Evaluting Video-Based Motion Capture

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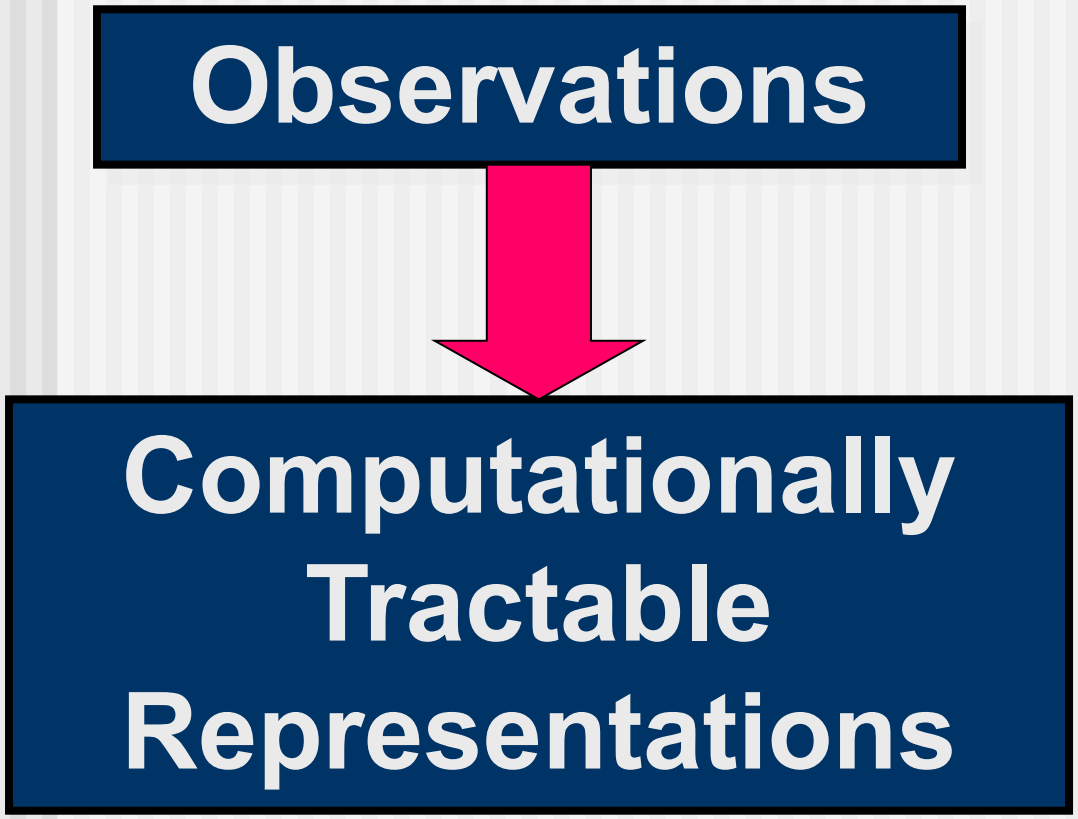
The Message…

- Motion capture for animation is hard!
- It's hard in ways that are challenging for computer vision
- Despite advances in computer vision, don't expect miracles too soon

Outline

- What do we want from motion capture?
- Why is this so hard?
- An experiment
  - What do observations tell you
- Computer vision in this light

Motion Capture



Note:

Motion capture means capturing the motion, not the process of Animation by Observation!

Motion Capture

Observations

How cheap, relaible, non-intrusive, …?
Can't be too cheap!

Computationally Tractable Representations

How "High Quality"?
Needs to be "good enough"!

Motion Capture for Animation

Observations

Do whatever it takes!

Computationally Tractable Representations

High Quality "Skeletal" data! (good enough?)

What does animation need?

- Animation doesn't really need high-precision and accuracy
  - Not concerned about details
  - Not doing measurement
- "Just" need to capture mood, emotion, intent, subtlety, personality, …
  - All those things an actor can do

Two Problems

- Where does X live in the data?
  - Where X ∈ {style, personality, emotion, …}
- Small artifacts can destroy realism
  - Eye is sensitive to certain details
  - Amazing what you can’t get away with
    - See Kovar, Schreiner and Gleicher, SCA ‘02

How do we handle these problems?

- Don’t know which details are important!
- Must preserve ALL details
  - Since you don’t know what is important
- Need to understand artifiacts better

Motion Capture Animators are conservative:

Want *excess* precision just in case!

Not all Mocap Applications are like this!

- Computer Puppetry
  - Shin, Lee, Gleicher, Shin, Tog ’01.

Dream #1

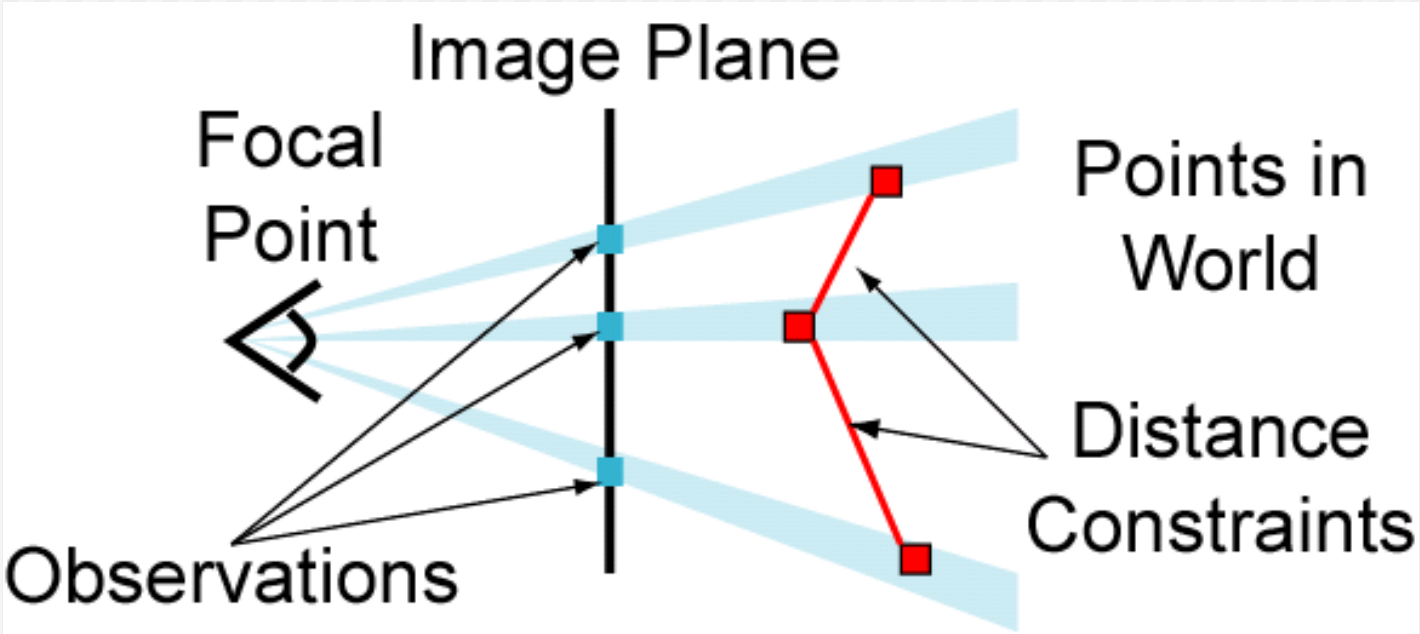
- Capture “essense” only
- Add details later

- This is equivalent to the vision problem that we’re getting to.
- This motivated our work.

Dream #2

- Cheap capture devices
  - Non-intrusive Ubiquitous
  - Easy to obtain Inexpensive
  - Easy to set up
- Single camera, video motion capture!
  - Multiple cameras, might as well be mocap hardware
- How much can you get?

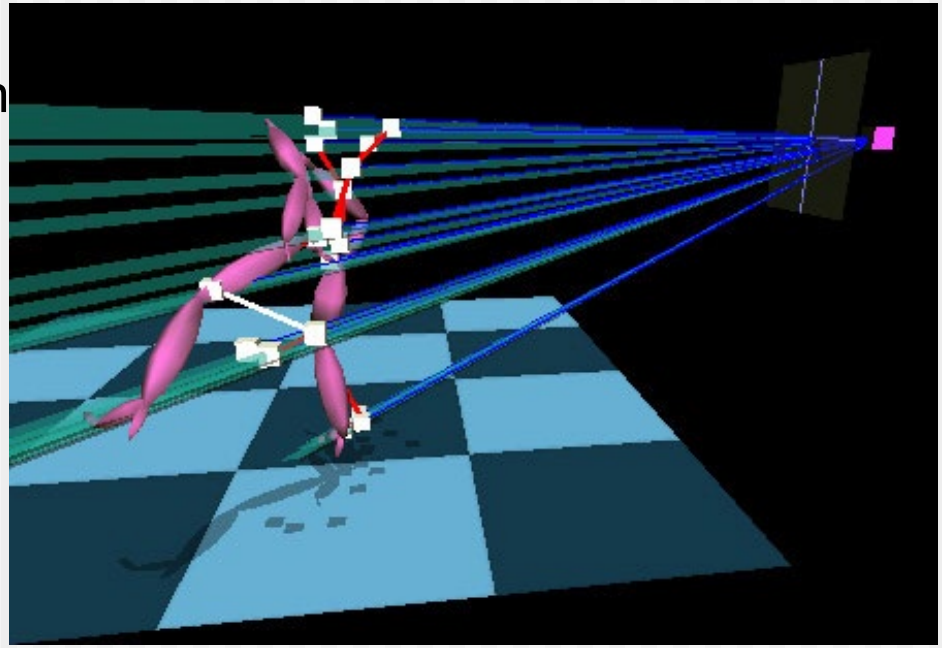
Experiment: Minimal Assumption Mocap



- Pinhole camera model
- Rigid skeleton
- Solve constrained-optimization for locations

Answer: Not a lot!

- See paper for details
  - Surprisingly low precision
  - Surprisingly many ambiguities
- Weak model
  - Few assumptions about motion
  - Distance constraints
  - Assume perfect observations



What's going on here?

- Limited information -> Limited results
- Not much info in a 2D observation

- 2D observations are a constraint
- Limit the possible causes
  - But still leave a large space
- How to choose amongst possibilities?
  - Optimization?
  - Probabilities?

Strong Models!
How Computer Vision does better.

- Computer vision human tracking works by using a stronger model
- Use more information about what motions are likely to choose amongst possible interpretations
- Encode what motions are likely
- The hot topic in human tracking
  - Rehg, Black, Forstythe, Reid, Brand, Shin, …
  - Impressive success, varying methods for implentation of “likelihood”

Strong Motion Models

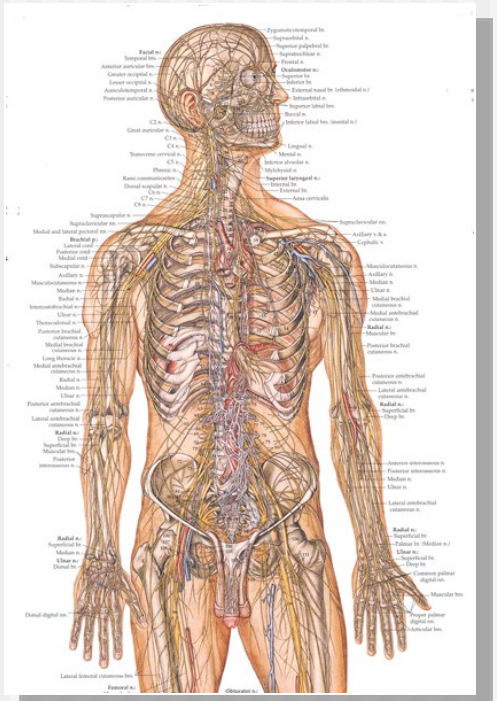
- Encode “likely” or “common” motions
- Observations select from these
  - Extreme: Matt Brand’s work
  - Novice dances, plays motion of expert
- Doesn’t work for animation!
  - Want ununusual, unlikely, specific, …
  - If you had seen the motion before, why not just play it from database?

Better Biomechanical Models

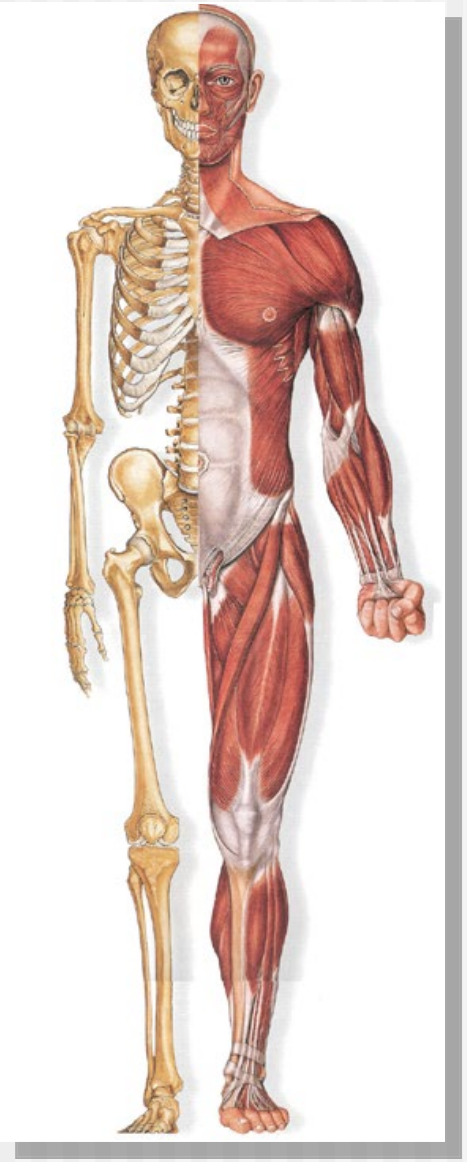
- Idea
  - use more knowledge of human to limit possibilities
- Problems
  - Need manipulatable representations for practicality
  - Humans are complex
  - Strong models only good if they are correct
  - Unclear how much more constraint this adds
- Little exploration in vision

Modeling Humans

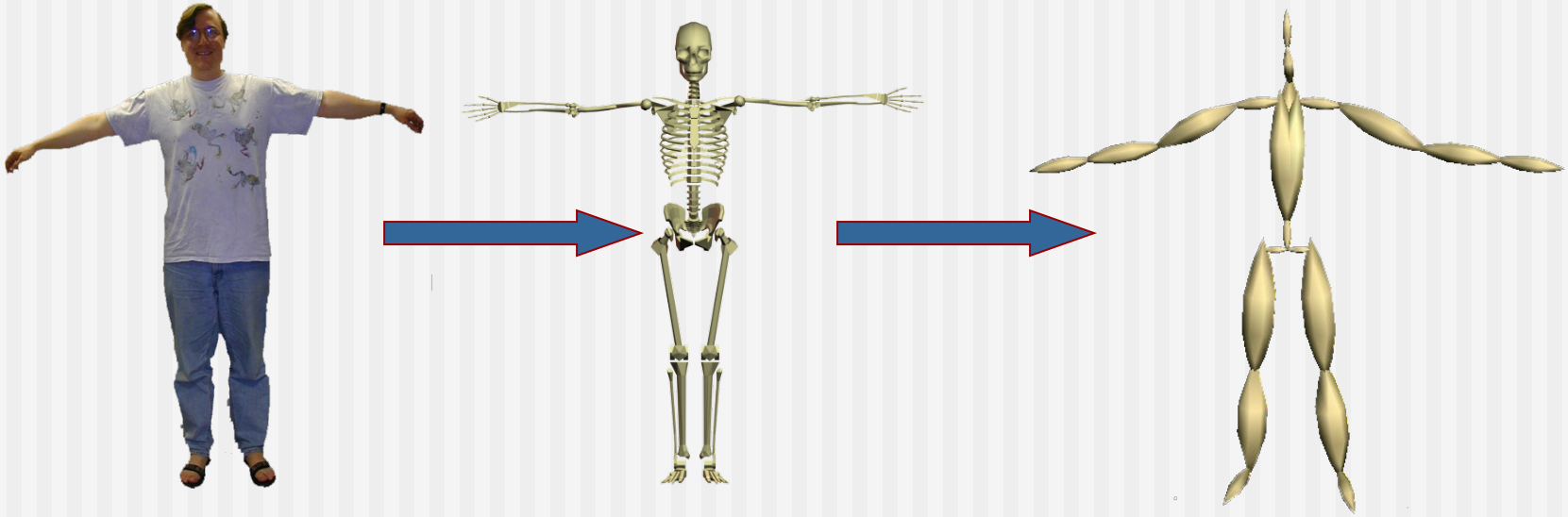
- Humans are complex!



Human motion can be understood at a very fine level of detail!



Abstractions



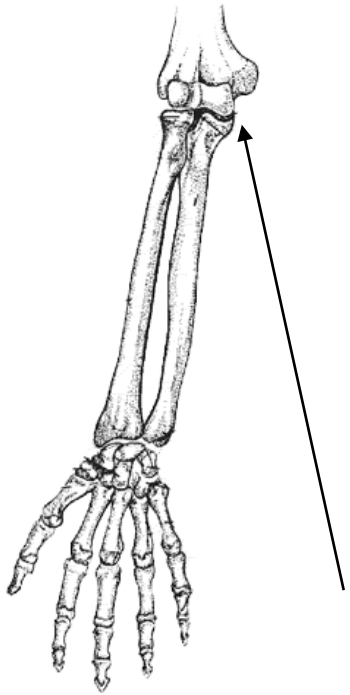
206 bones, muscles, fat, organs, clothing, …

206 bones, complex joints

53 bones Kinematic joints

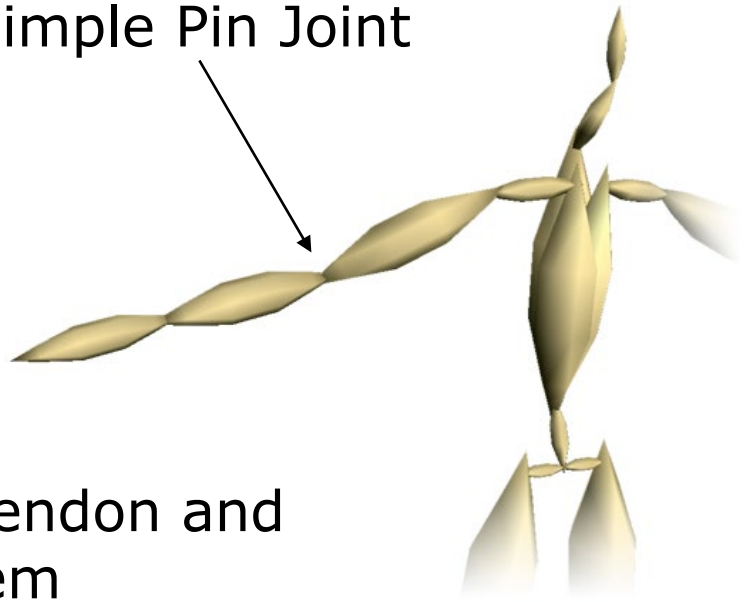
Abstractions vs. Reality (skeletons vs. humans)

Representation of complex human structure with varying degrees of simplification



Complex tendon and bone system

Simple Pin Joint



Prognosis

- Human tracking is improving
  - Primarily through use of strong models
- New approaches may not work for animation
  - Different quality goals
  - Different applications (classification)
- Looks like we'll have old approaches for a while
  - "engineer" away vision problem
  - Use expensive sensors

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