Primer on Final Project - Spring 2019

Today is just to get you thinking
Links on class homepage

Project

- Build something interesting to you
- Teams of three - choose your team
  - Group matching tomorrow at 5 PM in VCL
- 20% for 184, 40% for 284A

Timeline: 4 weeks

- April 9  Proposals due
  - We will give feedback
- April 30  Graded checkpoint
- May 9    Presentations
- May 14   Final reports due
A few cool projects from previous semesters
Lecture 25:

Intro to Animation

Computer Graphics and Imaging
UC Berkeley CS184/284A
Animation

“Bring things to life”

• Communication tool
• Aesthetic issues often dominate technical issues

Output: sequence of images that when viewed sequentially provide a sense of motion

• Film: 24 frames per second
• Video: 30 fps
• Virtual reality: 90 fps
Topics

History, goals, and principles

Artist-driven animation: rigging, posing, keyframing

Procedural animation: forward and inverse kinematics, physical simulation

Data-driven animation: motion capture, machine learning techniques
Historical Points in Animation
(slides courtesy Keenan Crane)
First Animation

(Shahr-e Sukhteh, Iran 3200 BCE)
First Film

Originally used as scientific tool rather than for entertainment

Critical technology that accelerated development of animation

Edward Muybridge, “Sallie Gardner” (1878)
First Hand-Drawn Feature-Length Animation

Disney, “Snow White and the Seven Dwarfs” (1937)
First Digital-Computer-Generated Animation

Ivan Sutherland, “Sketchpad” (1963) – Light pen, vector display
Digital Dinosaurs!

Jurassic Park (1993)
First CG Feature Film

Computer Animation - Present Day

Disney, "Big Hero 6" (2014)
Animation Principles
(slides courtesy Mark Pauly)
Goals of Animation

Aesthetic issues as prominent as technical issues

Violation of realism desirable in many contexts

Animation is a communication tool

• Should support desired communication

• There should be something to communicate
Animation Principles

From


In turn from

• “The Illusion of Life”
  Frank Thomas and Ollie Johnston

Same for 2D and 3D

http://www.siggraph.org/education/materials/HyperGraph/animation/character_animation/principles/prin_trad_anim.htm
Squash and Stretch

Refers to defining the rigidity and mass of an object by distorting its shape during an action.

Shape of object changes during movement, but not its volume.
Anticipation

Prepare for each movement
For physical realism
To direct audience’s attention
Follow Through

Overlapping motion
Motion doesn’t stop suddenly
Pieces continue at different rates
One motion starts while previous is finishing, keeps animation smooth
Ease-In and Ease-Out

Movement doesn’t start & stop abruptly.
Also contributes to weight and emotion
Arcs

Move in curves, not in straight lines
This is how living creatures move

Disney Animation: The Illusion of Life
Secondary Action

Motion that results from some other action
Needed for interest and realism
Shouldn’t distract from primary motion
Secondary Action

Today: often use simulation to compute secondary motion of hair, clothing, etc
Timing

Rate of acceleration conveys weight

Speed and acceleration of character’s movements convey emotion

Timing for Animation, Whitaker & Halas
Exaggeration

Helps make actions clear
Helps emphasize story points and emotion
Must balance with non-exaggerated parts

Timing for Animation, Whitaker & Halas
Personality

Action of character is result of its thoughts

Know purpose & mood before animating each action

No two characters move the same way
12 Animation Principles

1. Squash and stretch
2. Anticipation
3. Staging
4. Straight ahead and pose-to-pose
5. Follow through
6. Ease-in and ease-out
7. Arcs
8. Secondary action
9. Timing
10. Exaggeration
11. Solid drawings
12. Appeal
Computer Animation
Keyframe Animation

Animator (e.g. lead animator) creates keyframes
Assistant (person or computer) creates in-between frames ("tweening")
Keyframe Interpolation

Think of each frame as a vector of parameter values

Hearn, Baker and Carithers, Figure 16.11
Keyframe Interpolation of Each Parameter

Linear interpolation usually not good enough

Recall splines for smooth / controllable interpolation
Forward Kinematics: Artist-specified animation with skeletons

Articulated skeleton

- Topology (what’s connected to what)
- Geometric relations from joints
- Tree structure (in absence of loops)

Joint types

- Pin (1D rotation)
- Ball (2D rotation)
- Prismatic joint (translation)
Forward Kinematics

Example: simple two segment arm in 2D

Warning: Z-up Coordinate System
Forward Kinematics

Animator provides angles, and computer determines position \( p \) of end-effector

\[
\begin{align*}
    p_z &= l_1 \cos(\theta_1) + l_2 \cos(\theta_1 + \theta_2) \\
    p_x &= l_1 \sin(\theta_1) + l_2 \sin(\theta_1 + \theta_2)
\end{align*}
\]

Warning: Z-up Coordinate System
Forward Kinematics

Animation is described as angle parameter values as a function of time

\[ p_z = l_1 \cos(\theta_1) + l_2 \cos(\theta_1 + \theta_2) \]

\[ p_x = l_1 \sin(\theta_1) + l_2 \sin(\theta_1 + \theta_2) \]

Warning: Z-up Coordinate System
Example Walk Cycle
Inverse Kinematics
Inverse Kinematics: Artist just specifies end positions

Given the end effector position, find the joint angles.

Goals

• Position end of limb by direct manipulation
• (More general: arbitrary constraints)
Inverse Kinematics
Inverse Kinematics

Animator provides position of end-effector, and computer must determine joint angles that satisfy constraints.
Inverse Kinematics

Why is the problem hard?

• Multiple solutions separated in configuration space
Inverse Kinematics

Why is the problem hard?

- Multiple solutions connected in configuration space
Inverse Kinematics

Why is the problem hard?

- Solutions may not always exist
Inverse Kinematics

Why is the problem hard?

• We may not care for the most accurate solution
• Balance other desires: motion style, smoothness, robustness to external forces
Attendance Time

If you are seated in class, go to this form and sign in:

• https://tinyurl.com/184lecture

Notes:

• Time-stamp will be taken when you submit form. Do it now, won’t count later.

• Don’t tell friends outside class to fill it out now, because we will audit at some point in semester.

• Failing audit will have large negative consequence. You don’t need to, because you have an alternative!
Rigging

Rigging is a set of higher level controls on a character that allow more rapid & intuitive modification of pose, deformations, expression, etc.

Important

- Like strings on a puppet
- Captures all meaningful character changes
- Varies from character to character

Expensive to create

- Manual effort
- Requires both artistic and technical training
Rigging Example

Courtesy Matthew Lailler via Keenan Crane
Blend Shapes: Interpolate shape instead of skeleton

Courtesy Félix Ferrand
Motion Capture

Data-driven approach to creating animation sequences

• Record real-world performances (e.g. person executing an activity)

• Extract pose as a function of time from the data collected

Motion capture room for ShaqFu
Motion Capture Pros and Cons

Strengths

• Can capture large amounts of real data quickly
• Realism can be high

Weaknesses

• Complex and costly set-ups
• Captured animation may not meet artistic needs, requiring alterations
Motion Capture Equipment

**Optical**
Use reflective markers or special illumination

**Magnetic**
Sense magnetic fields to infer position / orientation.
Tethered.

**Mechanical**
Measure joint angles directly.
Restricts motion.
Sequential decision making: given my current state (joint positions, joint angles, etc.), how should I move to maximize reward (following motion path, motion style, etc.)?

Next Time: Physical Simulation
Acknowledgments

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