Computer Animation Algorithms and Techniques

Motion Capture

MoCap Technologies

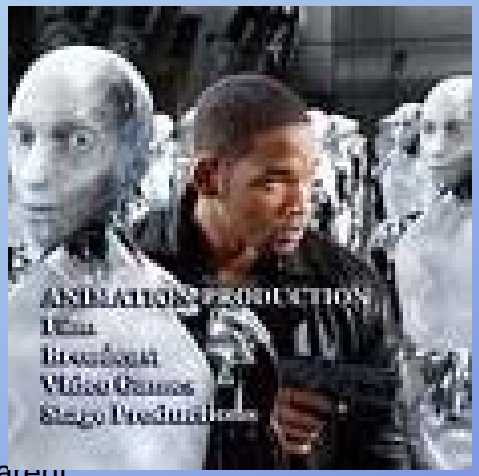
Instrument the *talent* to facilitate tracking feature points on the human figure

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

"Traditional" MoCap Technologies

- **Optical – uses video capture**
  - **passive – markers just reflect light**
  - **active – markers emit light**
- **Magnetic – active sensors sense their position and orientation in magnetic field**
- **Electro-Mechanical – rotors connected to limb-aligned rods record their status – for hands, optical sensors used sometimes**

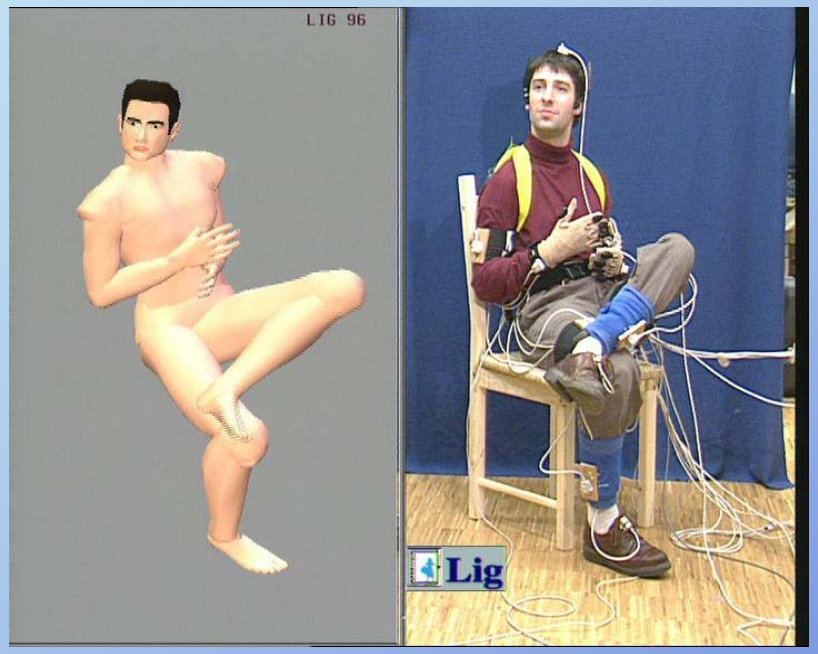
Optical - Passive

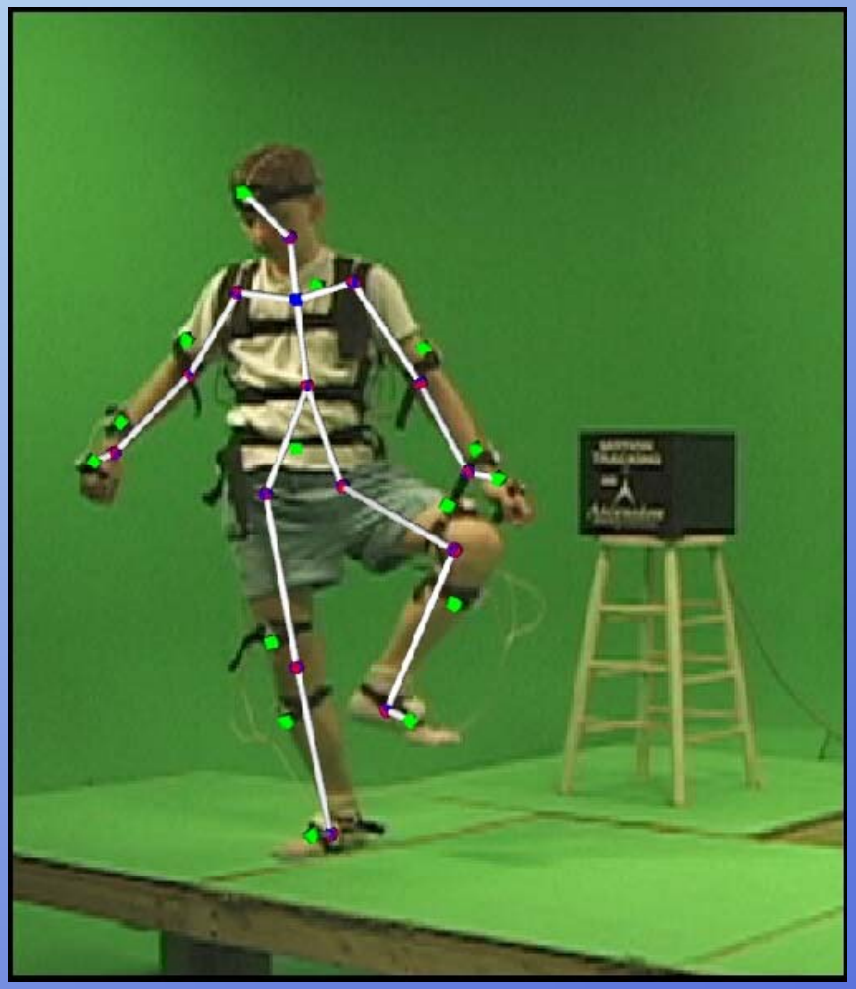


Optical - Active

Magnetic

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





Electro-Mechanical

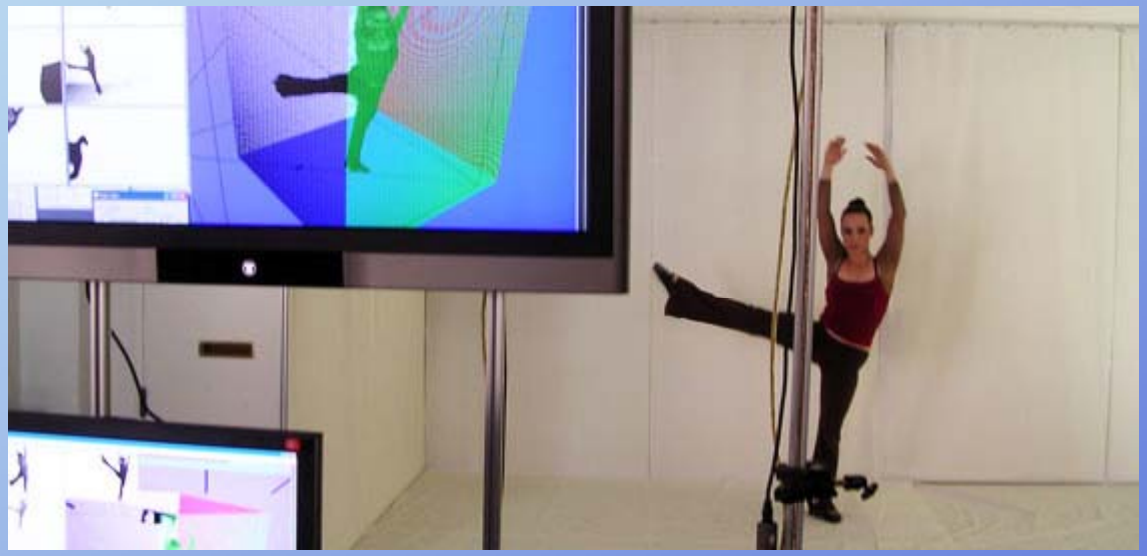
Newer MoCap Technologies

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

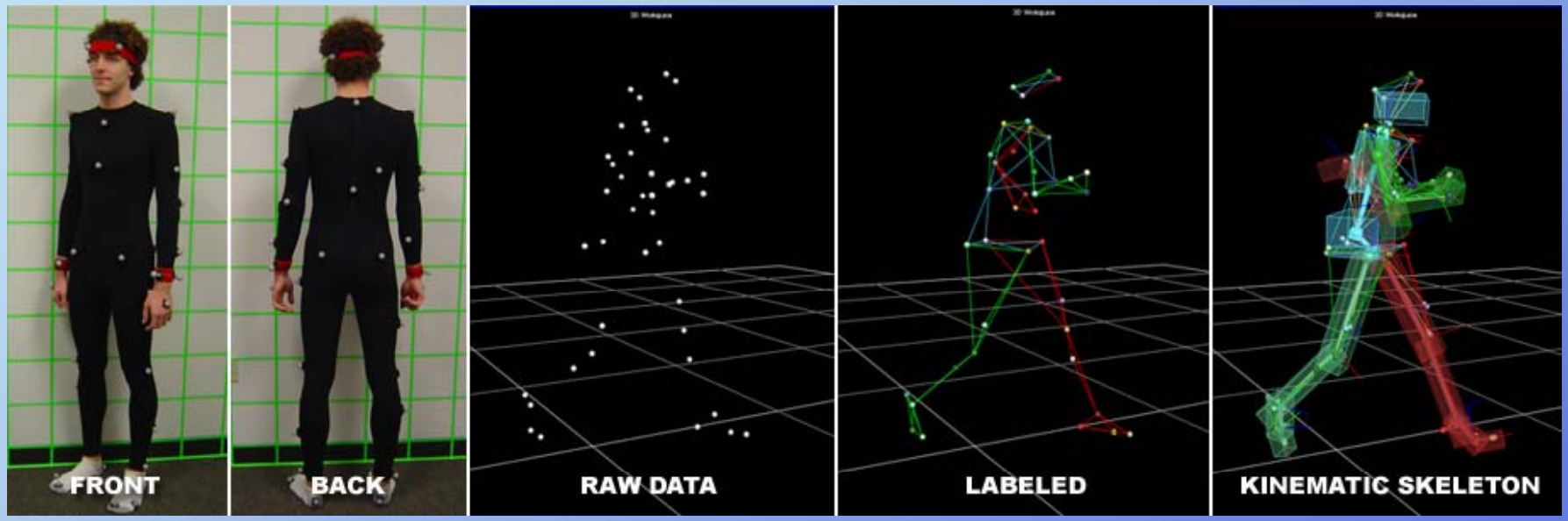
Markerless

Organic Motion
www.organicmotion.com/

Image Metrics (facial)
www.image-metrics.com/



Passive Optical – most common (?)



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

Motion capture lab

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

Extract markers from video

Basic image processing aided by constrained environment:

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

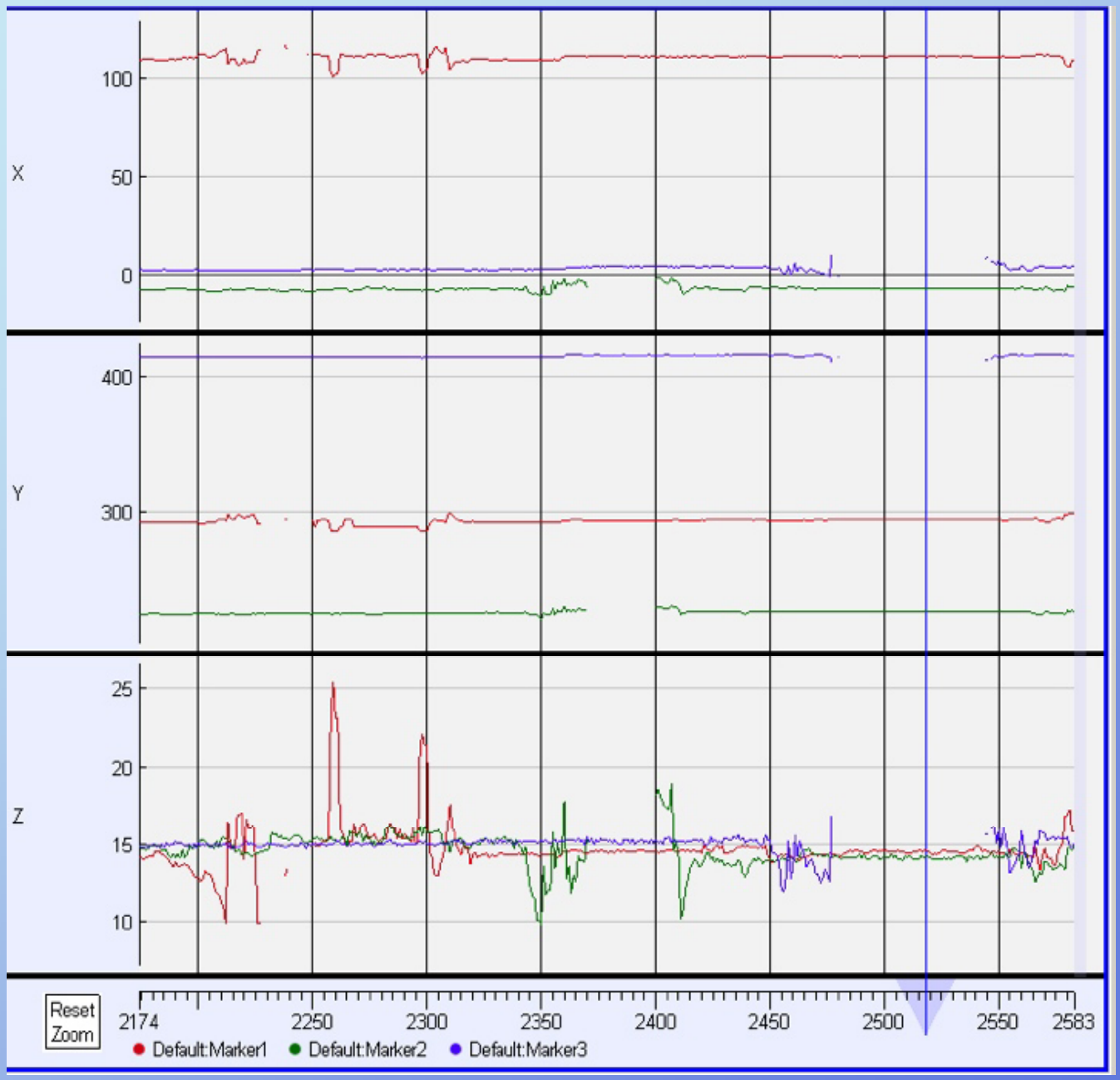
Marker tracking

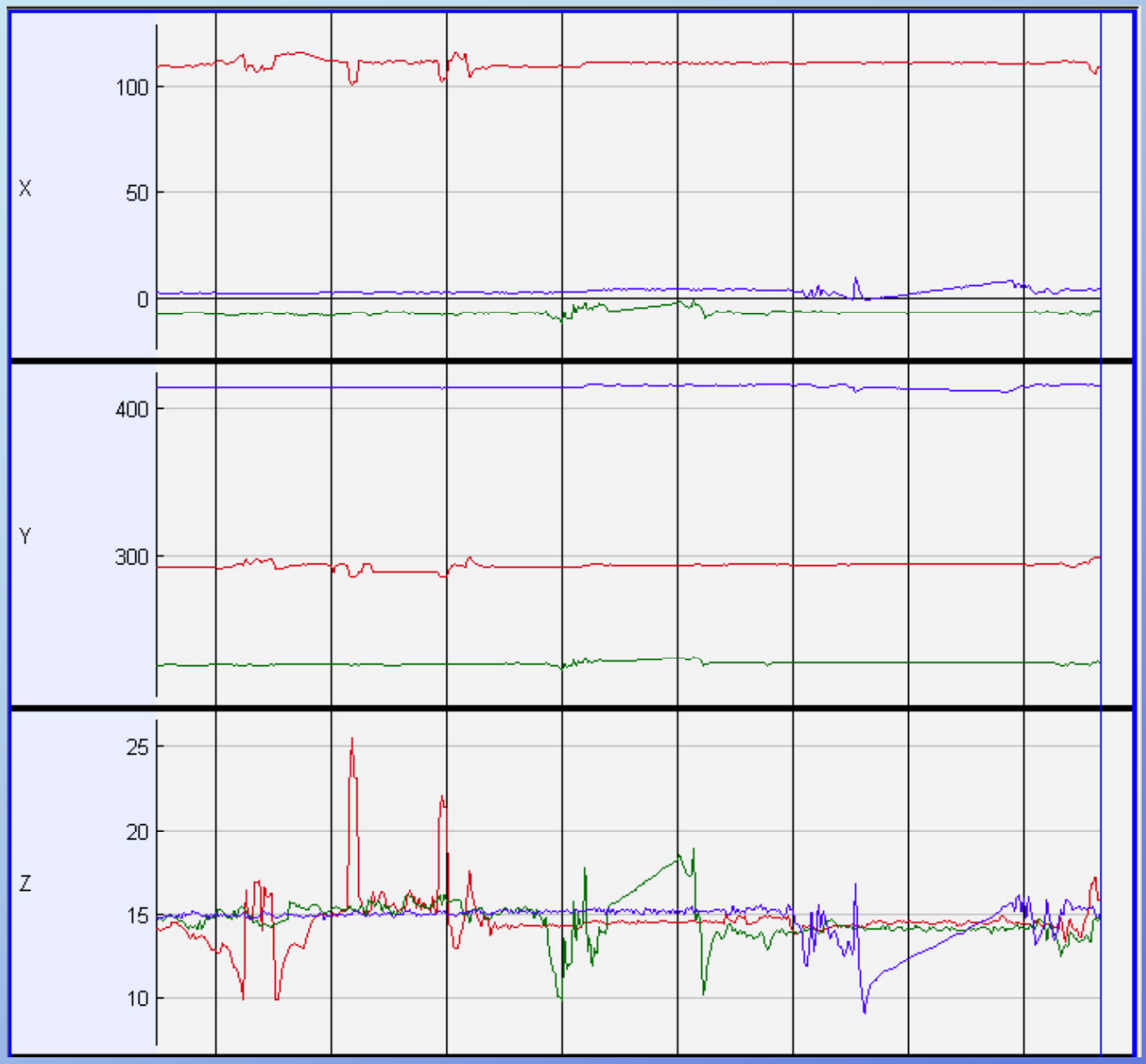
Given frames each with recognized markers

Associate markers over multiple frames

Temporal coherence using:
- **Position**
- **Frame rate**
- **Velocity**

Marker Clean-up


X
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
100
50
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Y
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25
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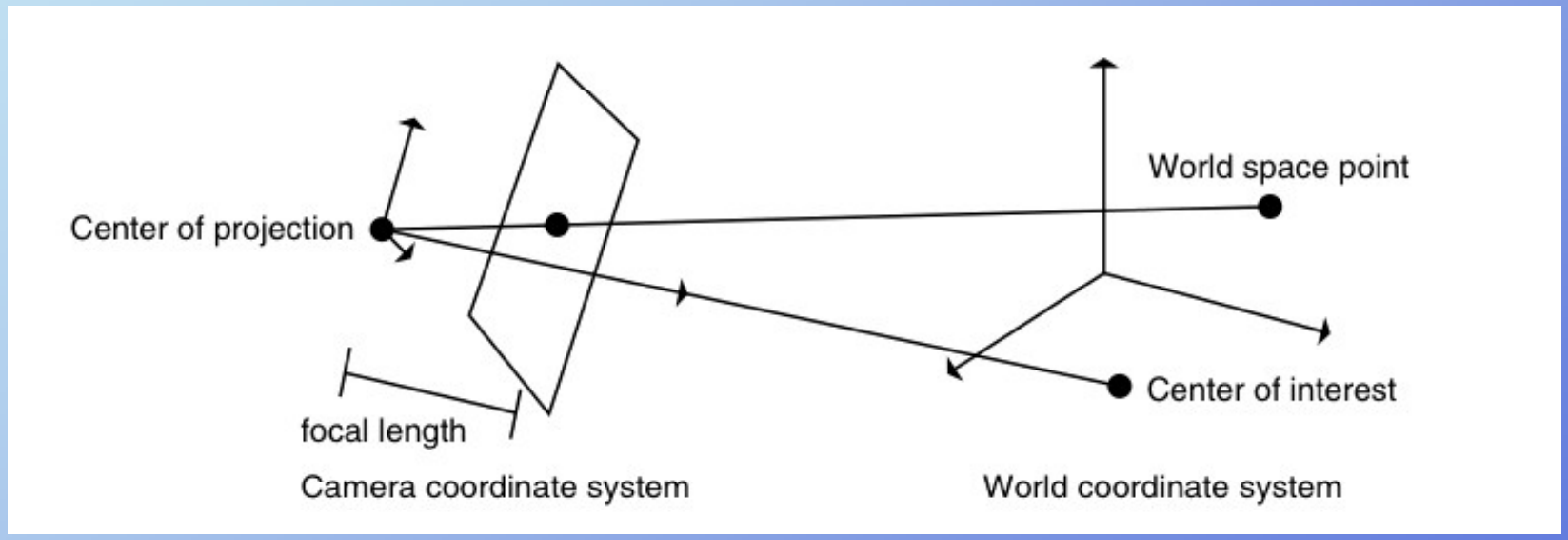
15
10

3D – image plane projection



Projecting marker onto image plane

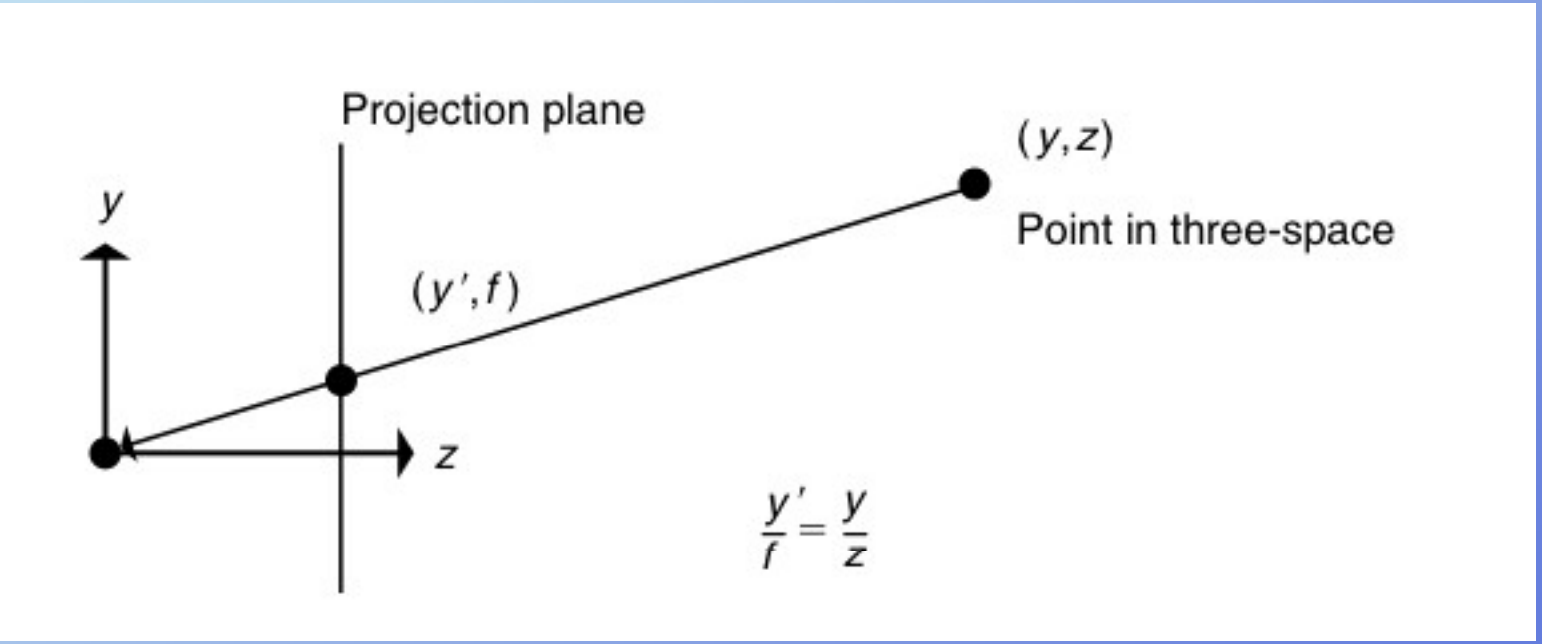
Camera calibration

Project known 3-space points to camera's image

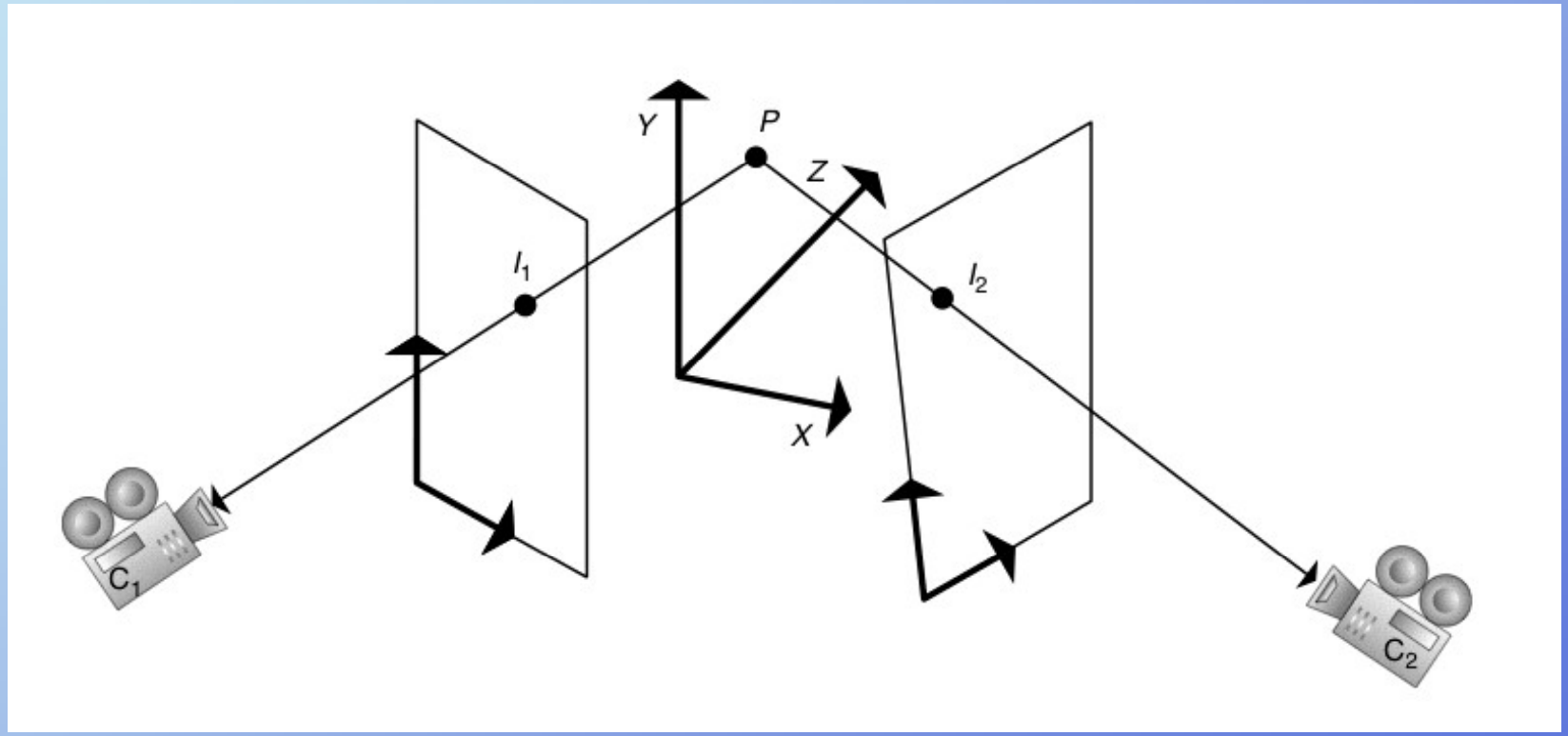
$$P' = MP$$

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

Projecting from 2D image out to 3-space

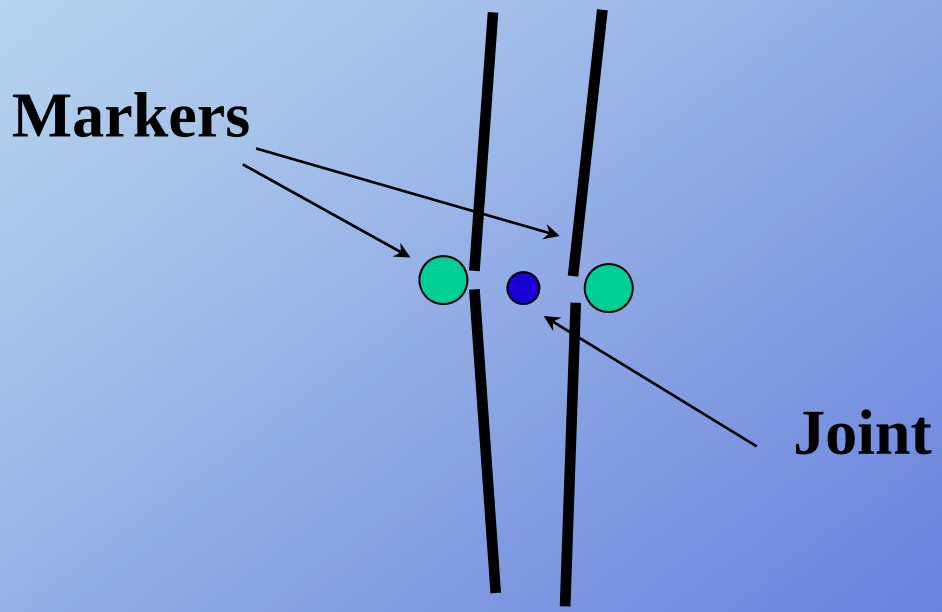


Reconstructing a 3D marker

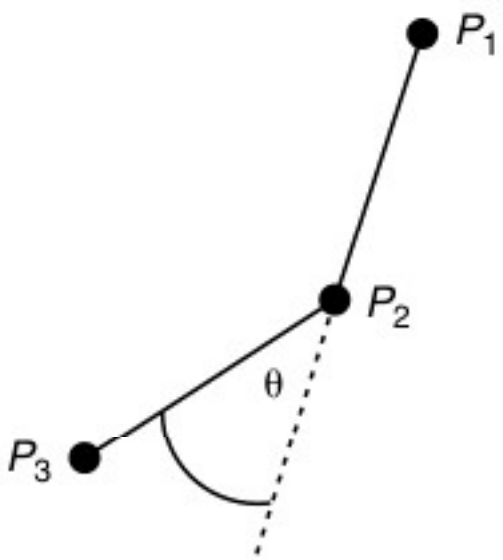


Fitting to the skeleton

Locate joints relative to markers



Reconstructing angles



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

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

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