Notes

- Final exam in LSK 460

Footskate

- Reference:
  - Kovar, Gleicher & Schreiner, “Footskate cleanup for motion capture editing”, SCA 2002
- Review: footskate problem is when feet that should be planted on the ground move instead
- Today: a semi-automatic method for fixing these constraints
- Caveat: most mocap done with proprietary software (e.g. Vicon, House of Moves)
  - I don’t know what they do

The problem

- Footskate has a few sources:
  - Error in original data - recall lots of potential sources of problem
    - Cameras not quite calibrated
    - Markers obscured
    - Markers confused with others
    - Estimation of underlying skeleton inaccurate
    - Etc.
  - Error in representation - recall humans really aren’t simple kinematic skeletons
  - Editing motion capture data
    - Adjust to fit new use
    - Retarget to a different body type
    - Etc.

General approach

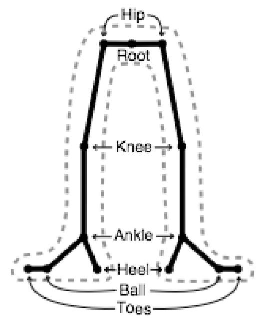
- Use inverse kinematics:
  - Identify where end effectors (parts of feed) need to be
  - Adjust skeleton to match those constraints
- Issues:
  - General purpose IK can be difficult to do robustly
  - Adjustments should be as small as possible, and as **smooth** as possible - no “popping”
  - In particular, no popping when constraints turn on or off

The solution

- Approach (analytic, special-purpose IK)
  - Identify constraints (when heel and/or ball is fixed on the ground)
  - Rotate/translate feet at the ankle to keep constraints
    - Smooth out discontinuity in motion to nearby frames
  - Adjust hips=root position to be close to where legs can reach feet
    - Smooth out discontinuities in motion to nearby frames
  - Connect the legs up, balancing joint changes and leg stretching
    - Again smooth out discontinuities

Identifying foot plants

- Automatic techniques available:
  - E.g. Bindiganavale & Badler, 1998
  - Look for "zero-crossings" of the 2nd derivative of motion curves
  - Check for proximity to floor
- But unreliable
  - So check/edit by hand after
- Standard model of lower body
  - Heel and ball may be planted
  - Toes just adjusted later to be above ground



Feet contacts

- Figure out where constrained parts of foot should be
  - If constrained in previous frame, keep position
  - Otherwise, if other part of foot was constrained, pick closest position that is consistent with rigidly moving foot
  - Otherwise, pick closest points on floor to average position of foot over next several frames
    - If 2 constraints, make sure they're consistent with rigidly moving foot

Ankle adjustment

- Once constraint points identified, translate and rotate foot (bend at the ankle) to meet the points
  - Minimize change from original data, or maybe fully constrain (foot flat on ground)
- Also need to make sure adjustment is smooth with nearby frames
  - Blend motion together, especially if constraint type changes
- Also make sure no part of foot below ground (e.g. if only 1 constraint)
- Left with feet in position, but rest of lower body inconsistent

Root adjustment

- Translate (don't rotate) hips so that legs can reach feet
  - In current position, even fully extended legs might not touch
- For one constrained foot, take sphere centred at ankle with radius=leg length
  - Then translate root minimum amount so that corresponding hip is inside the sphere
- For two constrained feet, take intersection of two spheres
- Smooth this in time: weighted average of nearby frames' ideal positions
  - No longer guaranteed to be in spheres, but close

Leg adjustment

- Alter the leg, extending from the hip, so that it connects to the ankle
  - 1 DOF in knee rotation
    - Pick the angle that matches the bent leg length to the distance from hip to ankle (but see later!)
  - 1 DOF in hip rotation
    - Rotate so bottom of leg touches ankle
  - Fix up shin-ankle rotation to match the target foot orientation
- See paper or textbook for trig formula for knee

Knee problems

- Getting the knee angle is tricky when leg is nearly fully extended
  - Large changes in angle may be needed to achieve desired length
  - Obvious popping in resulting animation
- Also may be given impossible situation (due to root smoothing): leg just not long enough
- So limit knee adjustment smoothly, then adjust leg lengths to handle the rest
  - Scale shin and upper leg by same factor

Efficiency

- Analytic formulas for IK in each frame
  - No iteration, very fast
- For smoothing, only need to look back or ahead a few frames, and just involves simple filtering or interpolating
  - Aside: "slerp" - how to "linearly" interpolate quaternions that represent rotations
    - Rotation quaterions lie on a 4D sphere
    - Two quaternions + centre define a hyperplane, intersection with sphere is great circle
    - To interpolate a fraction α between rotations, go α along this circle
    - ♣ See formulas in textbook, p.99