CENG 732
Computer Animation

Spring 2006-2007
Week 9
Animating Cloth
Motion Capture

Cloth Animation

- Cloth animation in Blender
- Cloth animation in Maya

Simple Draping

- Draping will occur as a cloth is hanged from a fixed number of support points
- The cloth is represented as a two-dimensional grid of points located in 3D.
  - Certain grid points are fixed
- Convex-hull of the fixed points determine where the draping will occur

Simple Draping

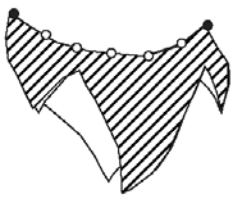
- Two phases
  - The draped surface is approximated with the convex hull of the constrained points
  - Iterative relaxation process where other grid points are displaced
    - Process continues until the maximum displacement is below a threshold

Simple Draping

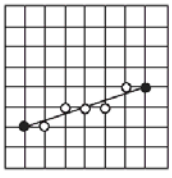
- Vertices on the grid are labeled as *interior* or *exterior* depending on whether they are inside the convex-hull or not

Simple Draping

- The grid points along the line between two constrained points are determined



Cloth supported at two constrained points



Constrained points in grid space

Catenary Curve

- The curve of a thread hanging between two vertices is called a catenary curve.
- It has the following form

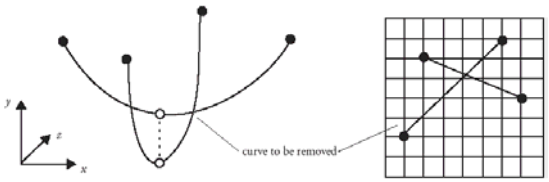
$$y = c - \left(a \cdot \cosh\left(\frac{x - b}{a} \right) \right)$$

where

$$\cosh x = \frac{e^x + e^{-x}}{2}$$

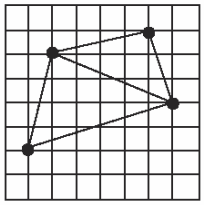
Catenary Curves

- If two curves cross each other in the grid space, the lower curve is removed
  - If a vertex is supported by two curves, the higher curve takes precedence



Simple Draping

- After the lower curve is removed a triangulation of the constrained grid points is constructed

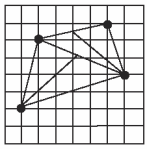


Simple Draping

- The vertices of the grid points that fall on the lines of triangulation are positioned in 3D space according to the catenary equations
  - Given two vertices (x1,y1) and (x2,y2) the catenary equation between these two points can be formed (Equation 6.3 in the book)

Simple Draping

- Each triangle is repeatedly subdivided by constructing a catenary from one of the vertices to the midpoint of the opposite edge on the triangle
  - Repeated for all vertices of the triangle
  - The highest of the three catenaries is kept. The triangle will be divided into two new triangles



Relaxation Procedure

- Effect of gravity is handled implicitly in the formation of the catenary curves
- Exterior vertices are placed at the lowest height possible (to create a downward pull)
- Relaxation procedure repositions each vertex to satisfy unit distance from each of its neighbors

Motion Capture

Motion Capture Videos

- Capturing Ronaldinho's motion
- Full Body Motion Capture Suit
- Motion Capture by Staffordshire University student
- Facial Motion Capture

Motion Capture Research

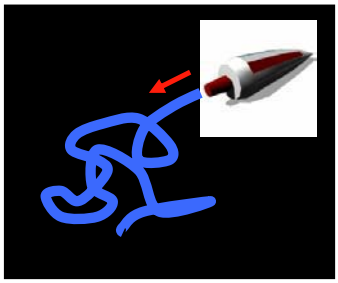
- Vision based motion capture
- Motion blending

What is Motion Capture?

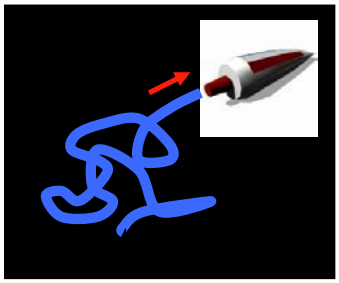
- The recording of RAW motion data for later use.
- Several different systems on the market
  - camera / optical
  - gyroscopes / accelerometers
  - magnetic / fiber optic



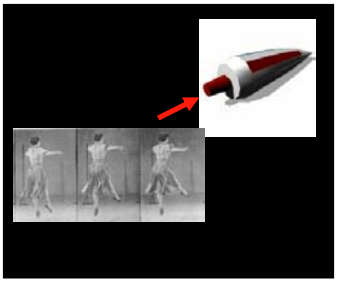
The Graphics Problem



The Vision Problem



The Motion Capture Problem



Computer Model

Motion Capture: Standard Pipeline

Multi-View High-Speed Recording

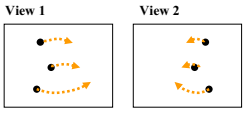
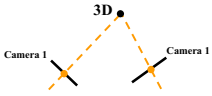


Image Feature Tracking



2D -> 3D Reconstruction

Kinematic Model Fitting

Where is Motion Capture Used?

- Motion Analysis & Research
- Games
- Films & Animated Shorts
- Human Factor Studies
- Performance Arts
- Virtual Reality Simulations
- Education
- etc.

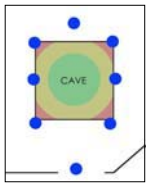
Marker Setup

- Usually defined by the desired output
  (CG Characters, Point Clouds, Joint Analysis, etc.)
- Typical human setup has 44 markers
- More markers require more CPU/processing time

Equipment / Configuration

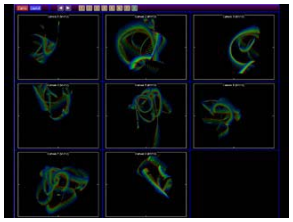
Camera	MX13 Cameras
Supplier	Vicon Motion Capture Systems
Resolution	1.3 million pixel digital CMOS sensor
Sample Rate	484fps, full frame
Configuration	8 Cameras in radial configuration

- Placement of cameras
- Coverage concerns
- Resolution and precision
- Movement concerns



System Calibration

- Multi-step Process
- Takes 5-10min (on a good day)
- Should be done regularly

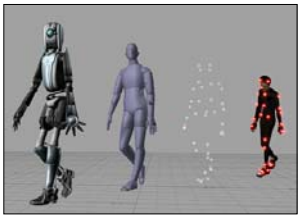


Wand and L-Frame Equipment

Define Tracked Rigid Bodies

Part of the Process

1. Calibrate Cameras
2. Put Markers on Subject
3. Calibrate Subject
4. Check Quality of Calibration
5. Record Motion
6. Cleanup Point Cloud
7. Label Markers in Point Cloud
8. Cleanup Resulting Data
9. Export Data
10. Import Data into Package of Choice

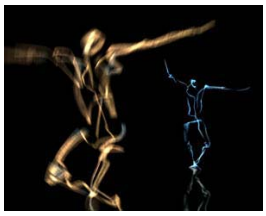


Motion Capture Based Puppetry

Virtual Actor System by SimGraphics

Popovic

Characters to Animate



Paul Kaiser / Merce Cunningham

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Visual Tracking

Visual Tracking: Unsolved for general settings