Animation

Keyframe Animation

These icons refer to explanatory videos on the class web site

anim2.mp4
Forward Kinematics:
Change Parameters – Connected Things Move
(All Tinker Toy users understand this)

Forward Kinematics: Transformation Hierarchies

Determine Object Locations?
Inverse Kinematics (IK):
Things Need to Move to a Particular Location – What Parameters Will Make Them Do That?

Of course, there will always be target locations that can never be reached. Think about that spot in the middle of your back that you can never scratch!

Forward Kinematics solves the problem “if I know the link transformation parameters, where are the links?”.

Inverse Kinematics (IK) solves the problem “If I know where I want the end of the chain to be \((X^*, Y^*)\), what transformation parameters will put it there?”
Particle Systems: A Cross Between Modeling and Animation?

The basic process is:

1. Emit
2. Random Number Generator
3. Display
4. Update
Particle Systems Examples

Chuck Evans

particles.mp4

Particle Systems Examples

particles.mp4
Particle Systems Examples

The Lion King (2019) -- Disney

Oregon State University
Computer Graphics
A Particle System to Simulate Colliding Galaxies in \textit{Cosmic Voyage}

Particles Don’t Actually Have to Be “Particles”
Newton's first law:
\[ \text{force} = \text{mass} \times \text{acceleration} \]
or
\[ \text{acceleration} = \frac{\text{force}}{\text{mass}} \]

In order to make this work, you need to supply physical properties such as mass, center of mass, moment of inertia, coefficients of friction, coefficients of restitution, etc.

Animating using Rigid-body Physics

Animating using Fluid Physics
**Computer Graphics**

**Animating using Physics**

- **D₀ = unloaded spring length**
  \[
  (D - D₀) = \frac{F}{k}
  \]

- **k = spring stiffness** in Newtons/meter or pounds/inch

- Or, if you know the displacement, the force exerted by the spring is:
  \[
  F = k(D - D₀)
  \]

  This is known as Hooke's law

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**Animating using the Physics of a Mesh of Springs**

- "Lumped Masses"
Simulating a Bouncy String

string.mp4
Placing a Physical Barrier in the Scene

Animating Cloth
Cloth Examples

cloth.mp4

Cloth Example

cloth.mp4
Cloth Example

Pixar

Functional Animation:
Make the Object Want to Move Towards a Goal Position

\[ m\ddot{x} + c\dot{x} + kx = 0 \]
**Functional Animation:**
While Making it Want to Move Away from all other Objects

\[ m\ddot{x} = \sum F_{\text{repulsive}} \]

- **Repulsion Coefficient**
- **Distance between the boundaries of the 2 bodies**
- **Repulsion Exponent**

**Total Goal – Make the Free Body Move Towards its Final Position**
While Being Repelled by the Other Bodies

\[ m\ddot{x} + c\dot{x} + kx = \sum F \]
Increasing the Stiffness

Stiffness = 3
Stiffness = 6
Stiffness = 9

Increasing the Repulsion Coefficient

Repulse = 10
Repulse = 30
Functional Animation

Motion Capture as an Input for Animation
Motion Capture is for Faces Too

Tron I –
Probably should have used physics, but didn’t
Card Trick

Pixar Animated Shorts