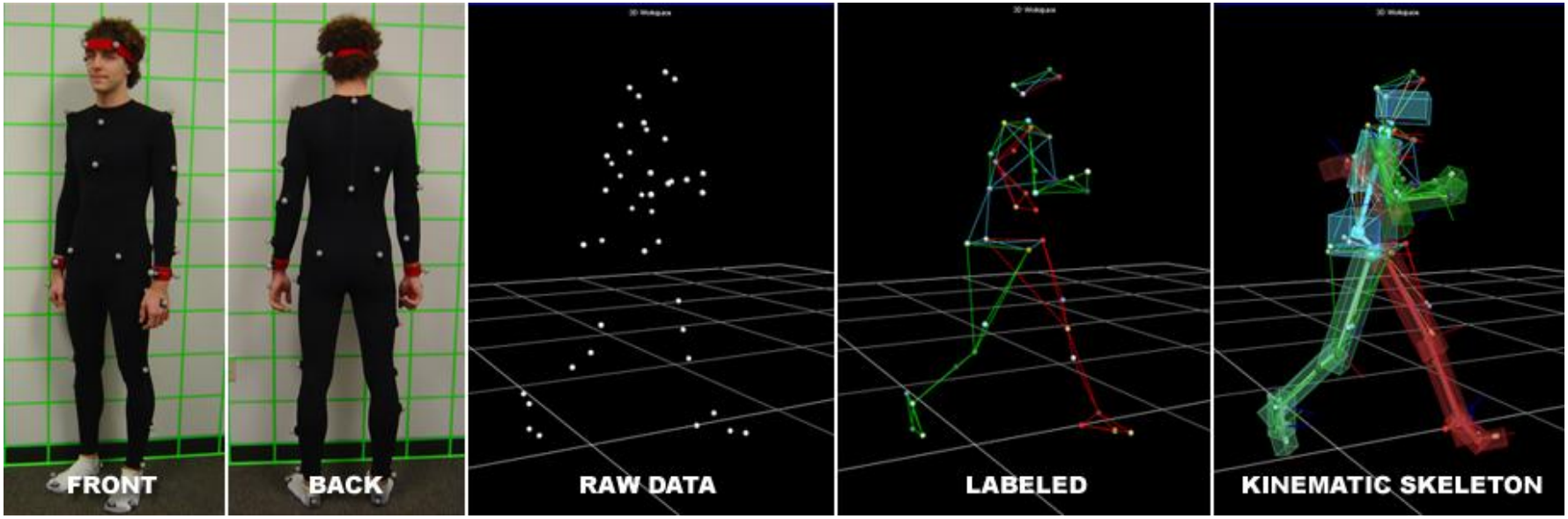
Passive Optical - most common (?)



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Motion capture lab

Multiple markers - e.g., 20-40
Multiple cameras - e.g., 8-14 high-res, high-speed
Constrained, conditioned space - 20x20 non-reflective
Multiple lights - synced w/ cameras
Vicon
http://www.vicon.com/applications/animation.html

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Processing the Images

PROCESSING STEPS

1. Extract markers from video
2. Track markers over time in video
3. Marker cleanup
4. 3D marker position reconstruction
5. Joint position reconstruction
6. Joint angle reconstruction

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Extract markers from video

Basic image processing aided by constrained environment:

- **High contrast markers**
- **Special illumination**
- **Non-reflective environment**

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Marker tracking

Given frames each with recognized markers

Associate markers over multiple frames

Temporal coherence using:

- **Position**
- **Frame rate**
- **Velocity**

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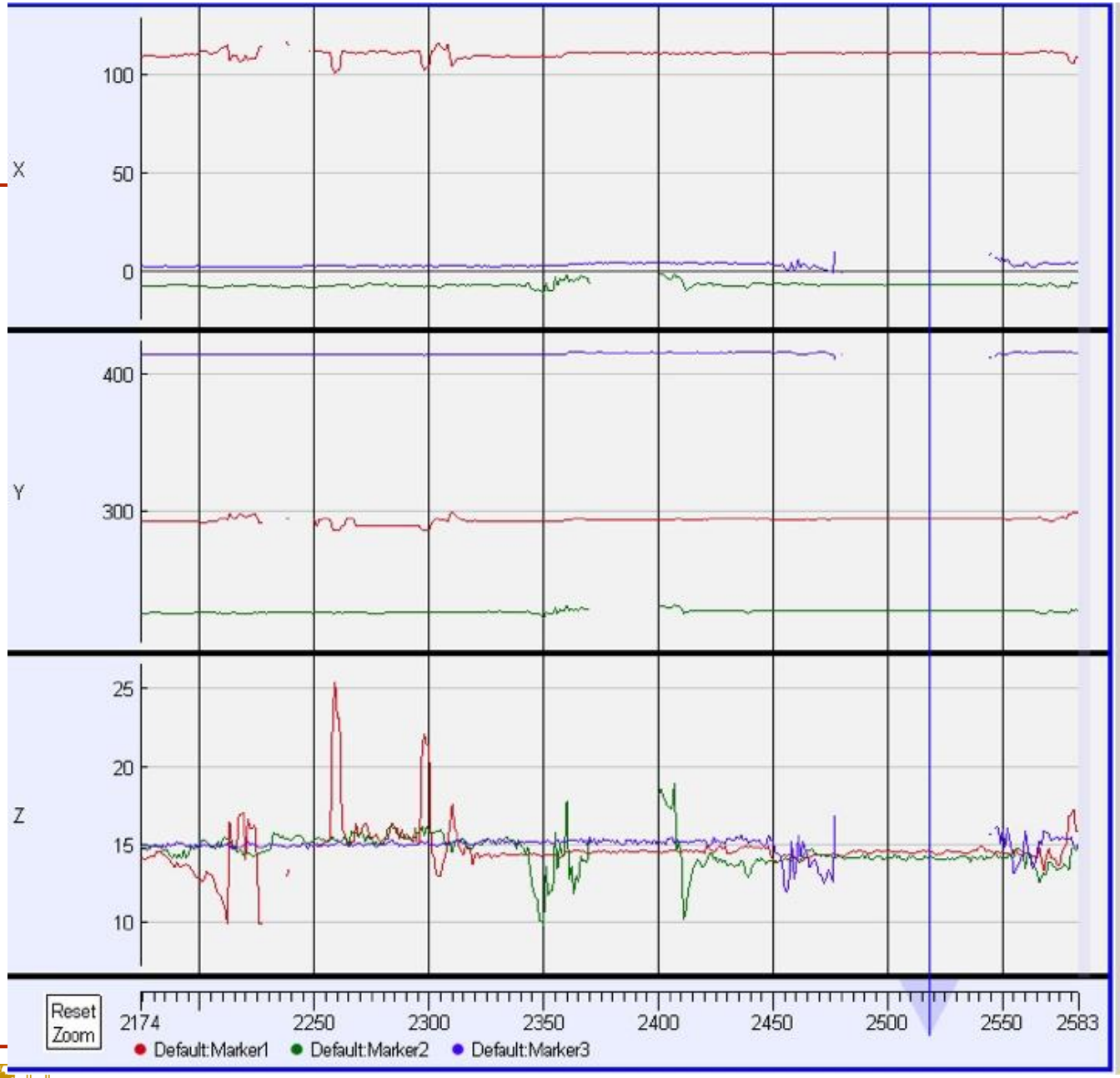
Marker Clean-up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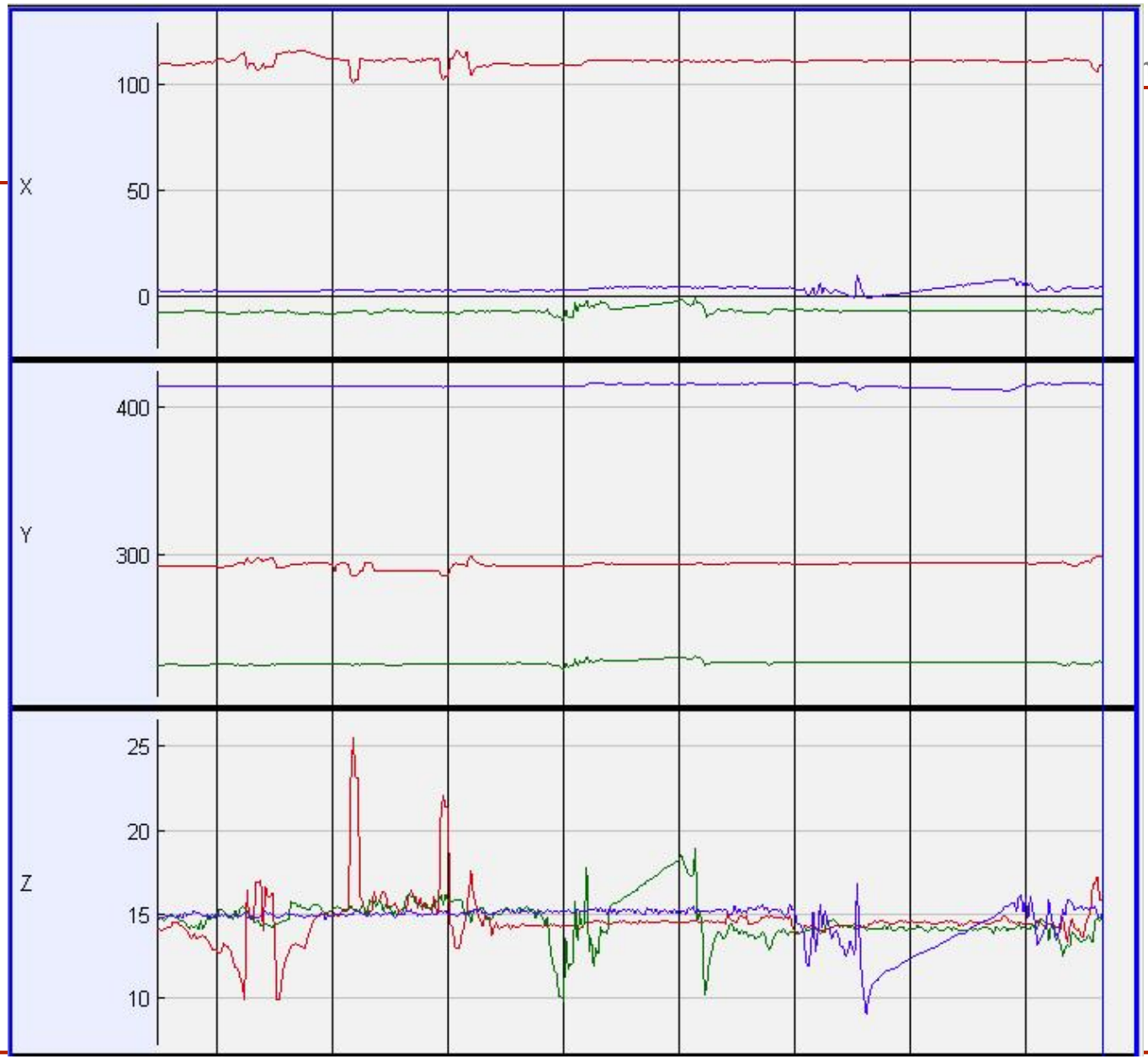
100
50
0
Y
400
300
Z
25
20
15
10
Reset Zoom
2174
2250
2300
2350
2400
2450
2500
2550
2583
Default:Marker1
Default:Marker2
Default:Marker3


X
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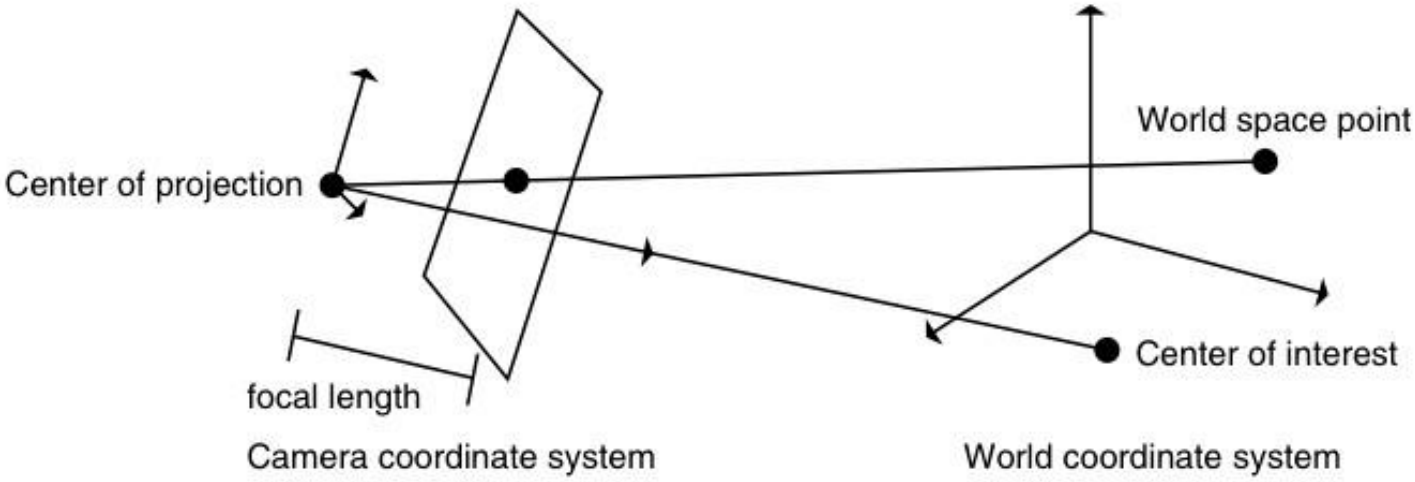
3D – image plane projection



Projecting marker onto image plane

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Camera calibration

Project known 3-space points to camera's image

$$P' = MP$$

Six degrees of freedom - use that many known point-pairs

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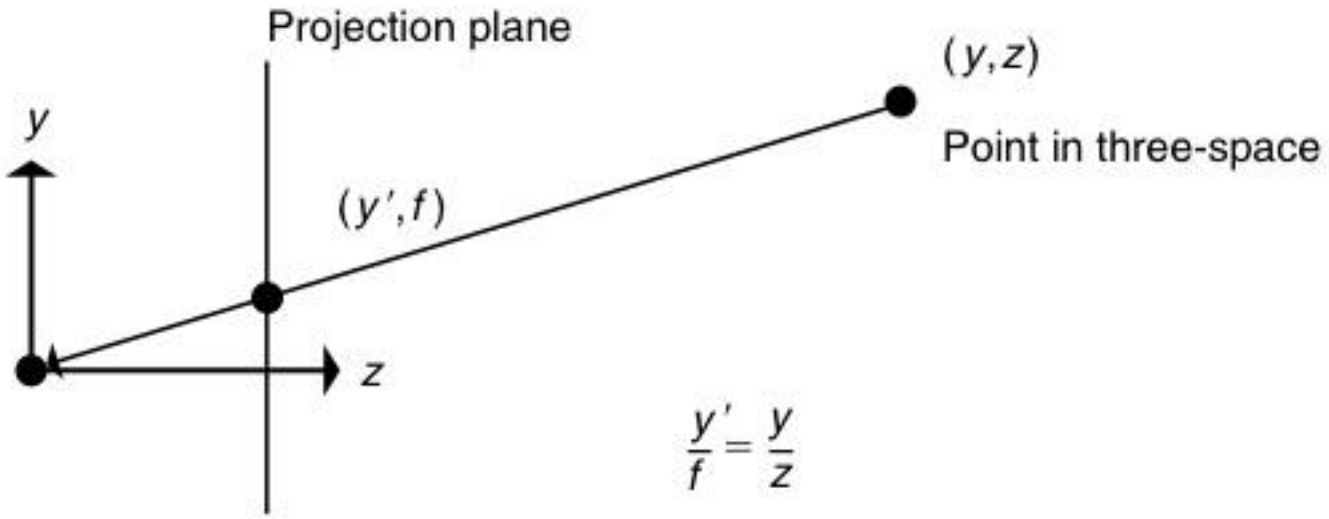
Projecting from 2D image out to 3-space



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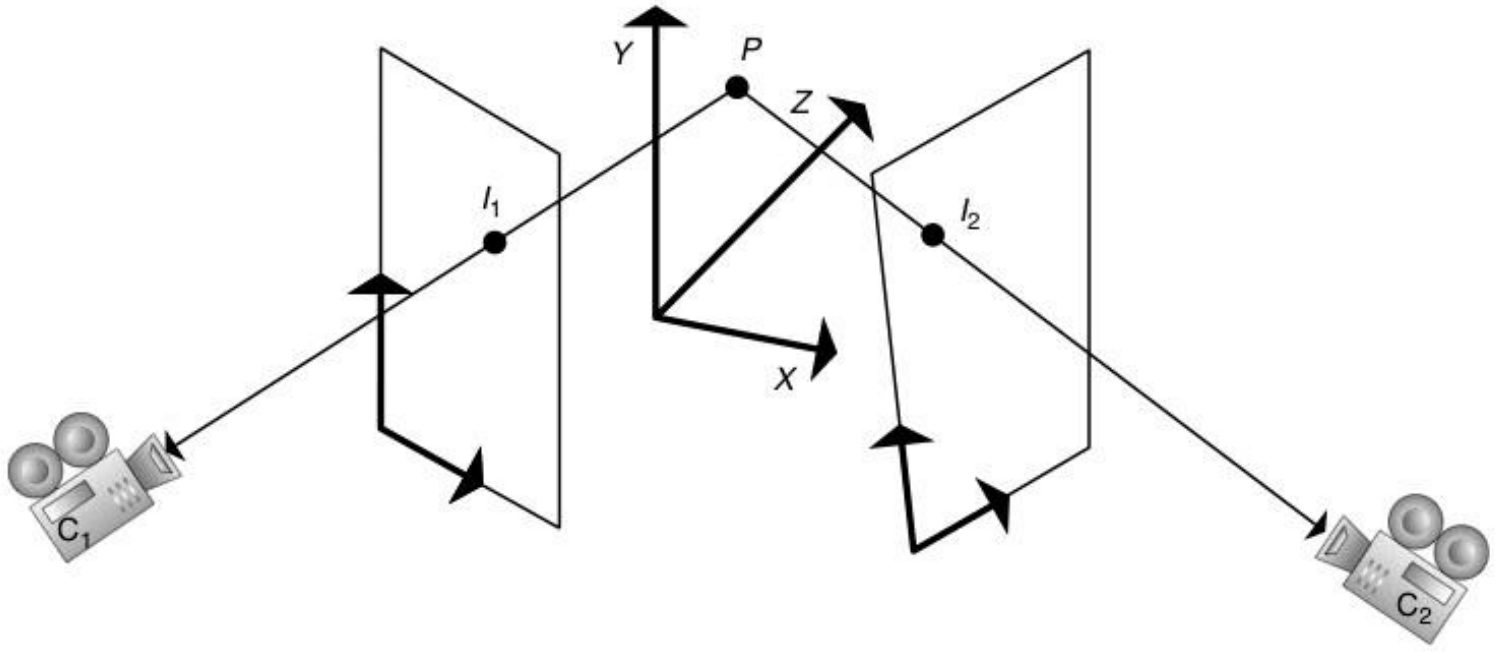
Reconstructing a 3D marker



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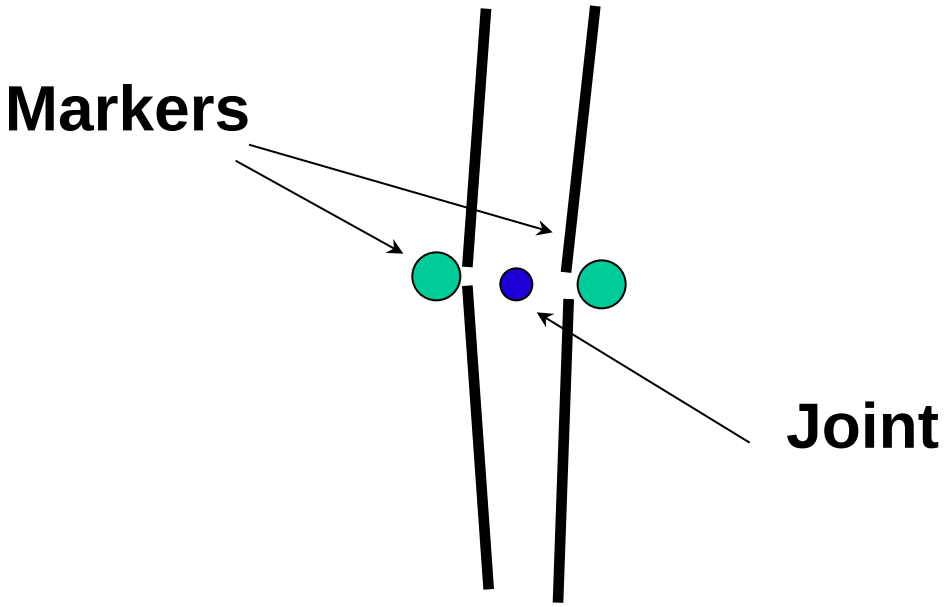
Fitting to the skeleton

Locate joints relative to markers



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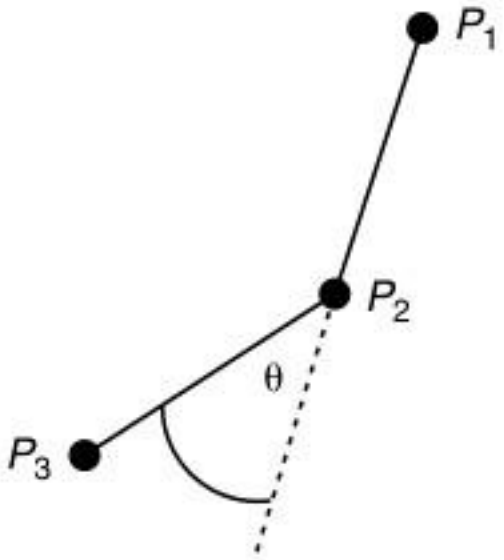
Reconstructing angles



$$\cos(\theta) = \frac{(P_3 - P_2) \cdot (P_2 - P_1)}{|P_3 - P_2||P_2 - P_1|}$$

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Mocap output

See sample files

http://accad.osu.edu/research/mocap/mocap_data.htm

http://mocap.cs.cmu.edu/

See sample files linked to at class website

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Manipulating the mocap data

Frequency deconstruction & manipulation

Transitioning between two motions – Blending

How to map a motion onto a figure with different geometry - Retargeting

Finding motion clips to create behavior – motion graphs