# Announcements

New version of assignment 1 on the web page:
www.cs.cmu.edu/~jkh/anim_class.html

**Test login procedure NOW!**

Tuesday's class in the motion capture lab:
Wean1326

Volunteers needed for capture session

# Motion Capture Technology

**Parent: Chapter 6.7**

**COMPUTER ANIMATION**

**15-497/15-861**

02/30/02

# Animation Technique #2
# Motion Capture

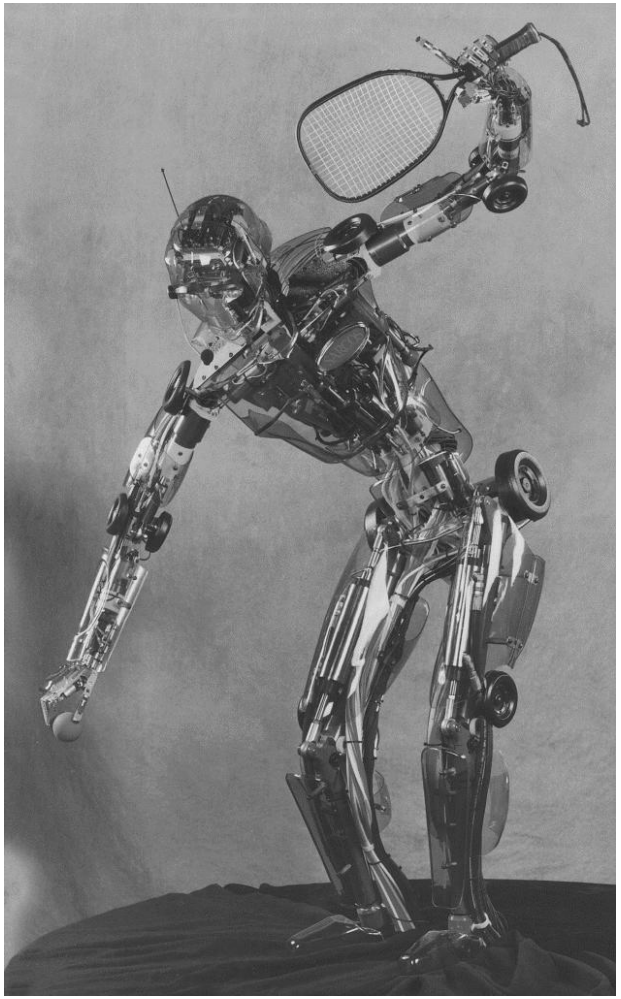
- What is motion capture?
  - Capture of motion of (human) actor
    - » Whole body
    - » Hands
    - » Face
  - More generally—one way of acting out an animation

# Animation Technique #2
# Motion Capture

- All the fine details of human motion will be there
  - if we can capture them
- Not terribly easy to
  - Edit
  - Generalize
  - Control

# Motion Capture

- Animation
- Interactive characters
- Robot control

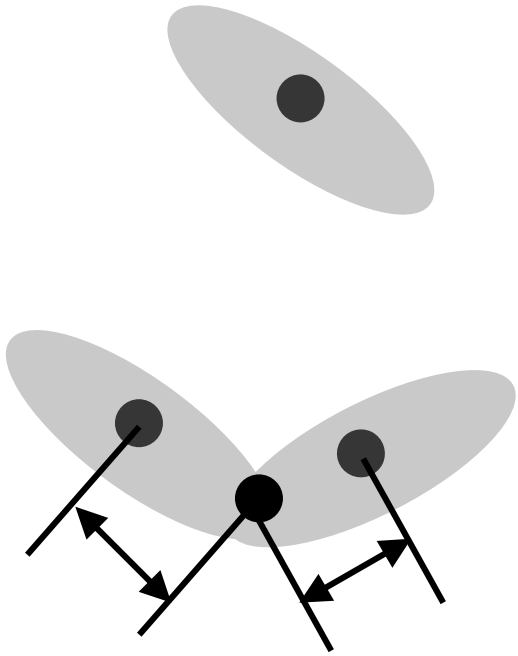



# Motion Capture

- track motion of reference points
- convert to joint angles
- use angles to drive an articulated 3-D model
- motion paths can then be adapted and generalized

# What is captured?

- What do we need to know?
  - X,Y,Z
  - Roll, pitch, yaw
- Errors cause
  - Joints to come apart
  - Links to grow/shrink
  - Bad contact points



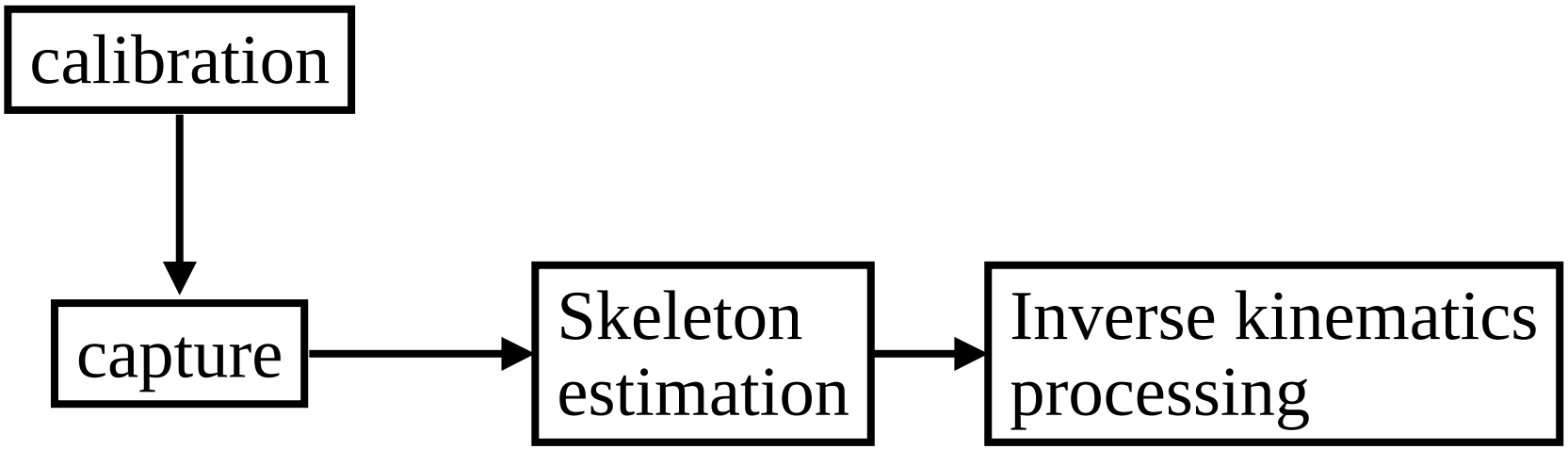
# How to use the data?

- Off-line
  - Processing by filtering, inverse kinematics
  - Produce libraries of motion trajectories
    - » Choose among them
    - » Blend between them
    - » Modify on the fly
- On-line (performance animation)
  - Driving character directly based on what actor does in real time

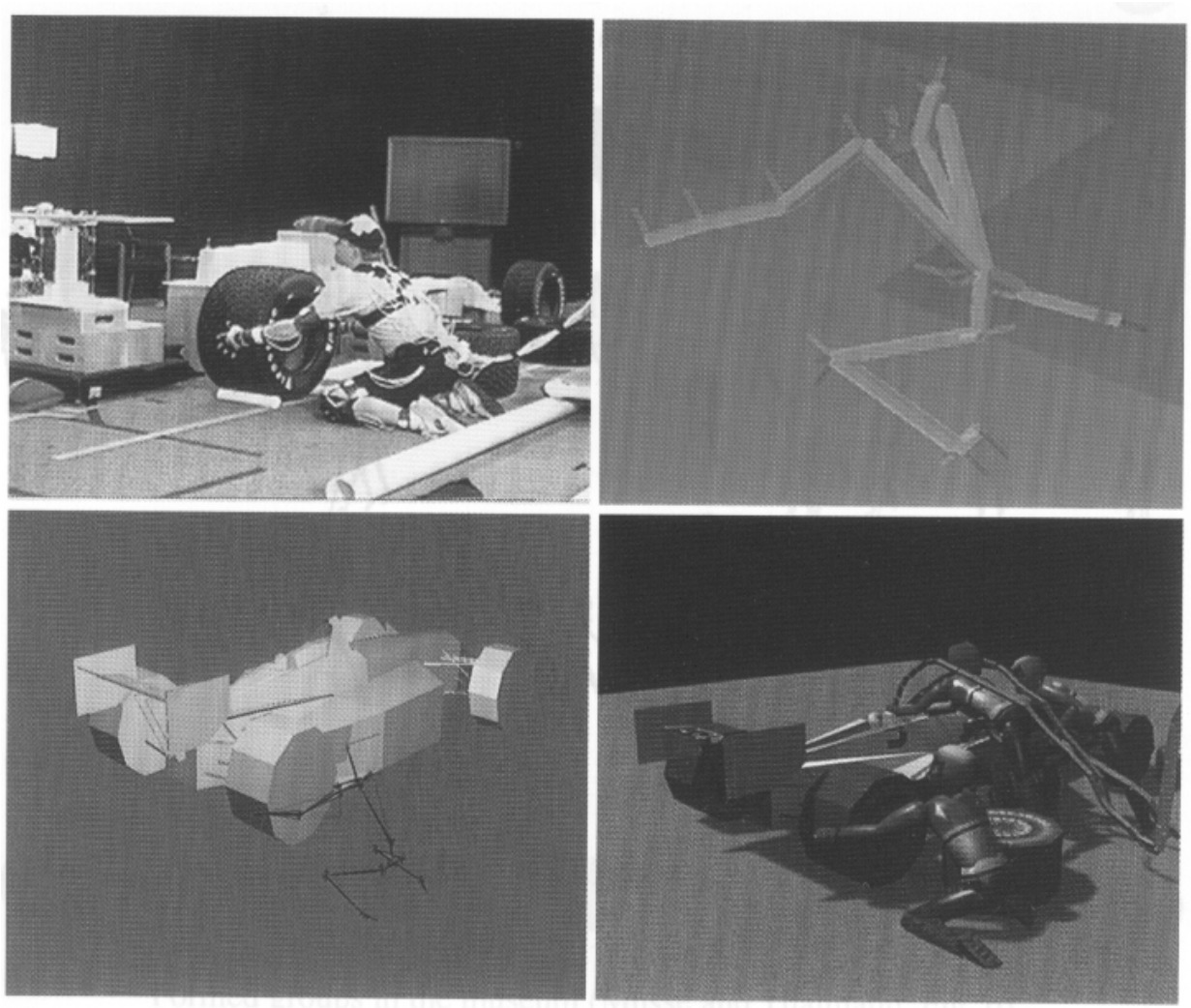
# History of the Technology

- Recording motion for biomechanics
  - High accuracy
  - Fewer recorded points
  - Hand digitizing film
  - Supplement with force plate, muscle activity
- Computer animation
  - Rotoscoping
- Robot measurements
  - Selspot LED system
- VR tracking technology
  - Less accuracy required
  - Fewer sensors

# Production Pipeline



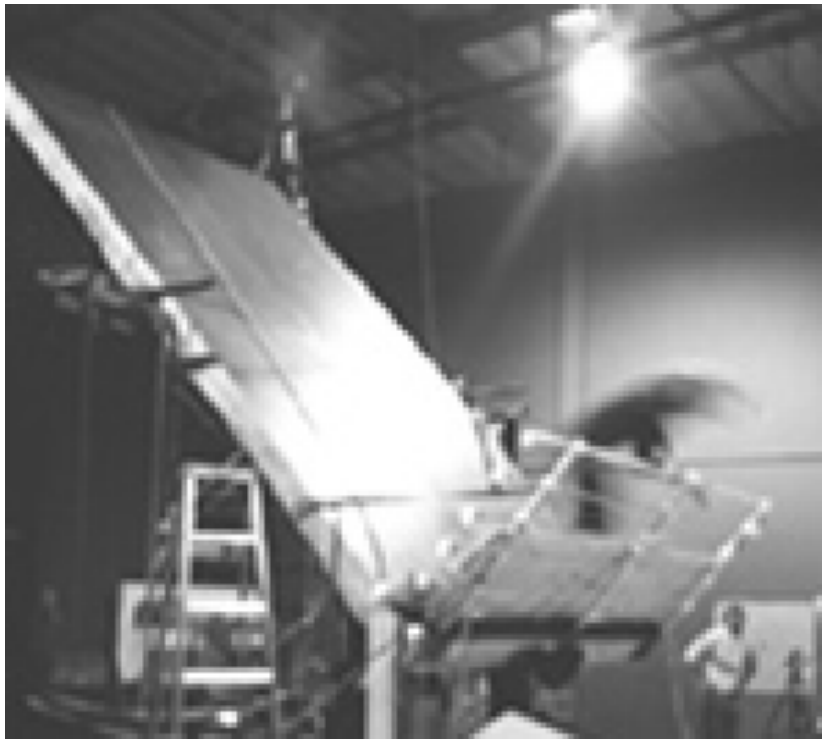
# Production Pipeline



Bodenheimer et al., Dealing with the Data

# What is captured?

dynamic or slow moving?

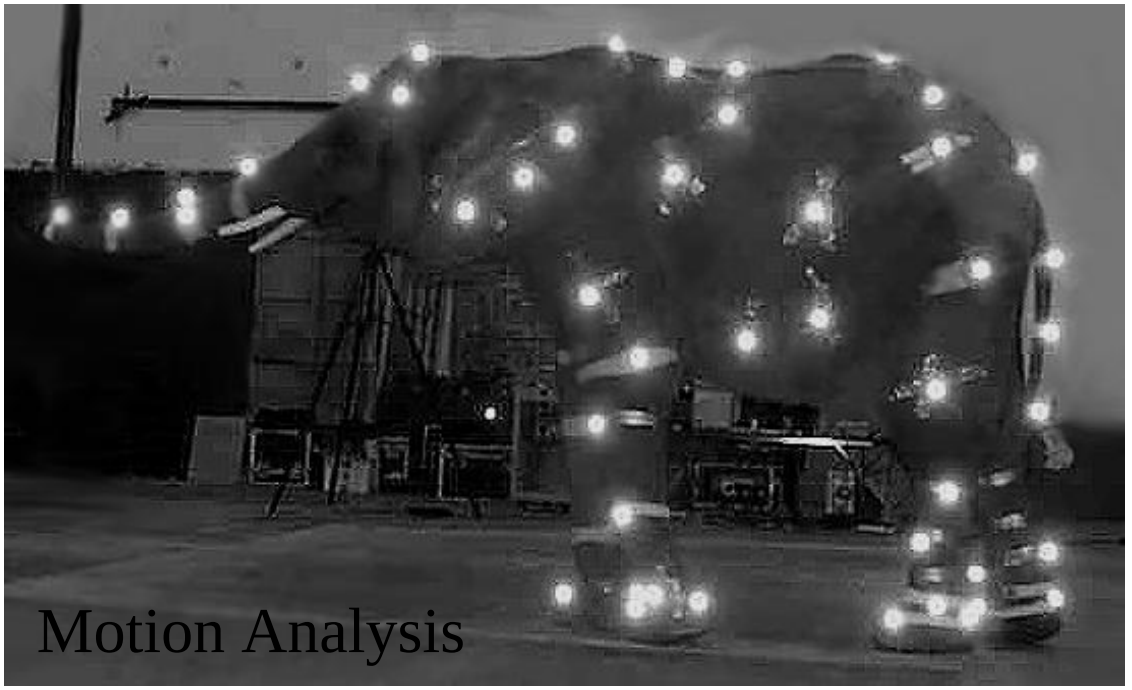


Titanic, House of Moves

# What is captured?

large scale

small scale




# What is captured?

"rigid" body motion

flexible objects

Titanic, House of Moves

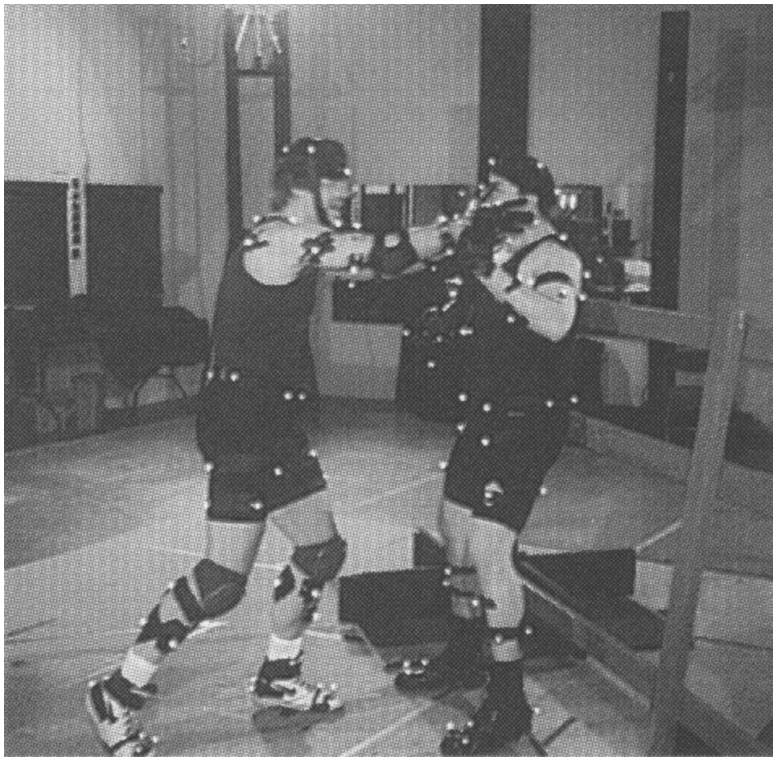
# What is captured?

- props often cause problems
  - ball in ping pong
  - fly fishing
  - sword
- passive behaviors are hard
  - complicated motions of clothes
  - explosions

# Technologies: Optical Passive

Vicon, Motion Analysis

Position of markers only



# Technologies: Optical Passive

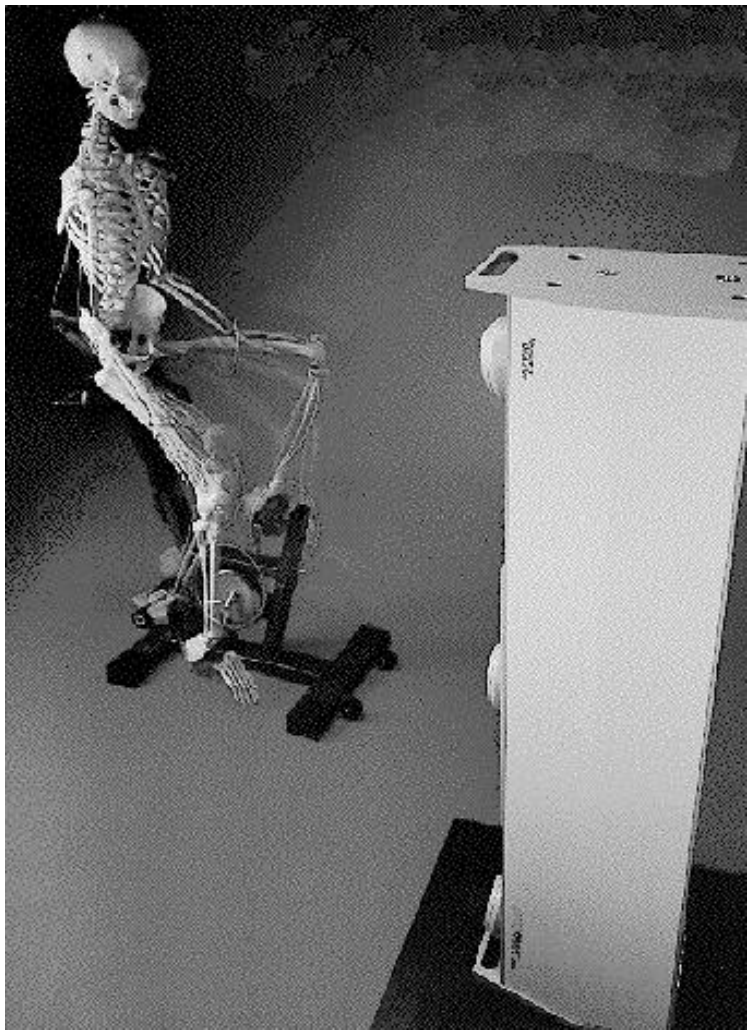
- $180K
- high resolution cameras
  - cameras at 120-240HZ, 1000x1000 pixels
  - IR or visible light strobe
  - 6 characters with 30 markers/each
- not outdoors (no sunlight)
- just recently real time

# Technologies: Optical Active

Optitrak

~56 markers at 100 fps

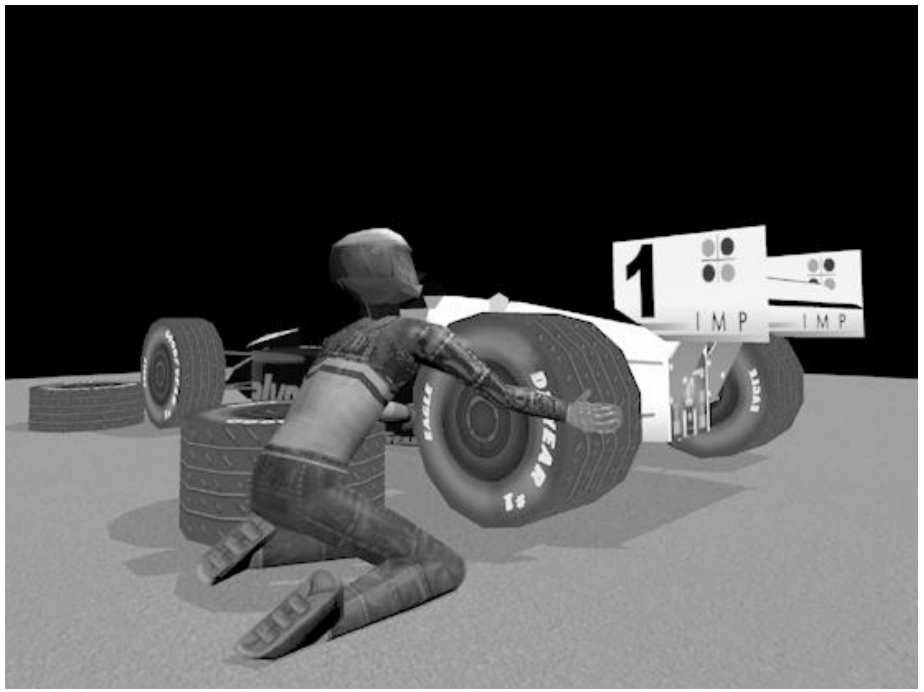
No correspondence problem



# Technologies: Magnetic

Ascension, Polhemus

Position and orientation



# Technologies: Magnetic

heavier sensors (more flop)

wires on body (wireless back to base station)

both position and orientation information

real time

$70K ($2K/additional marker)

limited accuracy (~10x less accuracy than optical)

smaller workspace

spikes in data -> filtering

~80 hz max

sensors are the cost and so it doesn't scale

sensitive to EMI/ metal, particularly in floor—hard to debug

# Technologies: Exoskeleton

Analogous, Sarcos

some restriction of movement

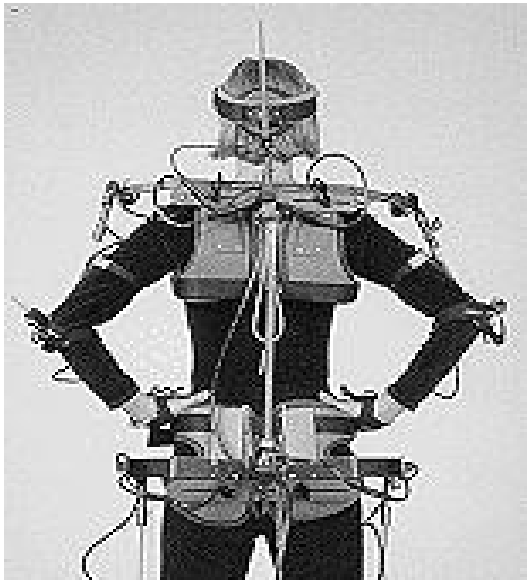
assumptions of transformation to rigid body motion made at time of design of system

another technology needed for the root node

not range limited

high frequency (500 Hz)

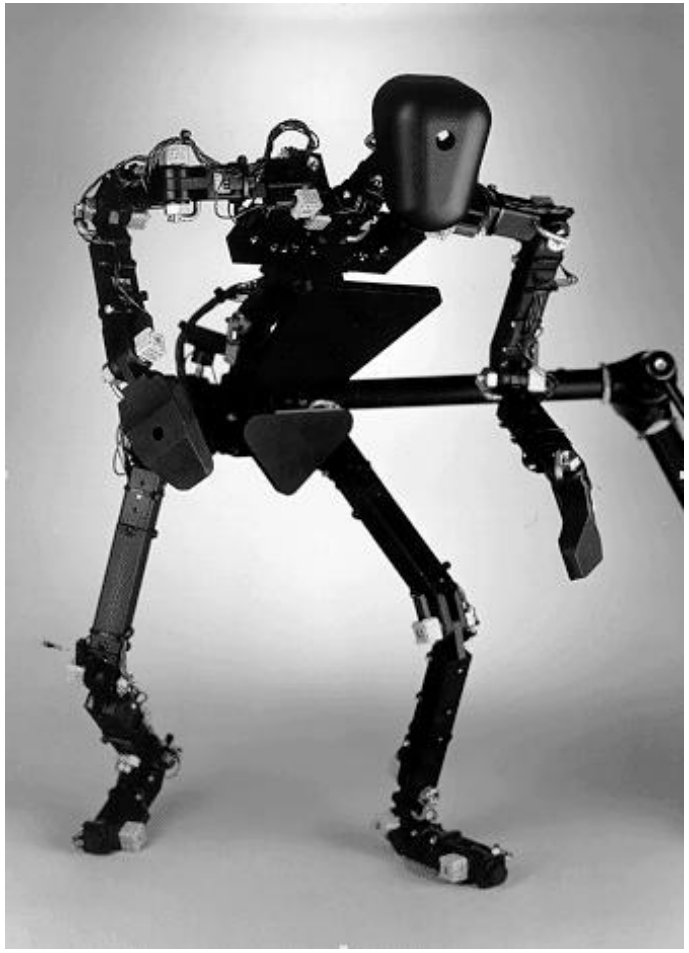
truly real-time



# Technologies: Monkey

Puppeteering  of animated characters

Not exactly motion capture but exoskeleton without the person?



# Technology Issues

- Resolution/range of motion
- Calibration
- Accuracy
  - marker movement
  - sensor noise
  - skew in measurement time
  - restrictions on the environment
  - capture rate
- Occlusion/correspondence

# Marker Placement

- Location should move rigidly with joint
- Stay away from bulging muscles
- Shoulders: skeletal motion not closely tied to motion on skin

# Calibration

- Calibration of sensors in room—fairly automatic
  - One  measurement for magnetic system
  - L-bracket and wand for optical system
- Calibration of subject—somewhat automatic
  - Where are sensors on subject wrt to joints?
  - What are limb lengths?
  - Joint limits?

## Eric Darnell, codirector of Antz

“The main problem with motion capture associated with characters has to do with massdistribution, weight and exaggeration. He says that it is impossible for a performer to produce the kind of motion exaggeration that a cartoon character needs, and the mass and weight of the performer almost never looks good when applied to a character of different proportions.”

## Richard Chuang, VP at PDI

“The mapping of human motion to a character with non-human proportions doesn’t work, because the most important things you get out of motion capture are the weight shifts and the subtleties and that balancing act of the human body. If the proportions change, you throw all that out the door, so you might as well animate it.”

## Godzilla: Karen Goulekas

"The reason that we pulled the plug on using the motion capture was, very simply, because the motion we captured from the human actor could not give us the lizard-like motion we were seeking. The mocap could also not reflect the huge mass of Godzilla either. During our keyframe tests, we found that the Godzilla motion we wanted was one that maintained the sense of huge mass and weight, while still moving in a graceful and agile manner. No human actor could give us this result."

# Research Topics

- Marker placement/extraction of rigid body model
- Retargeting
- Constraint satisfaction
- Dynamic models for correspondence problem
- Generalization of data
- Learning from demonstration
- Interfaces to mocap databases

# Upcoming Lectures

- Tuesday: motion capture demonstration: optical and magnetic
- Thursday: Guest Lecturer—Takeo Igarashi from Brown University
- Tuesday: video textures->motion textures
  - –important for 2nd assignment
- Thursday: motion editing
- Tuesday: generalizing motion

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