

Character Animation

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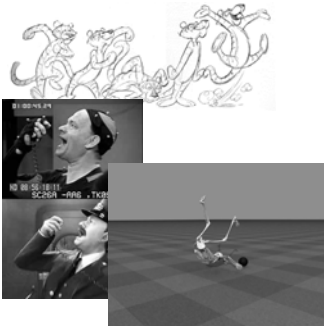
Computer Animation

- process of creating moving images with the help of computers
- as much an art as it is a science
- Character Animation deals with animation of characters



Three methods of animating characters

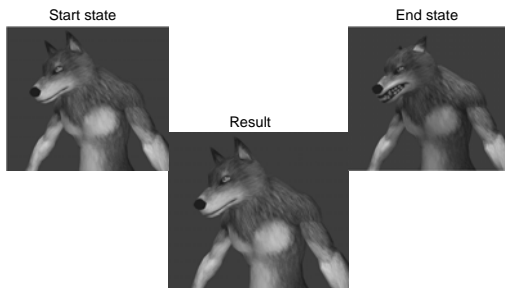
- Key framing
- Motion Capture
- Physics based



Keyframing

- Simplest form of animating an object
 - object has a beginning and an end state (position, form, color, etc) – specified by artist
 - computer is used to smoothly interpolate between states (create in-between frames)

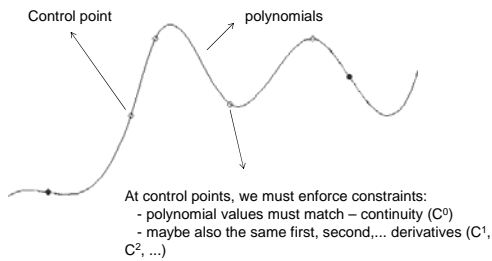
Keyframing - example



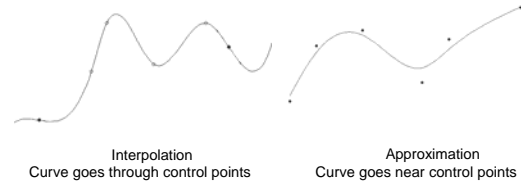
More on Keyframing

- Why stop here?
- Can provide multiple intermediate poses/keyframes
- Standard way to generate a curve that interpolates given values: Splines
 - Piece-wise polynomial function

Splines



Interpolation vs. Approximation



Linear vs. Higher order interpolation



Linear interpolation not smooth enough – leads to robotic movements
Cubic splines almost always used for motion curves

Splines

- Many, many different choices
 - Hermite splines, catmull-rom, B-splines, Bezier curves, etc.
- Choice depends on the application, but some curves are better than others
 - Local vs Global control
 - How does adjusting one control point affect the curve

Keyframing in Flash

- Flash provides a “tweening” capability – short for “in-betweening”
- Tutorial:
<http://www.echoecho.com/flashtweenings.htm>

Keyframing - recap

- Requires artists to create keyframes (important poses)
- Computers used to create in-between frames (replaces interns/assistant animators)
- Videos



Motion Capture (mocap)

- Main idea: hire actor to play desired motions, record them so that they can be played back



Skeletons

- Mocap usually operates on skeletons (aka articulated figures)
- Skeleton: hierarchical tree structure made up of links/bones and joints



Skeletons and mocap

- To describe a character pose, we need root position/orientation and joint angles for each joint in the skeleton
- Record all this data for each frame



But how does it work?

- Actor wears a special suit with markers on it (markers can emit light, reflect light, etc)
- Track position of each marker using multiple cameras (6-24), at as much as 200Hz – no need to interpolate between frames

But how does it work?

- More processing can be used to obtain joint angles for skeleton
- Store joint angles – data driven animation

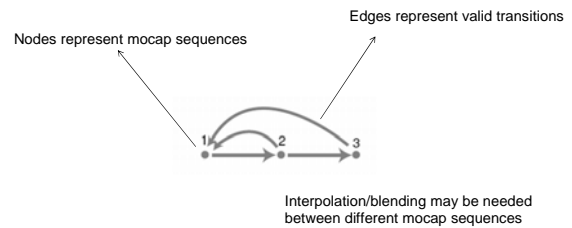
Mocap

- Large databases of mocap sequences are available
 - Carnegie Mellon University's motion capture library for example (<http://mocap.cs.cmu.edu/>)
- Video...

Extending Mocap

- Playing individual mocap sequences is easy, but not good enough for interactive applications
- Need to combine multiple mocap sequences: Motion Graphs (L. Kovar, M. Gleicher, F. Pighin - SIGGRAPH '02)

Motion Graphs



Video...

Extending Mocap

- Creating new motions: "Pushing people around" (O. Arikian, D. A. Forsyth, J. F. O'Brien - SCA'05)
- Collect motions of real people responding to pushes
- Modify existing motions to respond to different kinds of pushes (direction/location)
- Video...

Mocap – the good

- Very useful tool
 - used a lot in games, movies, etc.
- Produces smoother, more natural results than keyframing
- Needs less effort to obtain results
- Can be used to create new motions

Mocap – the bad

- It requires specialized studio, hardware, etc.
- Can only be used for some kinds of creatures
- Only suitable for motions that are anatomically/physically (not martial arts) possible.
- If conditions (e.g. terrain) change, mocap data might become inappropriate



Physics Based Simulation



Physics Based Character Animation

- Let the laws of physics dictate how the characters should move
 - ragdolls
- Can potentially eliminate many drawbacks from mocap-based methods – virtual actors



Physics Based Character Animation

- Draws upon the fields of Computer Graphics, Biomechanics, Computational Dynamics, Artificial Intelligence, Machine Learning, Robotics, etc



Physics Based Character Animation

- Simulating the physics of articulated bodies is relatively easy
 - Euler-Newton equations, Featherstone's ABM, Lagrangian Dynamics, etc.
- Many hard problems:
 - character control
 - maintaining balance
 - repertoire of skills
 - learning from MOCAP

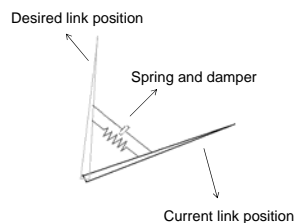
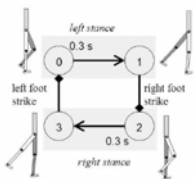


Physics Based Character Animation

- Some recent success: Simbicon (K. Yin, K. Loken, and M. van de Panne, SIGGRAPH '07)
- Video...

Simbicon

- Control strategy: Finite State Machine + PD control



A few last words...

- Every method has pros and cons
- Combining the three methods is very powerful
- State of the Art in Industry
 - Dynamic Motion Synthesis: Natural Motion, Endorphin
- Video...

Thank you!

Any Questions?