Munging motion capture data

goal: take captured motion and make it work on an arbitrary figure without destroying the style of the motion. Allow the animator control over the motion (speed, contact with environment, style).

subproblems:

- cyclification
- transitions
- generalization between motions
- extracting style
- scaling

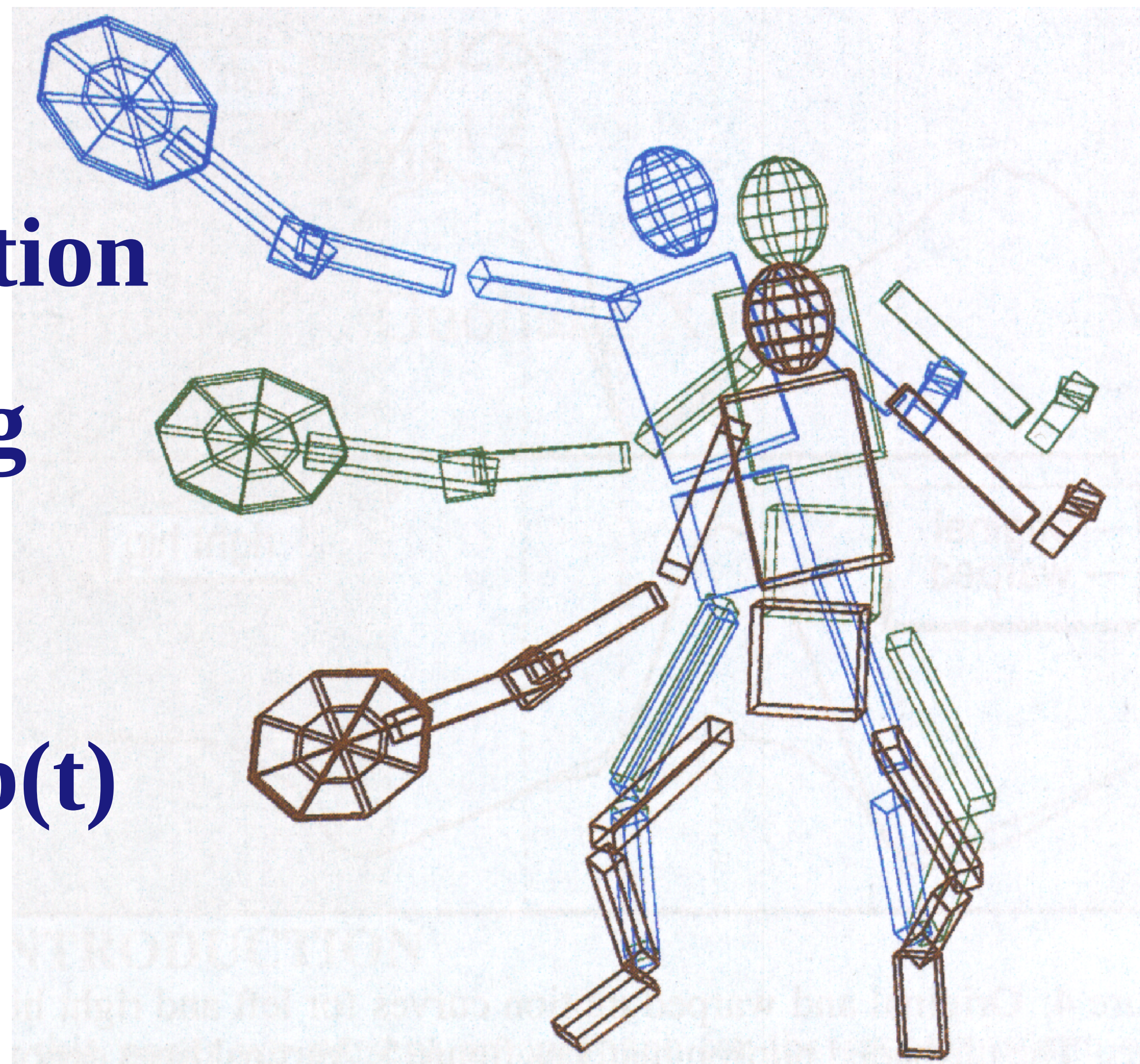
Generalization

Motion Warping
Witkin and Popovic, Siggraph ’95

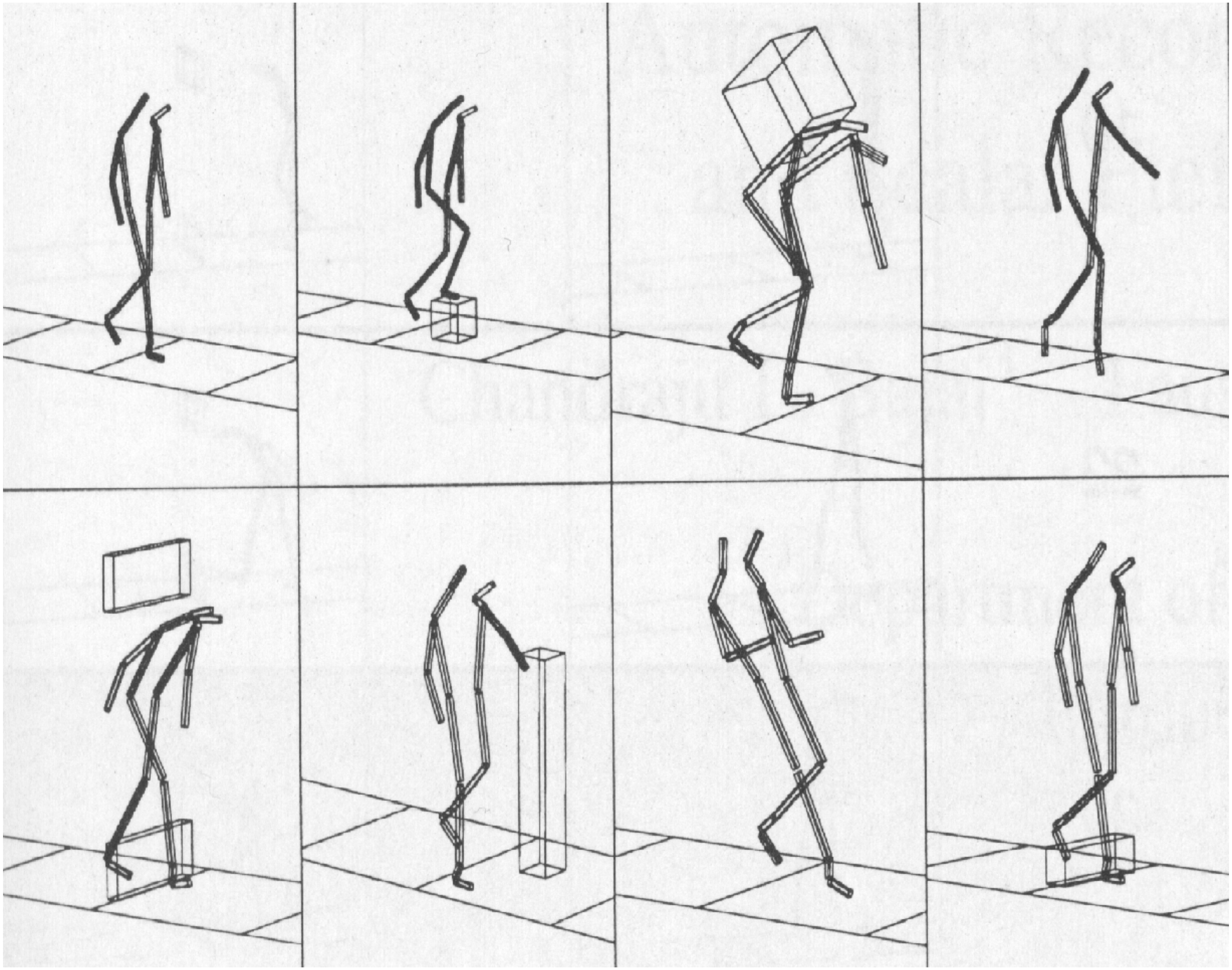
keyframes as constraints in a smooth deformation

keyframe placing the ball on the racket at impact

$\theta'(t) = a(t)\theta(t) + b(t)$



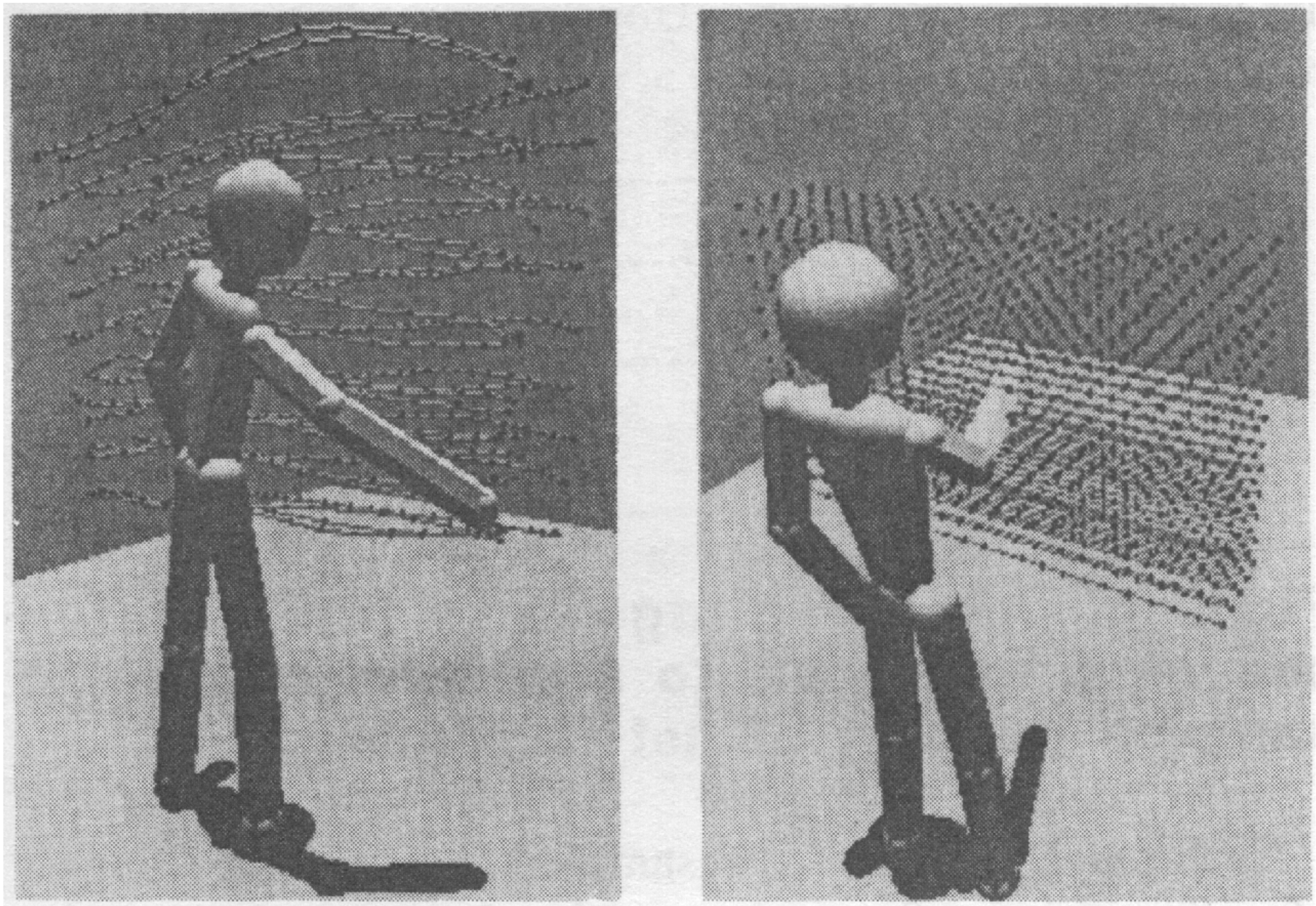
few keyframes
possibly unrealistic motion



Generalization

Interpolation Synthesis for Articulated Figure Motion

Wiley and Hahn
Vrais '96



Initial Data Resampled Data

1) Resample data

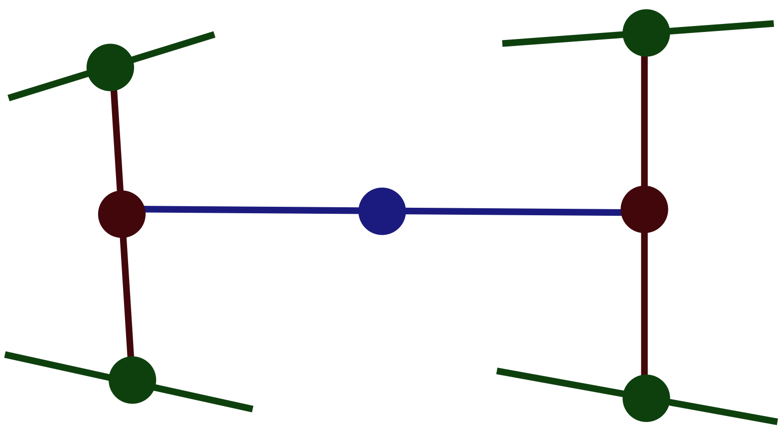
2) linear interpolation:

$c = (1-u)a + ub$ for position components

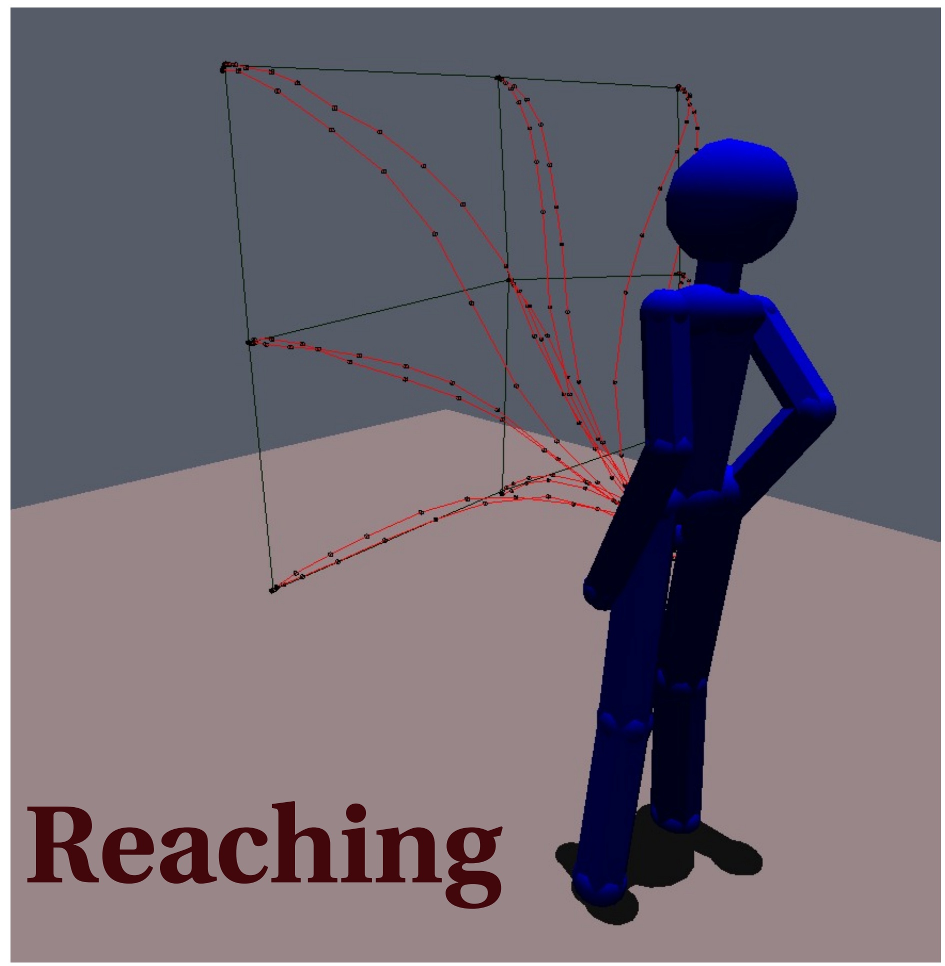
spherical linear interpolation:

$r = q \sin ((1-u)W)/\sin(W) + p \sin (uW)/\sin(W)$

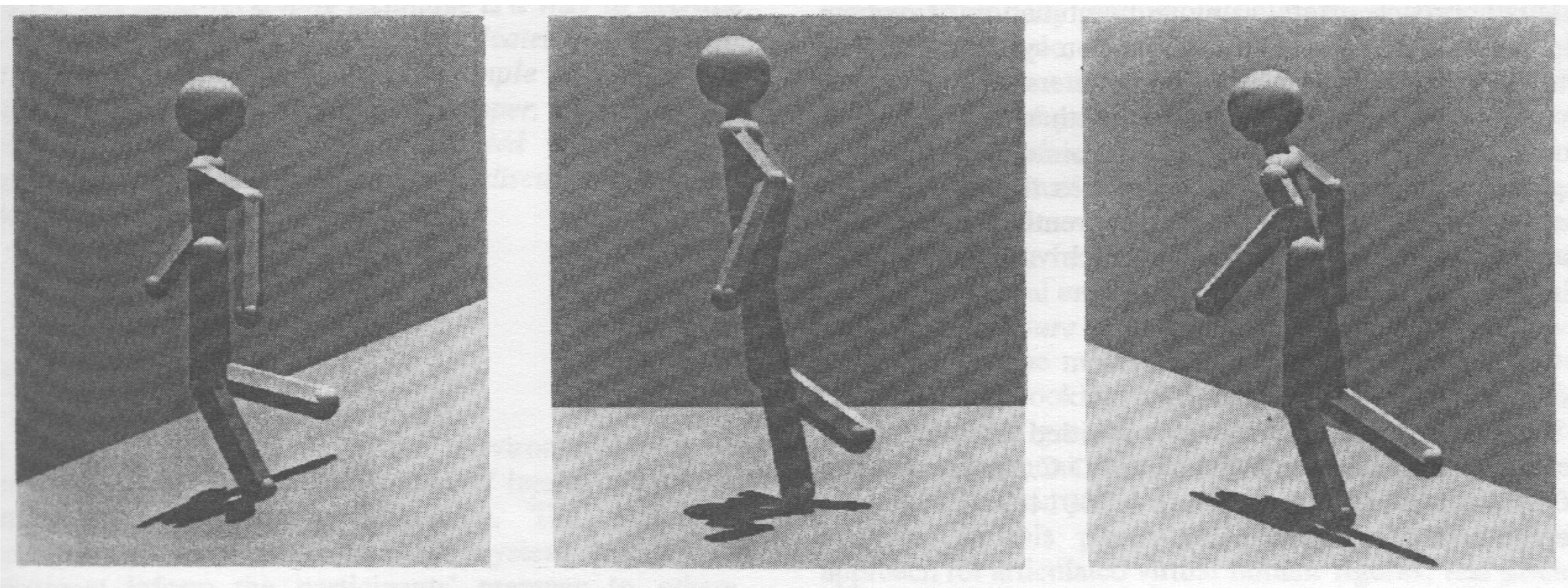
where $W = p \cdot q$ for quaternion orientations



x y z

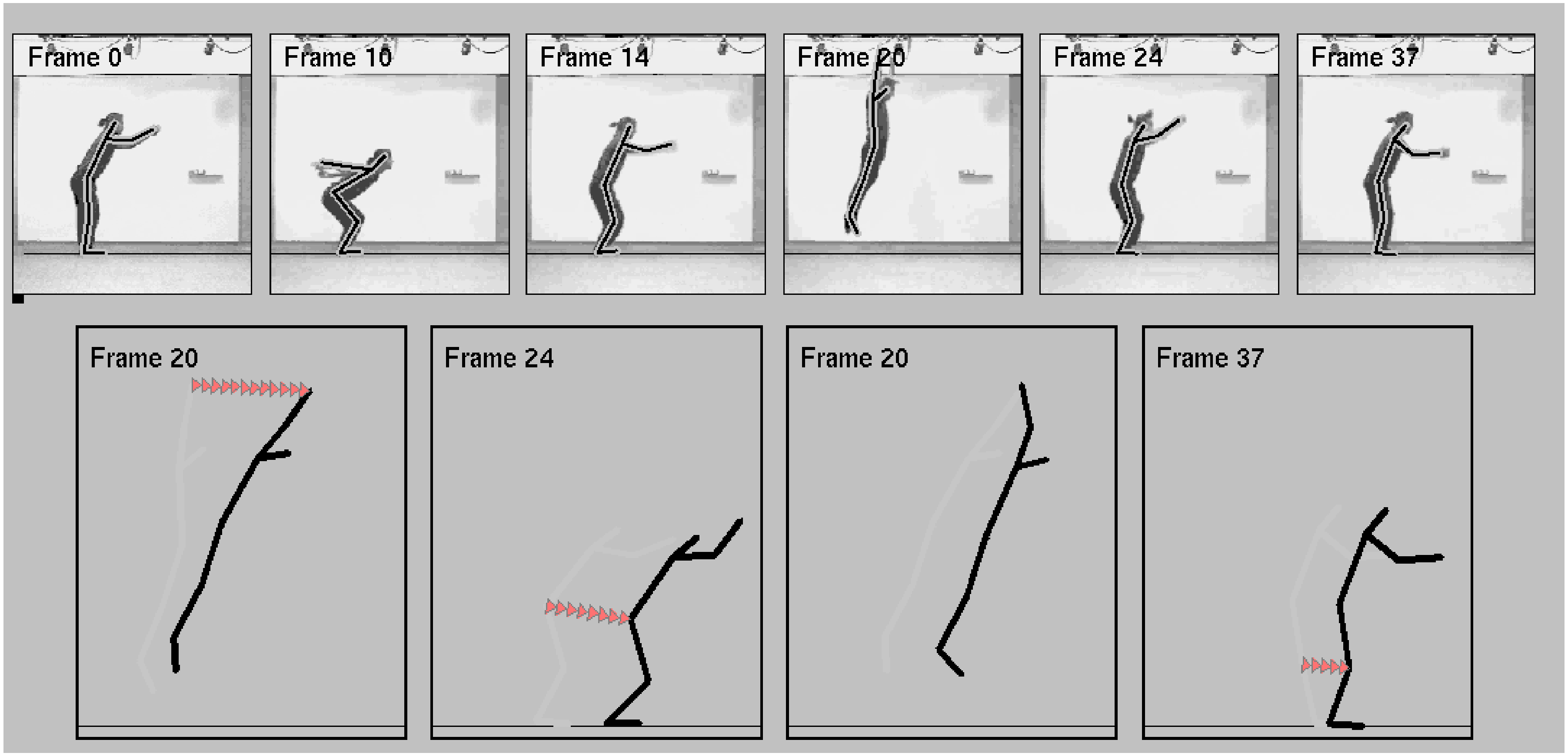


Walking motion sampled on five different slopes and interpolated

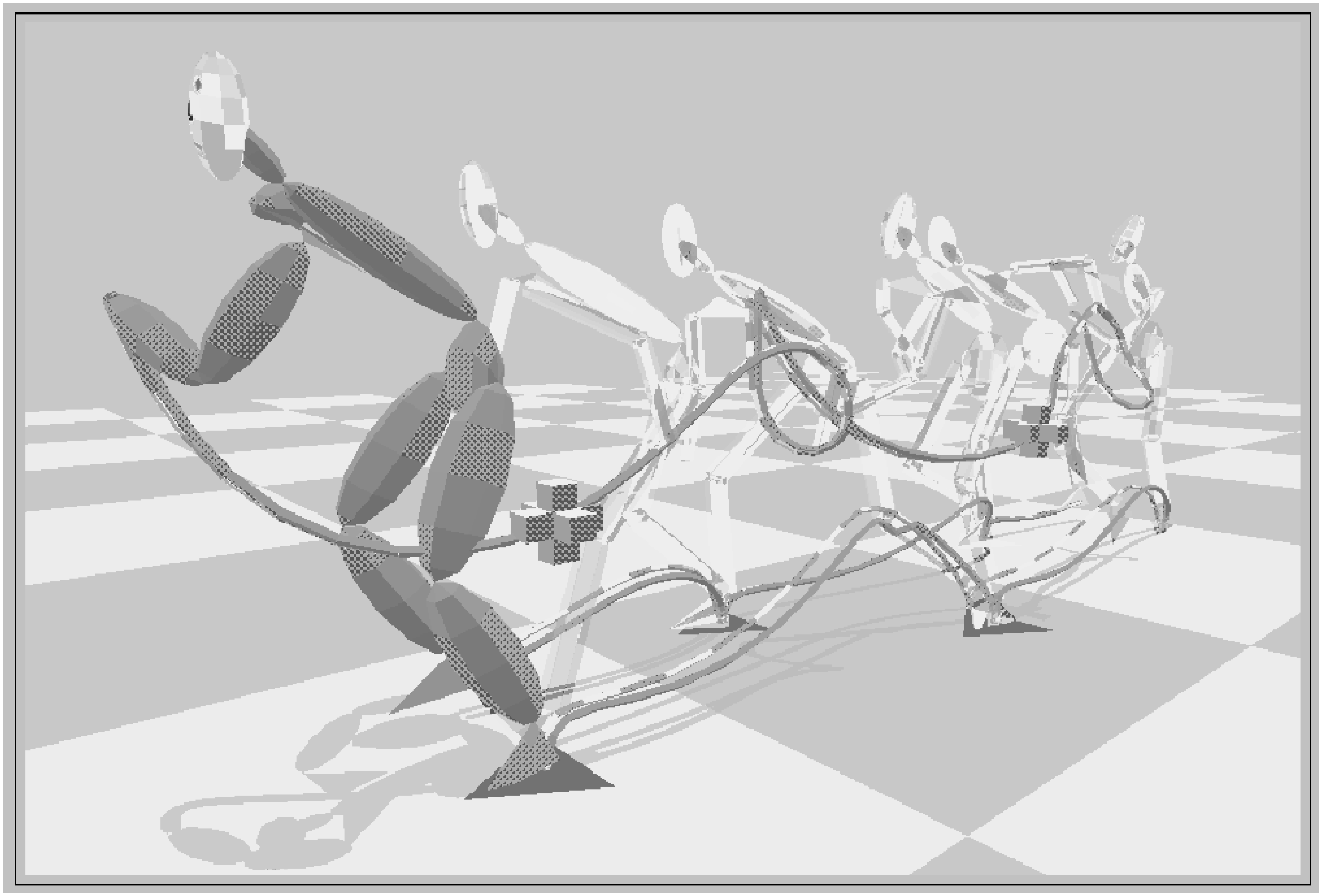


Generalization

Motion Editing with Spacetime Constraints, Gleicher 1997 Symposium on Interactive 3D Graphics



Generalization



Generalization

combine motion displacement techniques (Witkin and Popovic) with trajectory optimization (spacetime constraints)

1. interactively add constraints
2. minimize change in motion while maintaining constraints
3. allow user to interactively refine

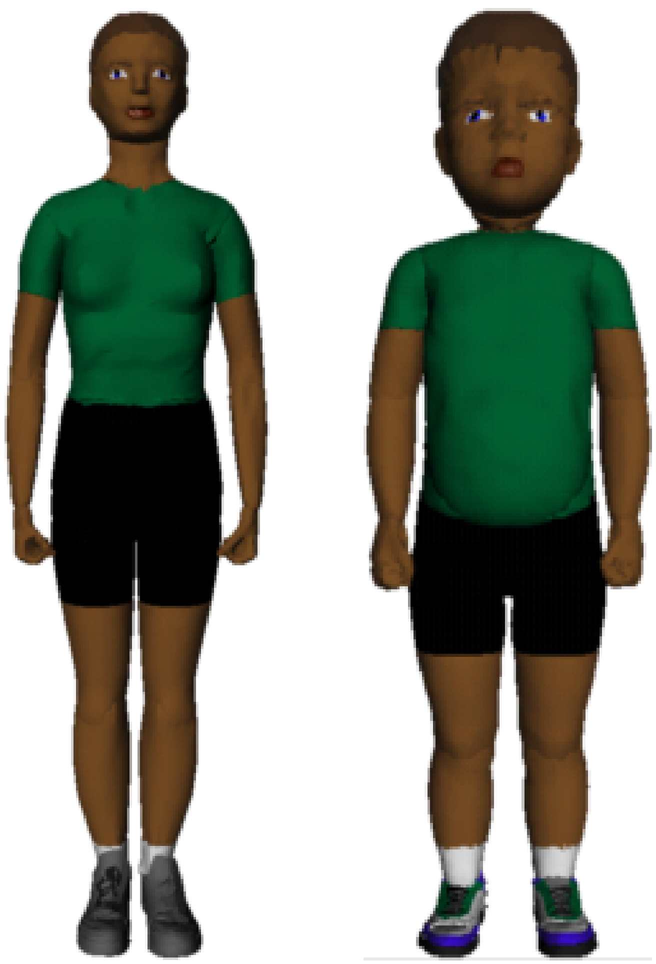
minimize $g(x)$ subject to $f(x) = c$

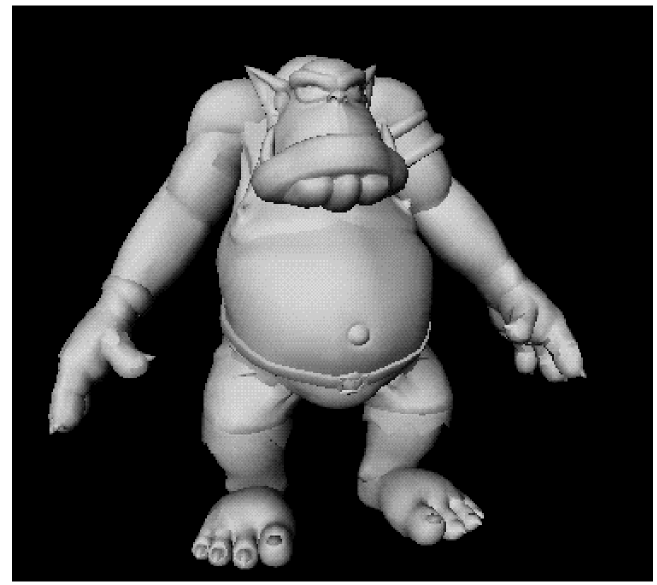
represent as $m(t,x) = m_0(t) + d(t,x)$

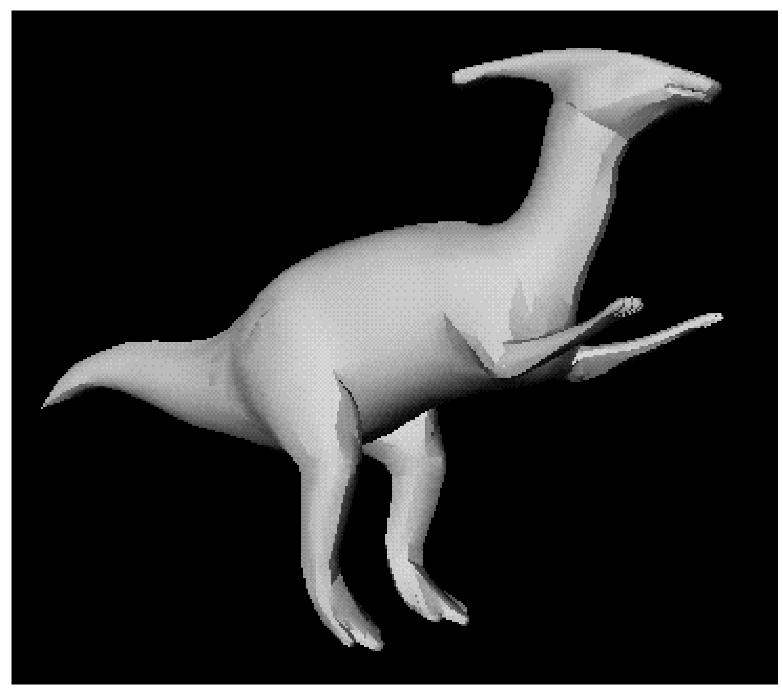
Scaling

contact

1998 Siggraph, Gleicher





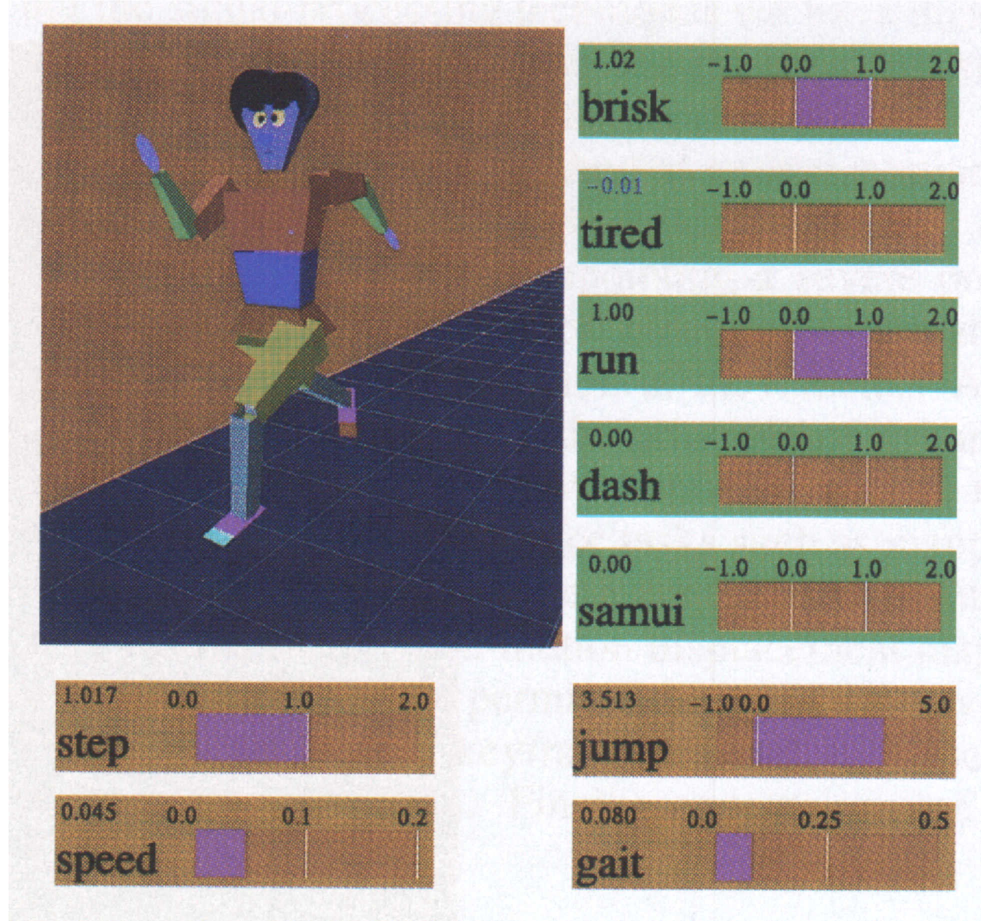


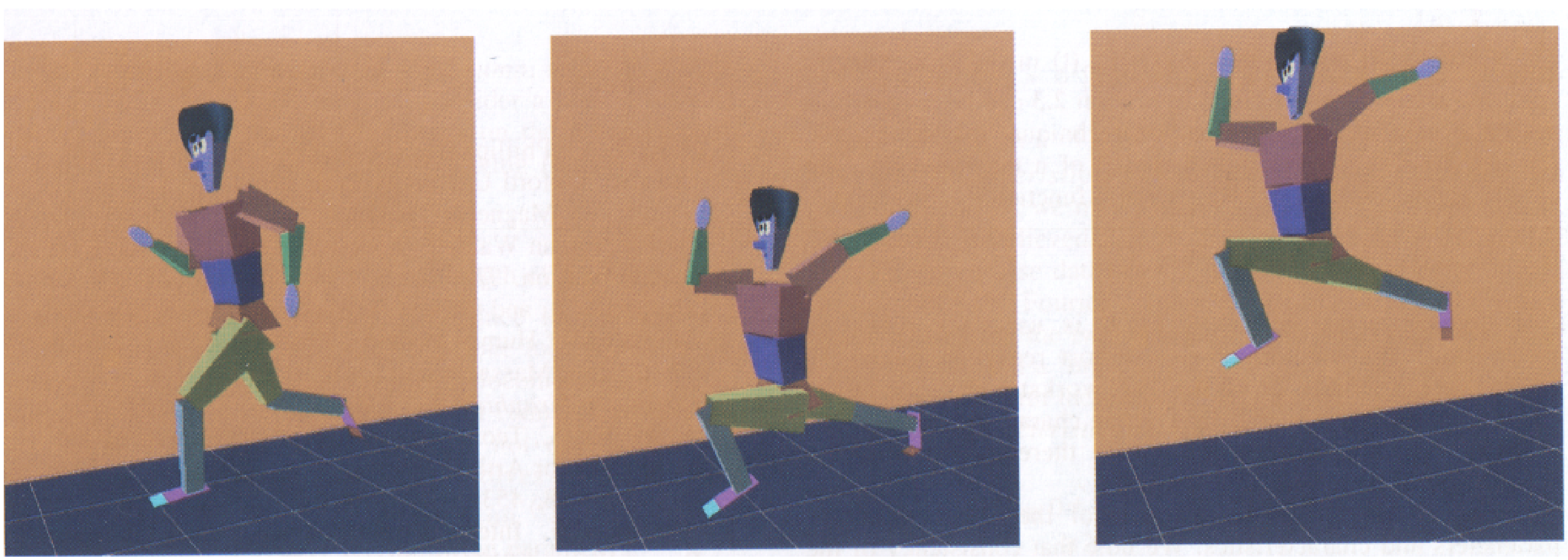
Style

Style

Fourier Principles for Emotion–based Human Figure Animation

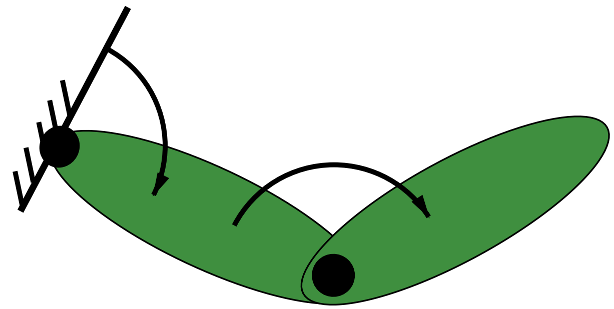
Unuma, Anjyo, Takeuchi
Siggraph ’95





Hierarchical model

joint angle data



Fourier model

$\theta(t)$ motion of a joint

$$\theta(t) = A_o + \Sigma A_n \sin(nt + \phi_n)$$

Interpolation

$$\alpha(s,t) = (1-s)A_o + sB_o +$$

$$\Sigma((1-s)A_n + sB_n) \sin(nt + (1-s)\phi_n + s\gamma_n)$$

Representation of data:

- Fourier series
- wavelets
- spline with knot points

Modification Technology:

- smoothing of spline
- interpolation between two motions
- maintenance of constraints
- trajectory optimization

Type of Modification:

- style of motion
- cyclification
- constraints on the motion
- transitions between motions

Evaluation Criteria:

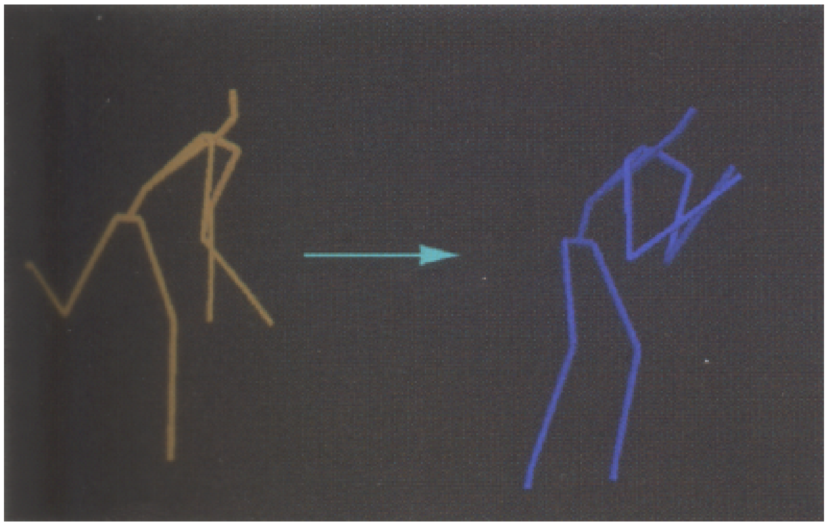
- how many motions?
- how good is the motion?
  - kinematic/dynamic/natural
- usable UI

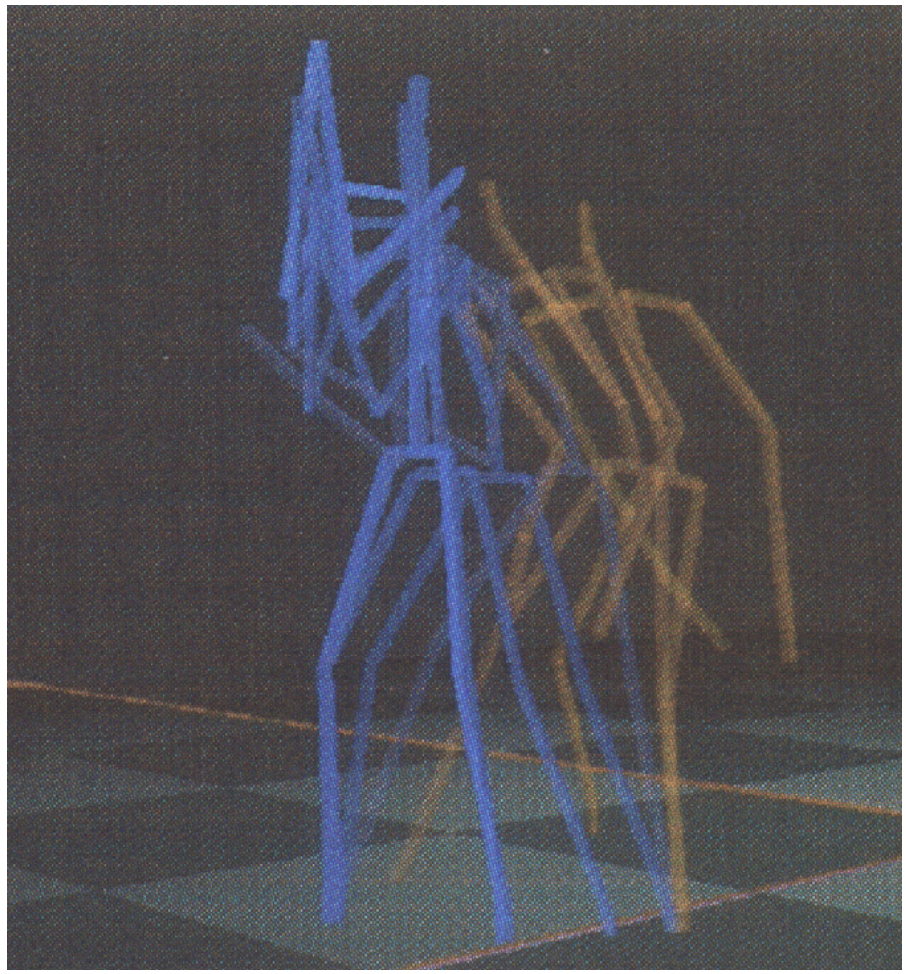
Where can we go from here?

- deducing a CS?
- what do we gain with a CS?
  - greater generality?
  - scaling to new creatures?
  - more natural looking motion?
- how much knowledge is required?
  - state machine
  - control laws (fitting of parameters)
  - constraints based on human behavior

Transitions

Efficient Generation of Motion Transitions using Spacetime Constraints
Rose, Guenter, Bodenheimer, Cohen
Siggraph ’96





Inverse Kinematics for the feet