Joint is described as an object containing a position, value, parent joint, child joint(s), and a set of triangles which transform as children of the joint with amounts designated by weights given per vertex of each triangle.

Time (t)

Initial
Position
(x_0)

Target
Position
(x)

Initial
Velocity
(v_0)

Path Estimate

$$a = \frac{2(x - x_0 - v_0 t)}{t^2}$$

Target
Acceleration
(a)

Skeleton in
bent position
$(\theta_x \forall x \in J_m)$

Unbend Phase

Model with skeleton attached ($J = \{j_0, \ldots, j_n\}$, contains at least a pelvis and both left and right hips, knees, ankles, heels, and toes)

Body Mass assigned to each limb ($\{m_0, \ldots, m_n\}$)

Target Acceleration (a)

Muscle spring constant for muscled joints ($\{k_0, \ldots, k_1 1\}$)

Rotation constraints for joints ($\theta_{min}, \theta_{max}$ $\forall j \in J_{muscled}$)

Muscled joints ($J_m = \{ j_{pelvis}, j_{Lhip}, j_{Rhip}, j_{Lknee}, j_{Rknee}, j_{Lankle}, j_{Rankle}, j_{Lheel}, j_{Rheel}, j_{Ltoe}, j_{Rtoe} \}$)

Calculate desired force $F_{target} = \sum_{j=0}^{n} m_j a$

IK Solver

Number of iterations for IK solver ($num_i tr$)

Bent skeleton reflecting $u(i)$.

$\theta_j = R\vec{D} \times R\vec{E}.$

Requires joints to be in a single chain.

Normalized vector $R\vec{E}$

Normalized vector $R\vec{D}$

Joint to move to target (E).

Target position for joint, in this case keeping E in it's original position (D).

$R = position(j)$ $\forall j \in J_{ik} \subseteq J$ starting with the root (hip joint).

PD Controller

Calculate error from desired force magnitude (E_{force})

Calculate balance error ($E_{balance}$)

$E_{all} = E_{force} + E_{balance}$

$u(i) = k_p E_{all}(i) + k_d (E_{all}(i) - E_{all}(i-1))$

$E_{all} \overset{?}{\leq} \epsilon$

Skeleton in bent position ($\theta_x \forall x \in J_m$)