

CSC418 Computer Graphics

Animation 1

- Keyframe Animation



Principles of Traditional Animation

- Developed largely during the early days of the Disney studio
- Great reference: The Illusion of Life: Disney Animation by Frank Thomas and Ollie Johnston



Principles of Traditional Animation

From "Principles of Traditional Animation Applied to 3D Computer Animation" by John Lasseter, SIGGRAPH 87

1. Timing
 - Space actions to show mass and personality of characters
2. Slow In and Out
 - Spacing of inbetween frames to achieve subtlety of timing and movement
3. Anticipation
4. Follow Through and Overlapping Action
5. Arcs
 - Visual path of action

Principles of Traditional Animation

6. Secondary Action
 - Action of an object resulting from the motion of another action
7. Squash and Stretch
8. Straight Ahead Action and Pose-To-Pose Action
9. Staging
 - Present an idea so that it is unmistakably clear
10. Exaggeration
11. Appeal

What can be animated?

- Lights
- Camera
- Articulated figures
- Deformable figures
- Clothing
- Skin/muscles
- Wind/water/fire/smoke
- Hair
- Given the right time scale, most things...

Keyframing in Cell Animation

Key frames

- Key poses of an animation sequence
- Show important story element or pose
- Drawn by lead or senior animator
- Capture the general impact of a scene

In-betweens

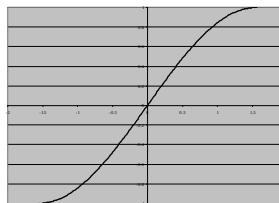
- All the cells drawn “in-between” the key frames
- Complete the flow of the motion
- Normally drawn by junior artist, an “in-betweener”
- “in-betweener” may also clean up the keyframes

Keyframing in Computer Animation

- Based on same idea as in cel animation
- Animator specifies keyframes
- Computer interpolates between them to create in-between frames
- Early keyframe system developed by Burtnyk and Wein working at NFB

Interpolation

- Linear variation of control variables
- Cubic splines
- Ease-in ease-out curves
 - E.g. sine based

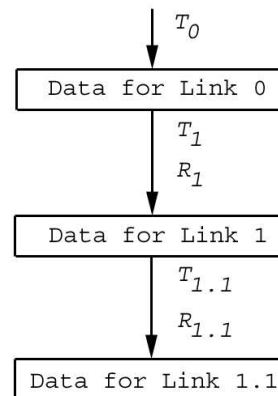
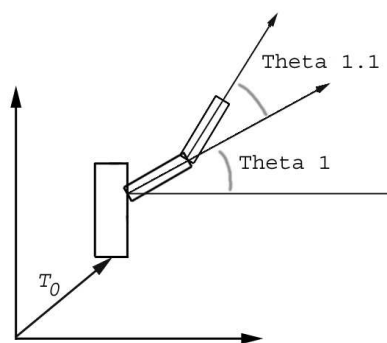


- Track a path in space
- Arc length reparameterization, velocity curves to control timing

Articulated Figures

- Represented as a hierarchy of transformation matrices
- Root node specifies world coordinates of figure (usually at hip)
- Joints normally have 1, 2 or 3 rotational degrees of freedom (DOF)
- 3 dof
 - Gimbal joint (locks)
 - Ball joint (quaternions)

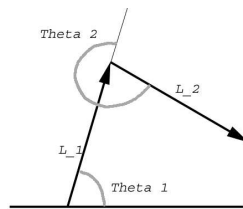
More on Joint Hierarchies



Forward and Inverse Kinematics

- Kinematics: The study of motion when only position and velocity are considered.
- Forward Kinematics
 - Position is specified by setting value for each dof
 - Hard to achieve world space constraints
 - Movement flow (relatively) easy to control
- Inverse Kinematics
 - Specify world space constraints that one or more parts of the skeleton must achieve
 - Solve for joint angles to achieve these
 - Good for meeting world space constraints (!), but movement flow can be a problem
 - Most skeletons are highly redundant, so problem is underconstrained

Forward and Inverse Kinematics



- Consider the above two joint, planar arm. Forward kinematics gives:
- Inverting these equations gives the inverse kinematics equations:

What makes IK interesting?

- For real characters, most IK problems are highly underconstrained
- System is redundant
- Subspace of solutions satisfies constraints
- What solutions satisfy animator's goals?

What more is there to animation?

Coming later to a lecture hall near you...

- Dynamics
- Motion Capture
- Secondary Effects
- Skinning
- Water
- Cloth
- Fire
- other groovy things

Now...

- Videos!

Next lecture

- Cameras and Projection