

CS 4732: Computer Animation

Modeling Human Movement

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Modeling Human Movement: It's Hard!



- We know too well how people move
 - Sometimes they just don't "feel" or "look" right!
- □ The human body is very complex
 - Many bones -> 200 DOFs!
- Plus
 - Muscles
 - Ligaments
 - Tendons
 - Skin
 - Hair
- Lots of variability too!
 - Genetics, culture, personality, emotional state, …



Talking About Humans

- □ Sagittal Plane
 - Perpendicular to the ground, divides left/right
- □ Coronal Plane
 - Perpendicular to the ground, divides front/back
- Transverse Plane
 - Parallel to the ground, divides top/bottom
- Distal
 - Away from the body
- Proximal
 - Toward the body
- Flexion
 - Rotation that decreases the angle between bones
- Extension
 - Rotation that increases the angle between bones



Layered Approach

- Model the human like, well, a human
 - Skeleton (bones/rig)
 - Responsible for articulation
 - □ Rigging:
 - Defining interactive controls for animation
 - Muscles
 - Responsible for deforming the shape, based on bone movement
 - Not anatomically based
 - Defines FFD lattices that deform the skin geometry
 - Skin
 - Carries the appearance of the figure



Muscle FFD





Reaching & Grasping: Joint Limits

- Movements near/outside of joint limits
 - looks unnatural
 - Some flexion/extension is linked (e.g., touch your toes)
- Enforcing constraints makes forward kinematics more useful
 - Specify several key poses with FK, then interpolate
 - Remember this:







Dexterous Hand (cont.)

Or coordinate movements





Handling Obstacles

Can use a gradient search

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	Values indicate potentials
00 01	30 30	30 26	30 25	29 24	28 23	27 22	26 21	28 22	29 23	30 24	31 25	32 26	33 27	(33)28	33 29	33 33	induced by obstacles
02	30	25	24	23	22	21	20	21	22	23	24	25	26	27	28	33	
03 04	29 28	24 23	23 22	24 28	28 28	26 19	19 18	20 19	21 20	22 29	25 30	26 31	27 32	28 34	29 30	34	Polygons indicate obstacles
05	27	22	21	26	19	18	17	16	17	24	21	02	06	34	03	34	Goal position for
06 07	26 25	21 20	20 19	25 18	18 17	17	16 15	15 14	16	17 12	02 11	01	02+	01	02	07	end effector
08	24	19	18	17	16	15	14	13	12	11	10	05	04	03	04	00	
09 10	25 25	20	19 20	18 19	17 18	16	15	12	11	10	09	06	05	04	05	10 15	
11	25	25	25	24	23	16	15	14	13	12	09	08	09	10	11	16	Selected key frames from path of arm computed by
12	26	26	26	25	24	17	18	15	16	22	12	11	10	11	12	17	genetic algorithm
13	27	22	21	20	20	19	17	17	16	18	13	12	11	12	13	18	
15	27	27	27	26	25	24	23	22	23	23	23	18	17	18	18	18	of arm
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Walk Like an Egyptian

- Differs from reaching because it is cyclic
- □ Also, needs to carry us
 - Dynamics plays a bigger role
 - Needs to be more "organic"
- Walking is dynamically stable, but statically unstable
- Knowledge of walking motion is necessary
- What makes walking different from running?

Mechanics of Locomotion: **WPI** Walk Cycle





Interactive Media & Game Development





Pelvic Movement (cont.)







Kinematic Walking

□ Walking has

- Stance phase: From heal strike to toe lift off
- Swing phase: From toe lift off to heal strike

□One approach:

- Position pelvis (e.g., using spline)
- Position feet (e.g., using spline)
- Orient pelvis according to gate phase
- Use IK to compute leg joints for foot location

Animator can get info from many sources Show book

Kinematic Walking (cont.)





Dynamic Walking

- Can add more realism by incorporating dynamics
 - Can cost a lot
- □ Take some short cuts
 - Simplify the dynamics (e.g., ignore swing leg on balance)
 - Consider forces to be constant over some interval
 - Replace high DOF leg with simple one (e.g., a telescoping leg)
 - Compute horizontal and lateral dynamics separately, then combine



Dynamic Walking (cont.)

- ■Stance leg provides upper force to the mass of the pelvis
 - Used to control torso dynamics
- Upward force of support leg must cancel downward acceleration of gravity
- To simplify, horizontal motion of the pelvis can be computed separately
 Consider it to be constant over stance phase



Hair □Very complex to model/render □ About 100,000 strands of hair Like flexible cylinders □ MANY forces Collisions Stiffness Cohesion



Hair (cont.)

□ Other characteristics

- Wetness
- Oiliness
- Cleanliness
- Split ends



Three main strand types
 Asian (mostly straight and stiff)
 African (mostly curly)
 Caucasians (somewhere in between)



Modeling & Rendering Hair

Simple approach

- Rigid geometry shaped/scaled like hair
- Add texture/alpha maps to cheaply increase realism
- Pony-tail style can be added to increase movement cues
- Can also model individually
 Geometric tubes or particle trails

Modeling & Rendering Hair (cont.)

Can model as hair mesh



Modeling & Rendering Hair (cont.)

Or as individual strands





Some Examples

Bingo:

http://www.youtube.com/watch?v=4h-01R7iXqk

Activision Movie

Lots more!