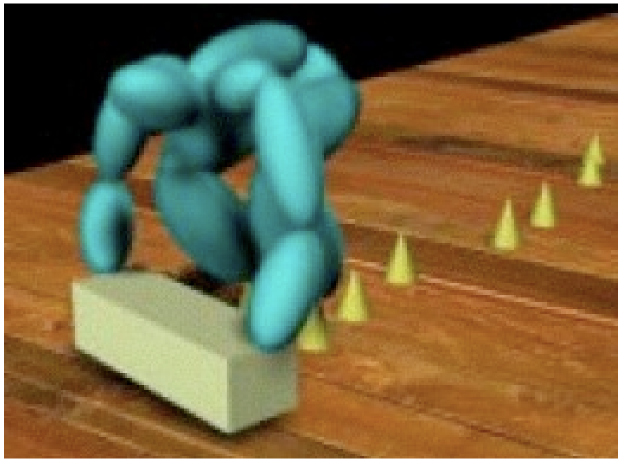
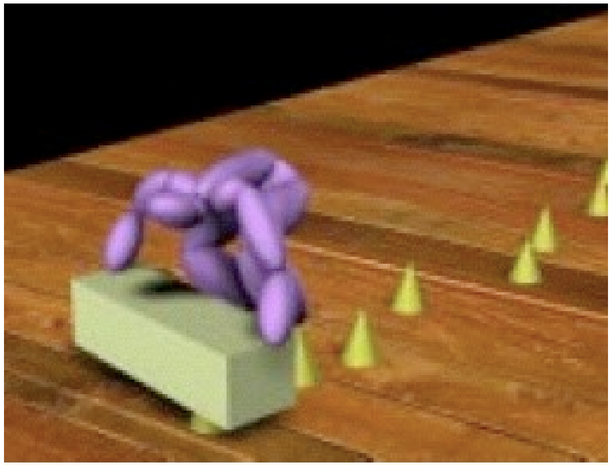
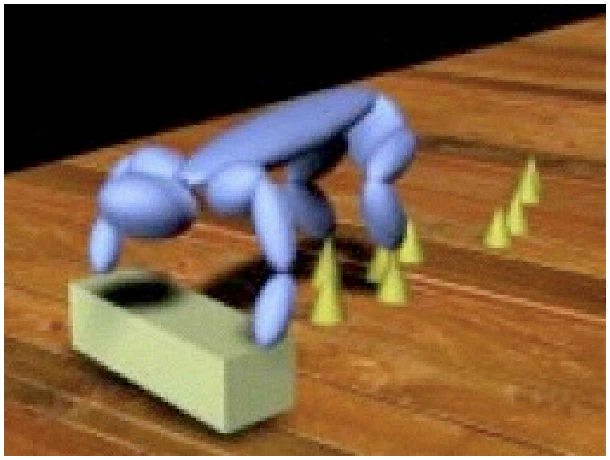
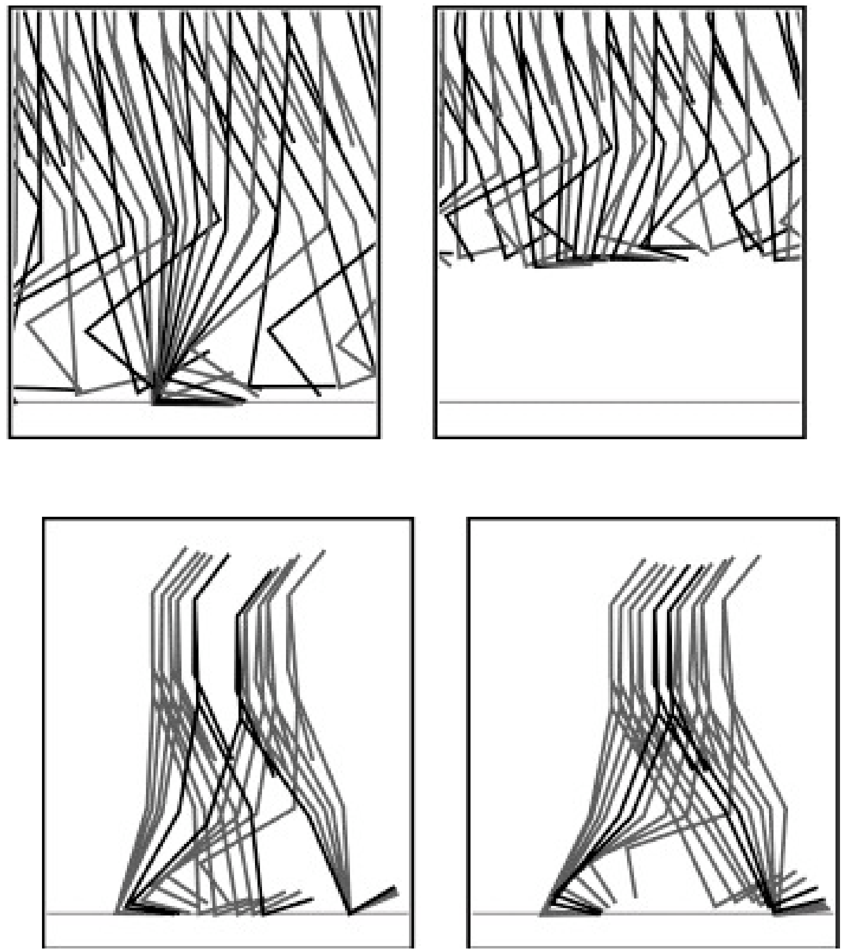
Retargetting Motion to New Characters



objective function
constraints
representation
starting point

Constraints

1. a parameter's value is in a range (useful for joint limits);
2. a point on the character (such as an end-effector) is in a specific location (useful for footplants or grabbing an object);
3. a point on the character is in a certain region (for example, above the floor);
4. a point on the character is in the same place at two different times (useful to prevent skidding), although this position is unspecified so that it can be adjusted;
5. a point on the character is following the path of another point;
6. two points are a specified distance apart (useful for when a character is carrying an object of a fixed size);
7. the vector between two points has a specified orientation.

Representation

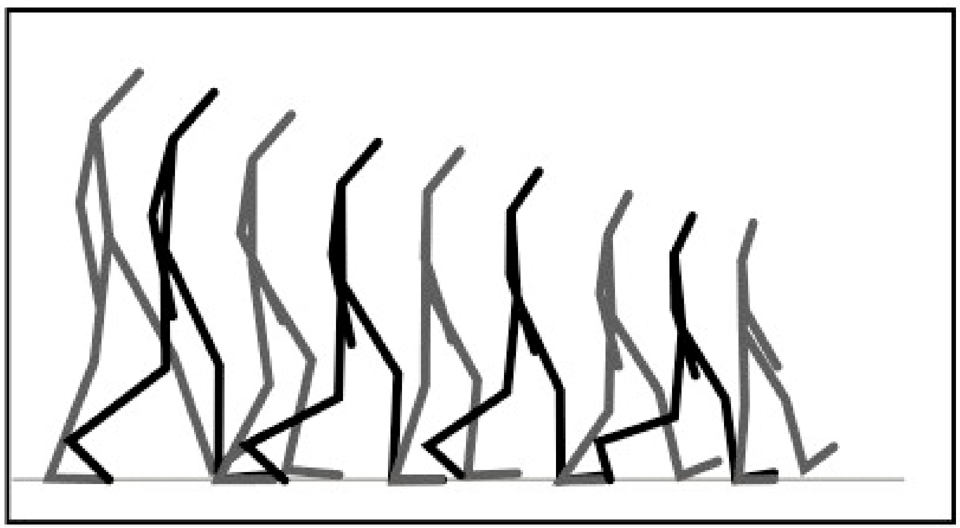
$$g(\mathbf{m}) = \int_t (\mathbf{m}(t) - \mathbf{m}_0(t))^2 = \int_t \mathbf{d}(t)^2,$$

$$\mathbf{m}(t) = \mathbf{m_0}(t) + \mathbf{d}(t)$$

Procedure

1. Begin with an initial motion with identified constraints.
2. Find an initial estimate $\mathbf{m_1}(t)$ of the solution by scaling the translational parameters of the motion, and then adding a translation to define the center of scaling. This translation is computed by finding the constraint displacements of the scaled motion for the target character, interpolating these values, and smoothing.
3. Choose a representation for the motion-displacement curve based on the frequency decomposition of the original motion.
4. Solve the non-linear constraint problem for a displacement that when added to the result of step 2 provides a motion that satisfies the constraints.
5. (optional) If the result of step 4 does not satisfy the constraints sufficiently, solve using the result of the step $(\mathbf{m_1}(t) + \mathbf{d}(t))$ as the initial motion, and a denser set of control points for the new displacement.

$$\text{minimize}\, g(\mathbf{x})\, \text{subject to}\ \mathbf{f}(\mathbf{x}) = \mathbf{c}.$$



Objective function

$$g(\mathbf{x}) = \frac{1}{2}\mathbf{x}\mathbf{M}\mathbf{x}$$

$$r = \frac{1}{2}(\mathbf{f}(\mathbf{x}) - \mathbf{c}) \cdot (\mathbf{f}(\mathbf{x}) - \mathbf{c}) + \epsilon \frac{1}{2}\mathbf{x} \cdot \mathbf{x},$$

Taylor Expansion

$$\mathbf{f}(\mathbf{x} + \mathbf{\Delta}) \approx \mathbf{f}(\mathbf{x_i}) + \frac{\partial \mathbf{f}}{\partial \mathbf{x}} \mathbf{\Delta},$$

$$\mathbf{J}\mathbf{\Delta} = \mathbf{f}(\mathbf{x}) - \mathbf{c}.$$

Damped Least Squares

$$(\mathbf{J}^{\mathbf{T}}\mathbf{J} + \epsilon\mathbf{I})\mathbf{\Delta} = \mathbf{J}^{\mathbf{T}}(\mathbf{f}(\mathbf{x}) - \mathbf{c}).$$