Computer Animation
Algorithms and Techniques

Figure Animation
Virtual Human Representation

**Body Modeling**
- Geometric representation
- Level of detail
- DoFs
- Accessories: hair, clothes
- Rigid v. flexible

**Activities**
- Upper body tasks: reaching, grasping
- Locomotion: walking, running
- Body language: stance, gestures

**Secondary motion**
- Upper body tasks: reaching, grasping
- Locomotion: walking, running
- Body language: stance, gestures
Body Modeling - Geometry

Polygonal representations
Body Modeling - Geometry

- Patches are defined by 4*4 arrays of control points
- Arbitrary level of uniform subdivision
Body Modeling - Geometry

Subdivision surfaces

Subdivision
- Use more subdivision
- on close objects

Same Data

Great lighting due to high Levels of tessellation!
Body Modeling - Geometry

Implicit surfaces
Body Modeling - Geometry

Body scan

http://www.cyberware.com/

Rick Parent

Computer Animation
Animation – Rigid Links

Hierarchical animation

Use FK or IK to animate

Interpolate between key frames

Rick Parent

Computer Animation
Animation – Skeleton Driven

http://www.emeraldinsight.com/journals.htm?articleid=1532798&show=html
Animation – Skeleton Driven
Animation - Layered Approach
Reaching

Modeling the arm
The shoulder joint
The hand
Coordinated movement
Obstacles
Strength
Modeling the Arm

Also used is 3-2-2 DoF
Modeling the Arm
Determine plane of motion (3 DoF)
then 1-1 DoF arm
Then 2/3 DoF wrist
Modeling the Shoulder
Reaching

Values indicate potentials induced by obstacles

Polygons indicate obstacles

Goal position for end effector

Selected key frames from path of arm computed by genetic algorithm

Initial configuration of arm

Rick Parent

Computer Animation
Approximating Human Reaching Volumes Using Inverse Kinematics
I. Rodríguez, M. Peinado, R. Boulic, D. Meziata
inma@aut.uah.es, manupg@aut.uah.es, ronan.boulic@epfl.ch, meziat@

Rick Parent

Computer Animation
Modeling the Hand
Grasping
Grasping
Grasping

Grasp planning for digital humans
Faisal Amer Goussous, U. of Iowa

Rick Parent

Computer Animation
Reaching – close v. distant

Extended grasping behavior for Autonomous Human Agents
R. Max, R. Boulic, D. Thalmann
Mechanics of locomotion

walk cycle v. run cycle

Pelvic transport
Pelvic rotation
Pelvic Tilt
Knee flexion
Ankle and toe joints
Anatomy of the Walk
Anatomy of the Run

Rick Parent

Computer Animation
Pelvic transport

1. a) Start of stance
2. b) Midstance
3. c) End of stance
Pelvic rotation over foot
Pelvic rotation around hips

Start of stance  Midstance  End of stance
Motion of pelvic
Pelvic tilt

Start of stance  Midstance  End of stance
Knee bend to allow tilt

1. Start of stance
2. Midstance
3. End of stance
Ankle and Toe bend
Walk Data
Walk Data

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[Graph showing knee angle over time for different walking speeds and subjects]
Walk Data

- Ankle Angle, degrees dorsiflexion

- Time, percent of cycle

- Steps/min

Subjects 1 and 4

Rick Parent

Computer Animation
Walk Data

Subject R

- 10 steps/min
- 91 meters/min

Subject P

- 06 steps/min
- 74 meters/min

Subject J

- 21 steps/min
- 04 meters/min

Subject B

- 02 steps/min
- 72 meters/min

Subject C

- 09 steps/min
- 71 meters/min

Subject G

- 11 steps/min
- 88 meters/min

Subject K

- 12 steps/min
- 87 meters/min

Angle between hindfoot-Midfoot and Forefoot, degrees

Time, percent of cycle
Using Dynamics in the Walk

- time-space curves traced by the feet
- time-space curve traced by the pelvis
- pelvis at time $t$
- left foot
- right foot
- foot at time $t$
- leg configuration at time $t$ determined by inverse kinematics
Using Dynamics in the Walk

Gravity

Stance leg pushing upward

Horizontal push of stance leg
Using Dynamics in the Walk

expansion

compression

expansion

Rick Parent

Computer Animation
Expressions v. speech
facial animation

Parameterized facial attributes

Blend shapes

Muscle models
  surface muscles
  deep muscles

Performance (or data) driven
  instrumented (mocap system)
  video

http://www.youtube.com/watch?v=uQJ7gwG0G5g
Parameterized Facial features
Facial blend shapes
Facial muscle model

Rick Parent
Surface muscle model

Figure 8: A simple grid (left, zygomatic major) and a non-uniform complex grid (right, orbicularis oris).

Geometry-based Muscle Modeling for Facial Animation
Kolja K"ahler J"org Haber Hans-Peter Seidel
“computer animation” facial

Figure 6. Snapshots taken simultaneously from three video cameras.
“computer animation” facial

Text to speech
Audio to speech

Phonemes to mouth shapes (visemes)

coarticulation
prosody

http://www.youtube.com/watch?v=fxADT-kZNrA
Dressing the Figure

Cloth and clothing
Simple draping
Clothes
Modeling dynamics
Collision detection and response
Dressing the Figure

Cloth supported at two constrained points

Constrained points in grid space
Dressing the Figure

curve to be removed
Dressing the Figure
Dressing the Figure
Dressing the Figure

(a) Original quadrilateral mesh

(b) Slew of original quadrilateral without changing the length of edges

(c) Diagonal springs to control slew
Angular springs

Original dihedral angle

Bending along the edge that changes dihedral angle
Angular springs

\[ l_1 = |v_2 - v_2| \]
\[ l_2 = |v_3 - v_2| \]
\[ l_3 = |v_3 - v_1| \]
Dressing the Figure
Dressing the Figure
Dressing the Figure

Rick Parent

Computer Animation
Hair

Complexity
100,000 strands

Collisions

Shadowing

Reflections

Hair types

Populate head with hair
Design hairstyle
Animate hair

Rick Parent

Computer Animation
Hair
Hair

http://run.usc.edu/cs599-s10/hair/c33-hair-sig07.pdf

Rick Parent

Computer Animation
Hair
Hair

Rick Parent

Computer Animation
Hair
Hair

Rick Parent

Computer Animation
Hair – Hierarchy

(a) (b) (c)

A Survey on Hair Modeling: Styling, Simulation, and Rendering
Kelly Ward, Florence Bertails, Tae-Yong Kim, Stephen R. Marschner, Marie-Paule Cani, and Ming C. Lin,
Hair
Hair
Hair