Motion Capture

Motion Capture in Movies

Motion Capture in Games

Magnetic Capture Systems

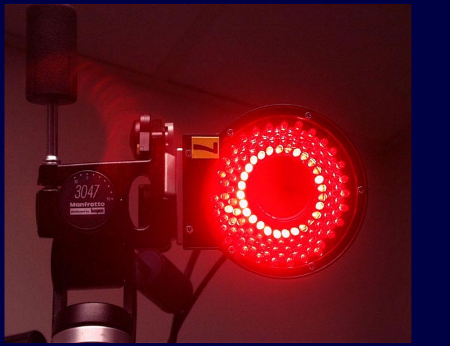
- Tethered
- Sensitive to metal
- Low frequency (60Hz)

Mechanical Capture Systems

- Any environment
- Measures joint angles
- Restricts the motion

Optical motion capture

- Place markers on the actor



- Cameras can determine marker positions

Optical Capture Systems

- 8 or more cameras
- Restricted volume
- High Frequency (240Hz)
- Occlusions

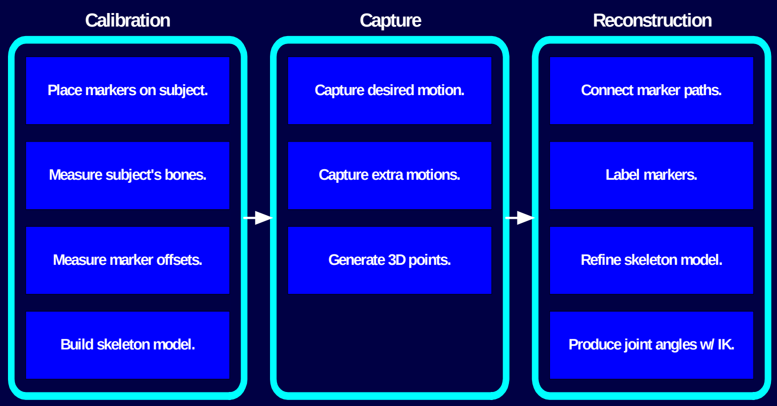
How Does It Work?

8 cameras + 120 Hz + Special tape = Raw Point Data

Optical motion capture process

1. Find the skeleton dimensions
   and exact marker positions on the body
2. Perform a motion trial
3. Compute marker positions from camera images
4. Identify and uniquely label markers
5. Calculate joint angles from maker paths

Current Approach



Calibration

Place markers on subject.

Measure subject's bones.

Measure marker offsets.

Build skeleton model.

Capture

Capture desired motion.

Capture extra motions.

Generate 3D points.

Reconstruction

Connect marker paths.

Label markers.

Refine skeleton model.

Produce joint angles w/ IK.

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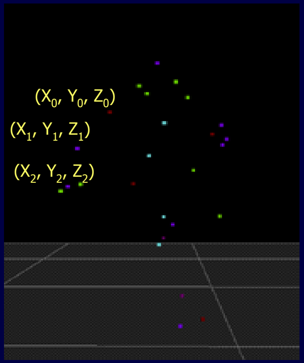
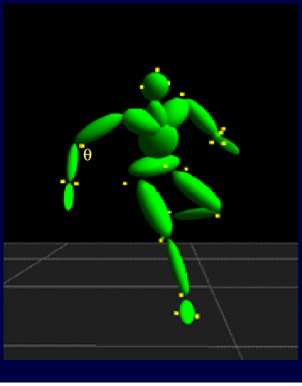
Marker Identification

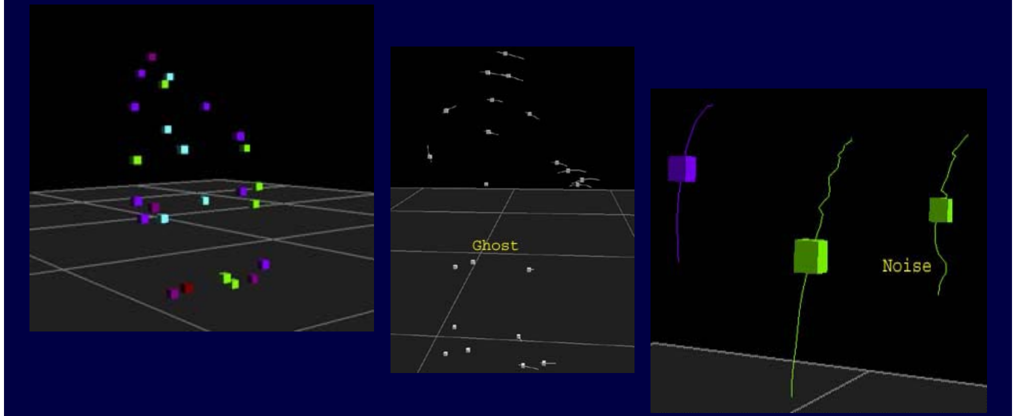


At each frame, motion capture gives us a set of points



We would like something more intuitive

Marker Identification Problems



Making sense of raw data…

Optical motion capture process

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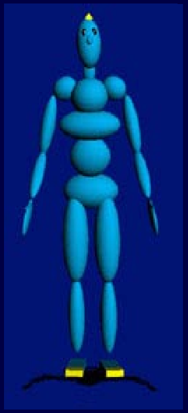
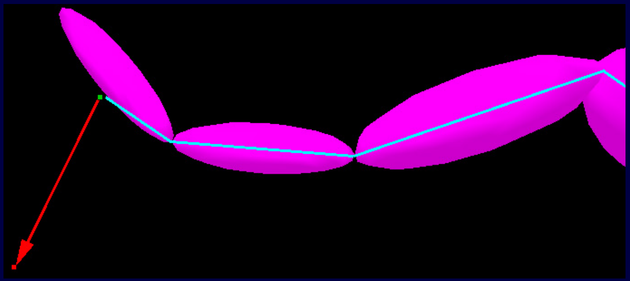
IK Problem Definition



1. Create a handle on body
   - position or orientation
2. Pull on the handle
3. IK figures out how joint angles should change

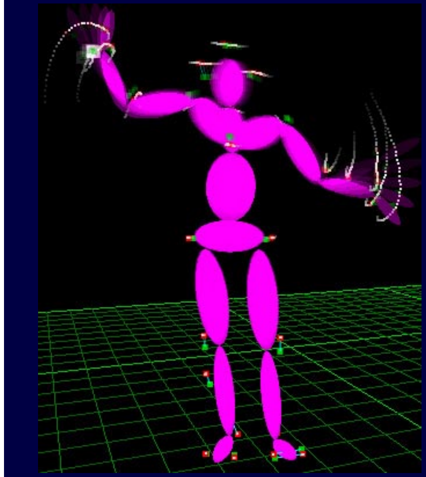
Inverse Kinematics



Inputs:
An articulated skeleton with handles. Desired positions for handles.

Outputs:
Joint angles that move handles to desired positions.

Inverse Kinematics (con't)



We are solving IK on a complex model (~50 DOFs and 30 handles).

Motion capture data often contains missing markers.

Many different formulations for IK problem, would like to use one that is best for motion capture data.

More Formally

Let:

q actor *state vector* (joint bundle)

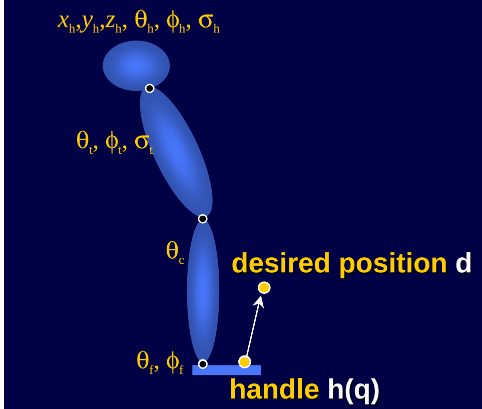
C(q) constraint functions that pull handles

Then:

solve for **q** such that **C(q) = 0**

What's a Constraint?

q=[$x_h, y_h, z_h, \theta_h, \phi_h, \sigma_h, \theta_t, \phi_t, \sigma_t, \theta_c, \theta_f, \phi_f$ **]**


$x_h, y_h, z_h, \theta_h, \phi_h, \sigma_h$
$\theta_t, \phi_t, \sigma_t$
θ_c
desired position d
θ_f, ϕ_f
handle h(q)

- Can be rich, complicated
- But most common is very simple:
- Position constraint just sets difference of two vectors to zero:

$$\boxed{C(q) = h(q) - d = 0}$$

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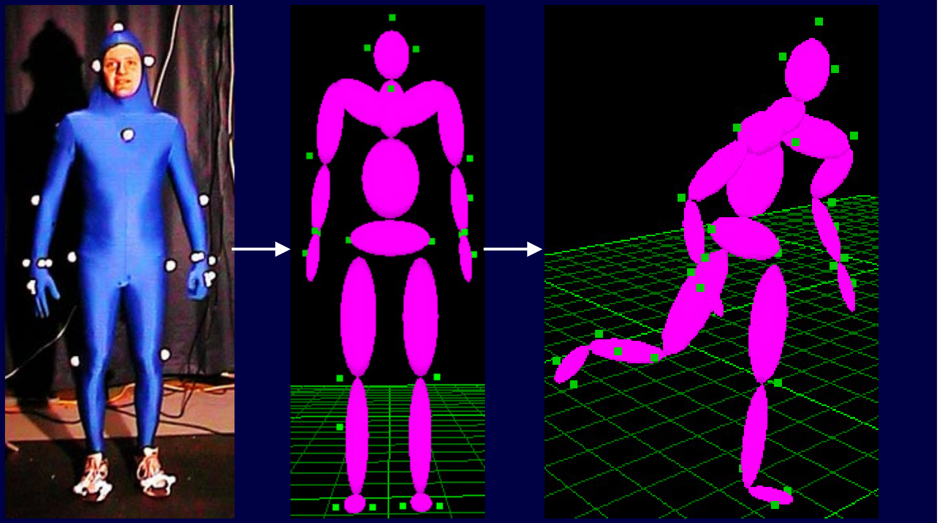
Problem Statement

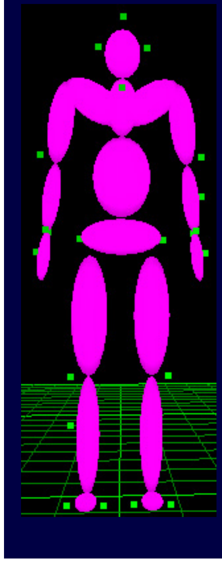


Automatic Calibration

Design Goals:

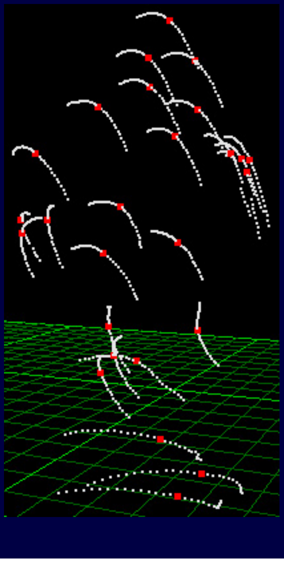
- Fully automatic
- Any skeleton
- Accurate

Input



Generic Skeleton

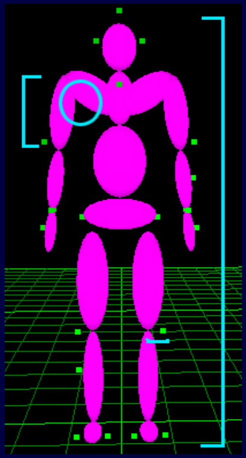
Actor’s kinematics structure, and rough handle positions



Calibration Data

Initial path data that exercises all of the subject’s DOFs

Independent Variables



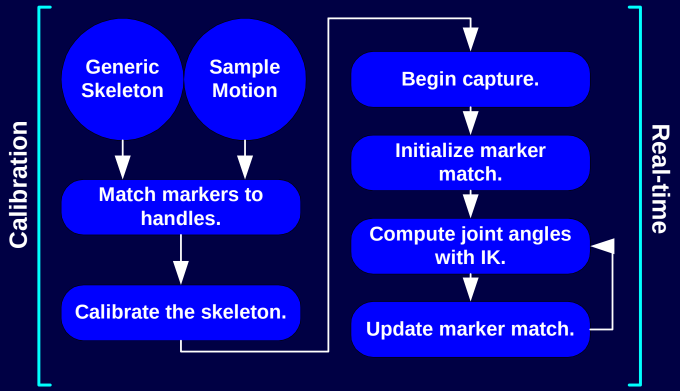
DOFs

Bone lengths

Handle offsets

Global scale

Real-time Motion Capture



Motion capture as UI

- Map a “whiteboard space” anywhere
- Full body user interface
  - Gesture recognition
- Full-body teleconferencing