Motion Capture
Part 2

Computer Graphics
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Manipulating Motion Data

- Adjusting
- Blending
- Transitioning
- Retargeting
Adjusting

Why is this task not trivial?

Figure 1: Some of the captured motion curves of human walking.

From Witkin and Popovic, SIGGRAPH 95
Adjusting

IK on single frames will not work

From Gleicher, SIGGRAPH 98
Adjusting

Define desired function with

\[ m(t) = m_0(t) + d(t) \]
Adjusting

\( d \in \text{“Some nice space”} \)

For example use b–splines or Gaussian bumps

The idea is to spread modification over a reasonable period of time

Support radius picked to match what user defines as reasonable

\[
d(t) = \sum_{i=1}^{n} c_i b_i(t)
\]
Adjusting

How would we do the IK?
- Racket position
- Right foot fixed
- Left toes fixed
- Balance

From Witkin and Popovic, SIGGRAPH 95
Adjusting

Use IK to solve for $d$ at time $t_i$

Select control points for function so that

$$d(t_i) = d^{t_i}$$
Adjusting

What if adjustments overlap?

From Witkin and Popovic, SIGGRAPH 95
Adjusting

Extend FK to include time

\[ p^t_i = K_p(m(t_i)) \]

\[ = K_p(m_0(t_i) + d(t_i)) \]

\[ = K_p \left( m_0(t_i) + \sum_{j=1}^{n} c_j b_j(t_i) \right) \]
Adjusting

Do IK to find control values

\[ dp^{t_i} = J_{p/m} \cdot dm \]

\[ = J_{p/m} \cdot J_{m/c} \cdot dc \]

Assemble all constraints into one system
**Blending**

If given two motions, can we blend them to find a motion 1/2 between them?

\[ m_\alpha(t) = \alpha m_a(t) + (1 - \alpha) m_b(t) \]

Assume same DOFs

Assume same parameter mappings
Blending

Consider something simple: fast and slow walks

From Bruderlin and Williams, SIGGRAPH 95
Blending

Define timewarp functions
Blending

Blend in normalized time

\[ m_\alpha(w) = \alpha m_a(w_a) + (1 - \alpha) m_b(w_b) \]

Blend playback rate

\[ \frac{dt}{dw} = \alpha \frac{dt}{dw_a} + (1 - \alpha)\alpha \frac{dt}{dw_b} \]
Blending may still break "features" in original motions

Touchdown for Run

Touchdown for Walk

Blend misses ground and floats
Blending

Add explicit constraints to key points

Touchdown for Run

Touchdown for Walk
Blending

Add quality metric on $d(t)$

Minimize accelerations/torques

Explicit smoothness

Other criteria...
Blending

Extend to multivariate interpolation

\[ m(w) = \sum_i \alpha_i(w) m_i(w) \]

\[ \sum_i \alpha_i(w) = 1 \]

Weights are now barycentric coordinates.
Blending

Extend to multivariate interpolation

"Speed"

"Hippiness"

Becomes standard interpolation problem...

If we have other examples place them in the space also
Transitioning

Transition from motion A to motion B

Perform blend in overlap region
Cyclification

Special case of transitioning

Both motions are the same

Need to modify beginning and ending simultaneously
Transition Graphs
Retargeting

Adapt motion to another character

*Figure 2:* Left: Frames from a rotoscoped walking motion are shown. Right: Applying this motion to a character that is 60% of the size of the original yields a motion that skates along horizontally above the floor.

From Gleicher, SIGGRAPH 98

Use IK across samples, similar to adjusting
Retargeting

Allow optimization of constraint parameters

Figure 8: Forcing a character with short legs to walk in the footsteps of a longer-legged character leads to an unnatural motion.

From Gleicher, SIGGRAPH 98
Retargeting

From Gleicher, SIGGRAPH 98
Suggested Reading

Fourier principles for emotion–based human figure animation
Munetoshi Unuma, Ken Anjyo and Ryozo Takeuchi
SIGGRAPH 95

Motion signal processing
Armin Bruderlin and Lance Williams
SIGGRAPH 95

Motion warping
Andrew Witkin and Zoran Popovic
SIGGRAPH 95

Efficient generation of motion transitions using spacetime constraints
Charles Rose, Brian Guenter, Bobby Bodenheimer and Michael F. Cohen
SIGGRAPH 96

Retargetting motion to new characters
Michael Gleicher
SIGGRAPH 98

Verbs and Adverbs: Multidimensional Motion Interpolation
Rose, Cohen, and Bodenheimer