Computer Graphics

Lecture 31
Spline lab wrap-up
A little more on curves
Animation (if time)
Joining Segments

Curve Properties: Continuity
B-Splines

- Offer arbitrary continuity

- The basis polynomials are splines themselves!
  \[ k: \text{polynomial order of "bump"} \]

\[ k = 1 \]

\[ k = 3 \]
Uniform B-Splines

uniform B-spline: "bumps" (knots) evenly spaced
Non-Uniform B-Splines

non-uniform B-spline: "bumps" (knots) are not evenly spaced
Non-Uniform Rational B-Splines: NURBS

- B-spline bases are polynomials - can't represent conic sections e.g., a circle:
  - $x^2 + y^2 = 0$

- Rational B-splines - use a ratio of two polynomials.
  - Numerator and denominator are both B-splines
Curves are great, but.

https://youtu.be/AcFwH161XtM?t=68

https://youtu.be/Zkx1aKv2z8o?t=1080
Animation

• Time-varying scene/model. That's pretty much it.

• Big challenges:
  • tedium
  • realism
Animation - Tedium

- **Keyframing** + interpolation

**Linear** interpolation? **Spline** interpolation?
Animation - Tedium

• Rigging

• Surface is deformed by a set of bones
• Bones are in turn controlled by a smaller set of controls
• The controls are useful, intuitive DOFs for an animator to use

Modeling DOF != Animation DOF
Animation - Tedium

Walk cycle
Interpolating Rotations

• Representation matters a lot - linear interpolation of rotation matrices are not rotation matrices.

• Quaternions are one answer
  • 4D vectors that make spherical interpolation nicer
Animation - Tedium

Forward Kinematics

Inverse Kinematics
Animation - Realism

- Tron (1982)
- Tron Legacy (2010)
- How to Train Your Dragon 2 (2014)
Animation - Realism

Motion capture

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

Motion capture in movies
Animation - Realism

Motion capture in games
Animation - Realism

• Motion capture technologies:

Magnetic  Mechanical  Optical