Notes

- The Incredibles?
- This Friday: deadline for final project approval

Beyond SSD

- Hack:
  - Add virtual bones to control the SSD better
- Advanced solutions:
  - Interpolate from several example poses
  - Simulate volumetric deformation (at least a skin layer or two on top of rigid bones)
- One simple solution: use FFD's around joints
  - Put a 3D FFD grid around joint (or over muscle), parameterize its motion according to joint angle
  - Control exactly what sort of deformation you get
  - But problematic for nearby joints, doesn't get full volumentric effects without a lot of work, …

Motion Capture

- We now have some basic tools to build elaborate characters
  - FK/IK/dynamics to move skeleton
  - Skinning around skeleton
  - Particle systems or rigid bodies for passive secondary motion (e.g. clothes, chains, the environment…)
- Still difficult to animate human motion
  - So many DOF even with simplified skeleton
- So record real motion instead: motion capture (mocap)

Mocap basics

- "Film" an actor
- Estimate skeleton pose from video at every frame: gives motion curves for joint angles
- Replay motion curves applied to CG character

- Big issues:
  - How to do the filming and pose estimation
  - How to "clean up" the output
  - How to use the cleaned up output for a particular task

Estimation

- Several techniques possible:
  - "Markerless mocap": use computer vision to estimate what's going on (hard to do accurately!)
  - Mechanical measurement: strap a device to actor that directly measures rotations
    - Really annoying to wear
  - "Marker-based mocap": stick several markers on tight-fitting suit, figure out where they are, estimate skeleton from that
    - Marker system could be electromagnetic
    - More common: retroreflective (ping pong balls)

Marker-based mocap

- Note: similar problem to match-move
  - See September 29 slides
- Usually mocap is better posed
  - Lots of highly synchronized cameras
    - E.g. 6-12 (for Polar Express, 72!)
  - High speed frame rates, strobe light to reduce motion blur
    - E.g. 120Hz
  - Well-calibrated set-up
  - Film in infrared, markers show up really well - much less ambiguity
    - Also makes the strobe much less annoying!
- But still issues: e.g. obscured markers

Skeleton estimation

- First stage: figure out where markers are
  - And which is which
  - Really want to know what the joint angles of an underlying skeleton are
- Issues:
  - Markers are on skin, which is some distance from bone, and which deforms and slides around
  - Human skeleton itself is more complex (joints have 6 DOF constrained in weird and wonderful ways)
    - Often want to allow for stretchable bones in computer representation (e.g. near shoulders)
  - Data could have bad errors, or be missing
- Calibration: start actor in a known pose

How to use the data

- Output from a mocap session: one long stream of joint angles
- Can replay, but what if that's not quite the motion you want?
  - Could conceivably just edit the motion curves (use mocap as a starting point), but painful - full detail is already there
  - What about video games?
- Two points to make:
  - Satisfying constraints (e.g. avoiding "foot-skate")
  - Massaging data to do what's needed

Foot skate

- Most of the time, mocap data is of a person with at least one foot planted on the ground
- Errors or modifications to joint angles and global position+orientation may cause foot to move
  - Called “foot skate”
- Very noticeable to audience: kills suspension of disbelief
- Need to figure out from data when/where a foot is stuck on ground
- Then enforce that as a constraint in subsequent uses of the data

Motion Graphs

- Often a good step in dealing with a lot of data: cut it up into small clips
  - E.g. taking a step, a jump, a kick, …
- Identify start and end poses in these clips that are “close” (ignoring global position+orientation)
  - With a little massaging, can jump from one clip to another smoothly
- Make a directed graph out of the result:
  - Each arc is a clip
  - Each node is a start and/or end pose