CS4620/5620: Lecture 31

Animation

- Forward Kinematics
- Inverse Kinematics
- Forward Dynamics
- Inverse Dynamics
- Motion Capture

Forward Kinematics
- Articulated body
  - Hierarchical transforms
  - Comes from robotics

Rigid Links and Joint Structure
- Links connected by joints
  - Joints are purely rotational (single DOF)
  - Links form a tree (no loops)
  - End links have end effectors

\[ M_1 = T(r_1)R(\theta_1) \]
\[ M_2 = T(r_2)R(\theta_2) \]
\[ M_3 = T(r_3)R(\theta_3) \]
\[ M = M_1M_2M_3 \]
**Animation**

- Forward Kinematics
- Inverse Kinematics
- Forward Dynamics
- Inverse Dynamics
- Motion Capture

**Motion capture**

- A method for creating complex motion quickly: measure it from the real world

[thanks to Zoran Popović for many visuals]

**Motion capture in movies**

[Final Fantasy]

**Motion capture in games**

**Magnetic motion capture**

- Tethered
- Nearby metal objects cause distortions
- Low freq. (60Hz)

**Mechanical motion capture**

- Measures joint angles directly
- Works in any environment
- Restricts motion
Optical motion capture

- Passive markers on subject

- Retroreflective markers

  Cameras with IR illuminators

- Markers observed by cameras
  - Positions via triangulation

- 8 or more cameras
- Restricted volume
- High frequency (240Hz)
- Occlusions are troublesome

- 70 cameras, reflective dots, lightweight suit

From marker data to usable motion

- Motion capture system gives inconvenient raw data
  - Optical is “least information” case: accurate position but:
    - Which marker is which?
    - Where are the markers relative to the skeleton?

Motion capture data processing

- Marker identification: which marker is which
  - Start with standard rest pose
  - Track forward through time (but watch for markers dropping out due to occlusion!)
- Calibration: match skeleton, find offsets to markers
  - Use a short sequence that exercises all DOFs of the subject
  - A nonlinear minimization problem
- Computing joint angles: explain data using skeleton DOFs
  - An inverse kinematics problem per frame!

Motion capture in context

- Mocap data is very realistic
  - Timing matches performance exactly
  - Dimensions are exact
- Therefore mocap data is generally a starting point for skilled animators to create the final product
Motion capture in context

• But it is not enough for good character animation
  – Too few DOFs
  – Noise, errors from nonrigid marker mounting
  – Contains no exaggeration
  – Only applies to human-shaped characters

Kinect: Xbox 360

• Camera and IR