

Intro to Animation

CSE 872 Fall 2009

1

Computer Animation:



What is animation?

Modifying scene parameters as a function of time

Why animate?

- Provides more information
- Interaction heightens immersion
- Fun

CSE 872 Fall 2007

2

Principles of Animation

1. *Squash and Stretch* -- rigidity & mass by distortion
2. *Timing* -- weight & size & even personality by spacing action
3. *Anticipation* -- preparation
4. *Staging* -- unmistakably clear presentation of ideas
5. *Follow Through and Overlapping Action*
-- relationship to the next action
6. *Straight Ahead Action and Pose-To-Pose Action*
-- 2 contrasting approaches
7. *Slow In and Out* -- subtlety of timing and movement.
8. *Arcs* -- path of natural movement
9. *Exaggeration* -- accentuating the essence
10. *Secondary Action* -- action resulting from and
11. *Appeal* -- make the audience enjoy watching.

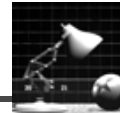


[Lasseter'87]

CSE 872 Fall 2007

3

Overview



- 1) Scripting
- 1) Keyframing
- 2) Kinematics
- 3) Motion Processing
- 1) Higher Level Animation
- 1) Dynamics and Simulation

CSE 872 Fall 2007

4

Example of Scripting

Specifying the parameters at every frame

```
define spinningCube()  
    rotAngle = pi * frameNumber / 50  
  
define carScript()  
    carTranslation = 10 * (frameNumber / 100)  
    wheelRotation = pi * frameNumber / 5
```

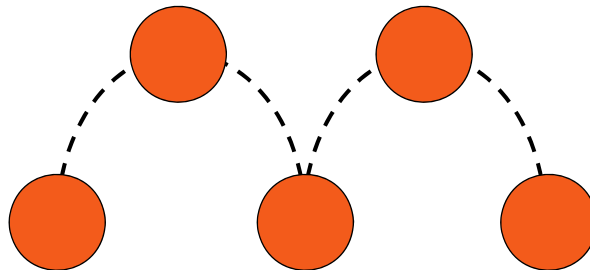


CSE 872 Fall 2007

5

Keyframing

Specify only the important frames,
interpolate the frames in-between



What and how to interpolate is important

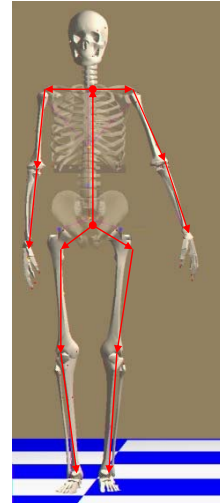
CSE 872 Fall 2007

6

Kinematics

The study or specification of motion, independent of the underlying physics that created the motion

Articulated Figure:
A figure made up of a series of links (bones) connected at joints



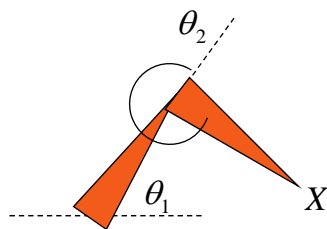
CSE 872 Fall 2007

7

Forward Kinematics

Given the character's state,
calculate its pose

$$X = f(\theta)$$



$$X = \begin{bmatrix} l_1 \cos \theta_1 + l_2 \cos(\theta_1 + \theta_2) \\ l_1 \sin \theta_1 + l_2 \sin(\theta_1 + \theta_2) \end{bmatrix}$$

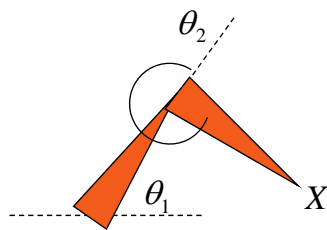
CSE 872 Fall 2007

8

Inverse Kinematics

Given the character's pose,
calculate its state

$$\theta = f^{-1}(X)$$



$$\theta = \begin{bmatrix} \frac{-(l_2 \sin \theta_2)x + (l_1 + l_2 \cos \theta_2)y}{(l_2 \sin \theta_2)y + (l_1 + l_2 \cos \theta_2)x} \\ \cos^{-1} \frac{(x^2 + y^2 - l_1^2 - l_2^2)}{2l_1l_2} \end{bmatrix}$$

CSE 872 Fall 2007

9

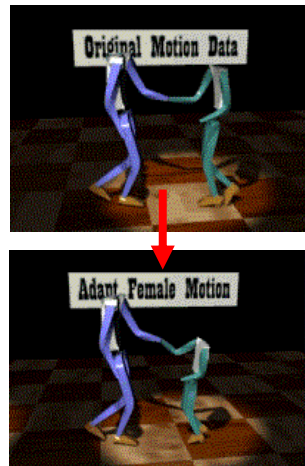
Motion Processing

Motion Capture



CSE 872 Fall 2007

Motion Editing



10

Behavioral Animation

Animating by describing an actor's behavior

An actor's behavior defines how the actor interacts with other actors and the environment

```
TRex()  
  if(player is close)  
    eatPlayer()  
  else if(can see player)  
    chasePlayer()  
  else  
    wander()
```

CSE 872 Fall 2007

11

Behavioral Animation

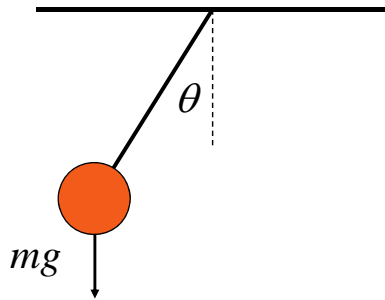


CSE 872 Fall 2007 Useful for crowd animations

12

Dynamics

Using “physics” to define the animation



Model choice is important

(1)	(2)
$\dot{X} = V$	$\dot{X} = V$
$\dot{V} = \frac{F}{m}$	$\dot{P} = F$
	$\dot{\theta} = \omega$
	$\dot{L} = T$

Can use “augmented” laws of physics

CSE 872 Fall 2007

13

Dynamics — Particle Systems

Particle Systems [Reeves83]

Represent “fuzzy” objects
(such as fire, smoke) as
a collection of particles



Particles contain local state

- Position
- Velocity
- Age
- Lifespan
- Rendering properties



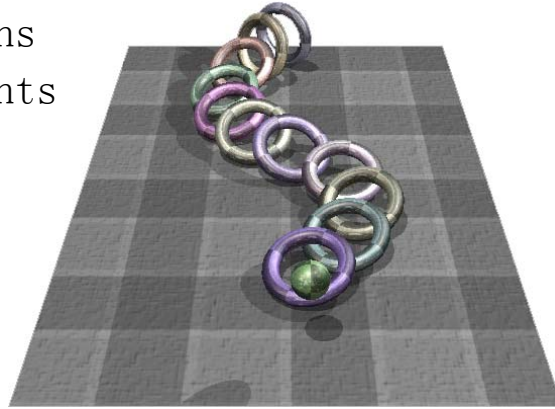
CSE 872 Fall 2007

14

Dynamics – Rigid Bodies

Rigid Bodies

- Integration
- Collisions
- Constraints



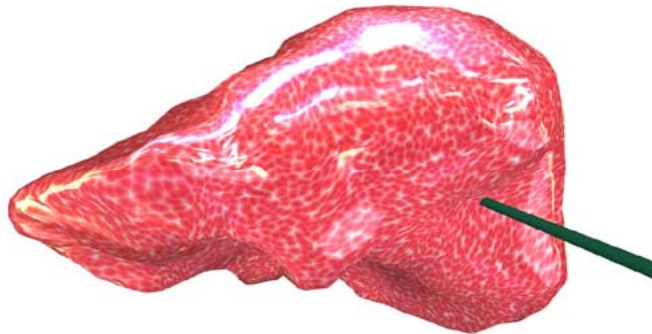
CSE 872 Fall 2007

15

Dynamics – Deformable Objects

Deformable Objects

- FFD
- Spring systems
- Finite Elements



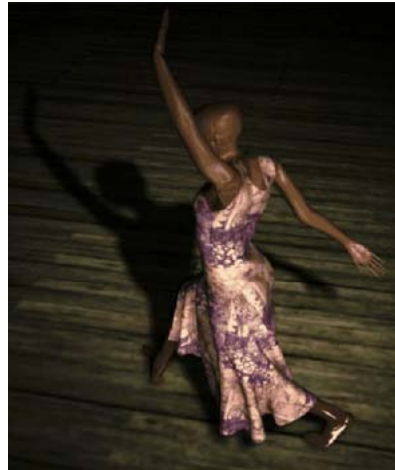
CSE 872 Fall 2007

16

Dynamics – Cloth

Cloth Simulation

- Stable Integration
- Adaptivity
- Material Properties



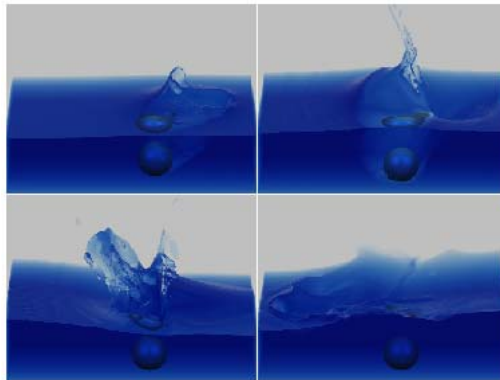
CSE 872 Fall 2007

17

Dynamics – Fluids

Fluid Simulation

- Navier Stokes, plus *lots* of topology changes



CSE 872 Fall 2007

[Foster & Fedkiw '01]

18

Real Time Animation

Zelda



CSE 872 Fall 2007

19

Offline Animation – Anything Goes

Final Fantasy



Pixar movies



20

Be Careful: Zombie Line

[Entis'07]

