Modeling Humans & Animals

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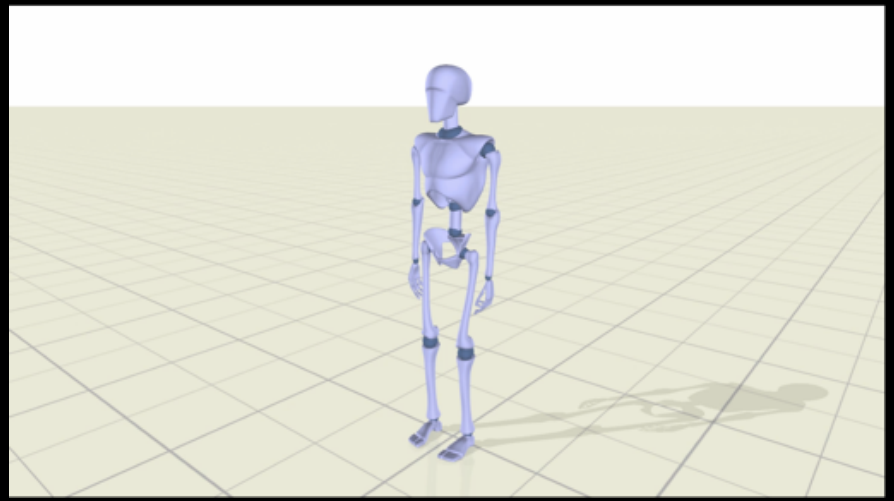
Simulation Model

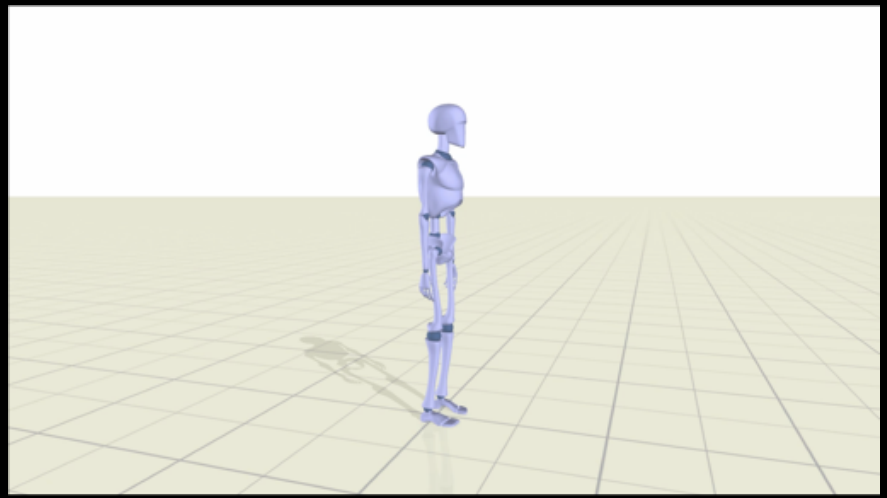
Joint Hierarchy

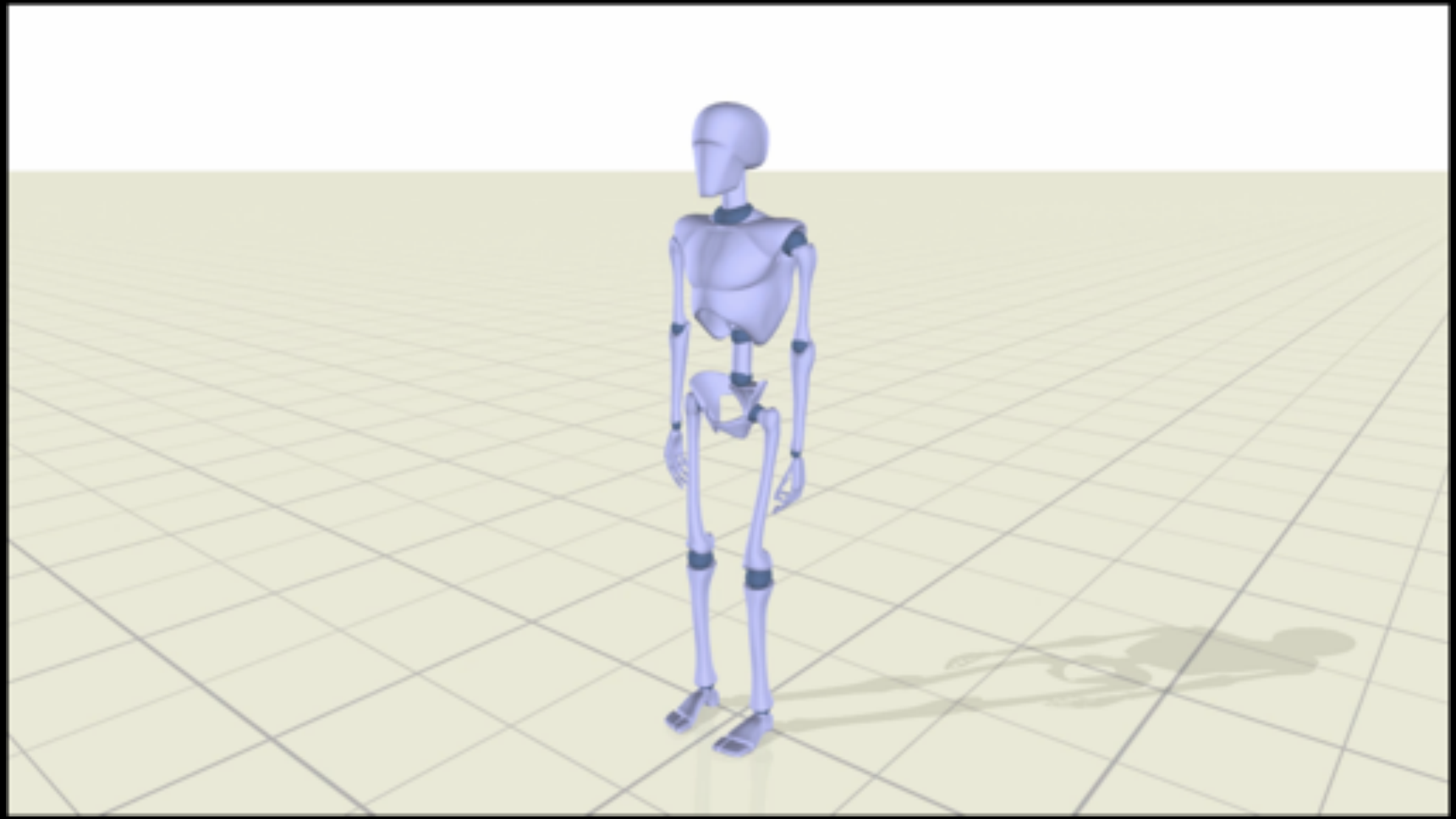
Virtual Actuators

Proxy Geometry

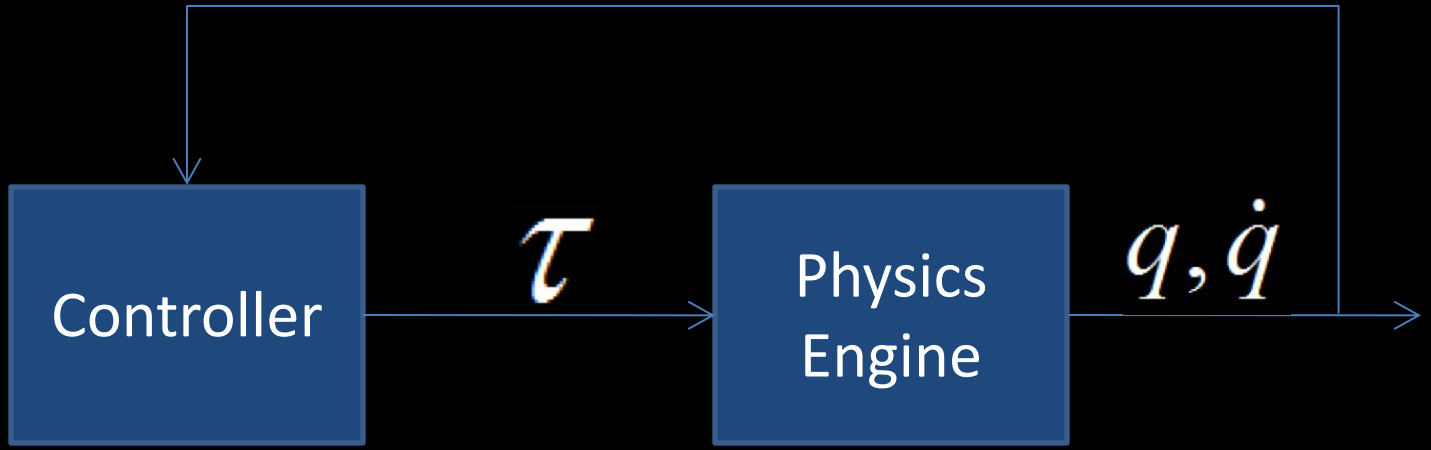
Visualization Mesh



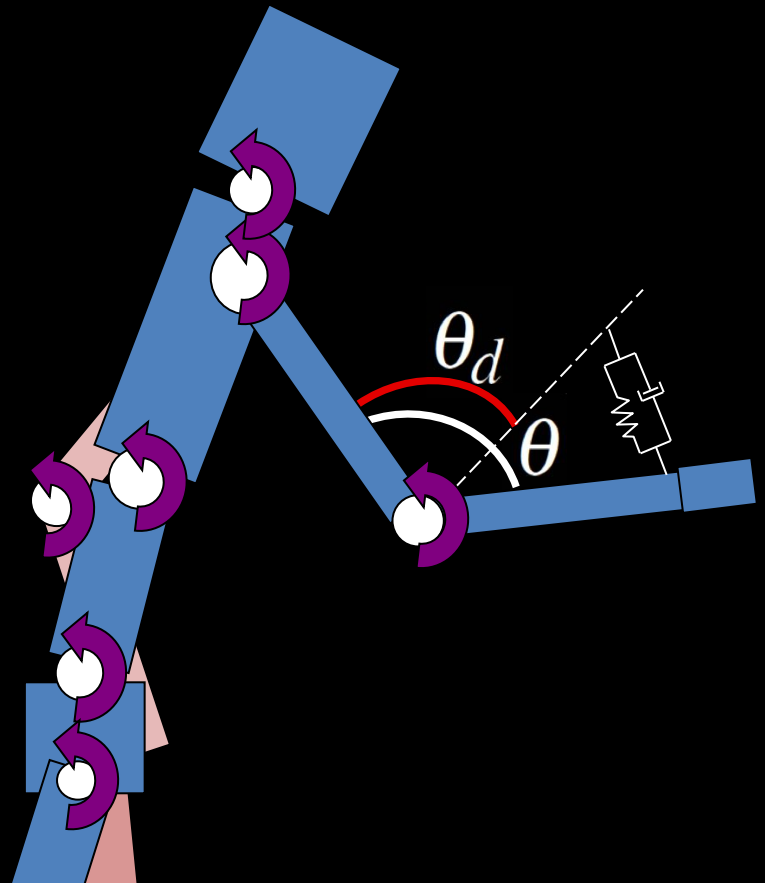


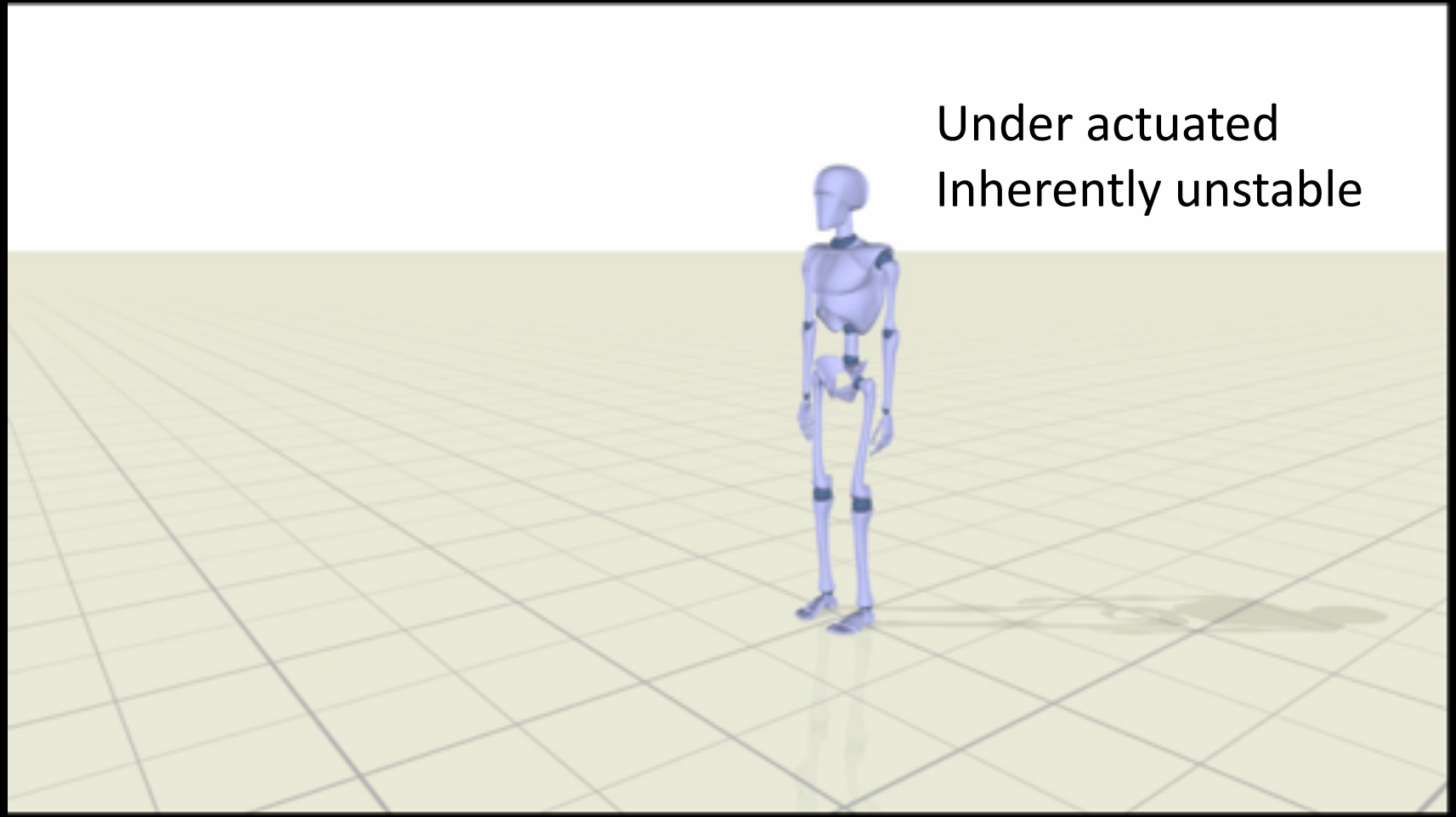


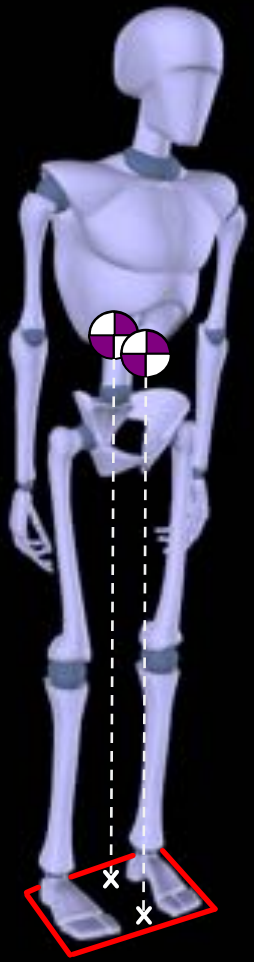
Physics-based Animation



Posture Control

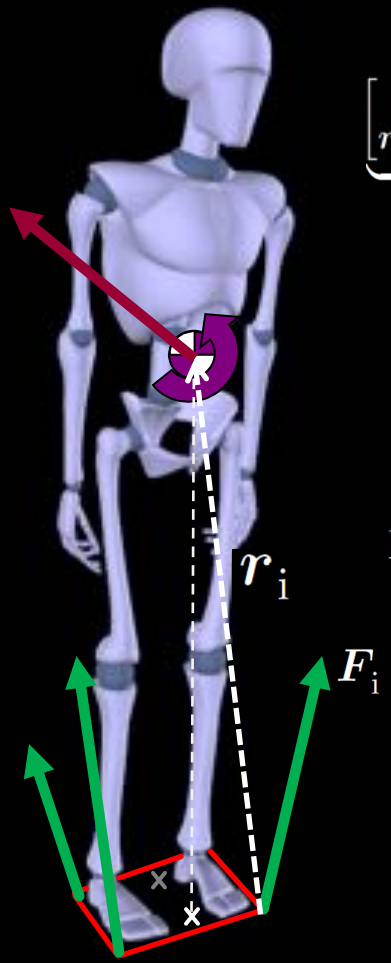



Under actuated
Inherently unstable



$$\underbrace{\begin{bmatrix} F^d \\ T^d \end{bmatrix}}_{b} = k_p(q_b^d - q_b) + k_d(\dot{q}_b^d - \dot{q}_b) + k_{ff}$$

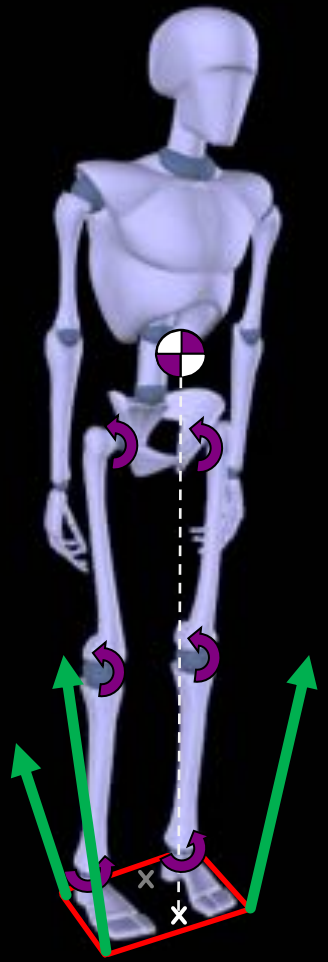
$$\underbrace{\begin{bmatrix} I & I & \cdots & I \\ r_0\times & r_1\times & \cdots & r_m\times \end{bmatrix}}_{A} \underbrace{\begin{pmatrix} F_0 \\ F_1 \\ \vdots \\ F_m \end{pmatrix}}_{x} = \begin{pmatrix} F_B \\ T_B \end{pmatrix}$$



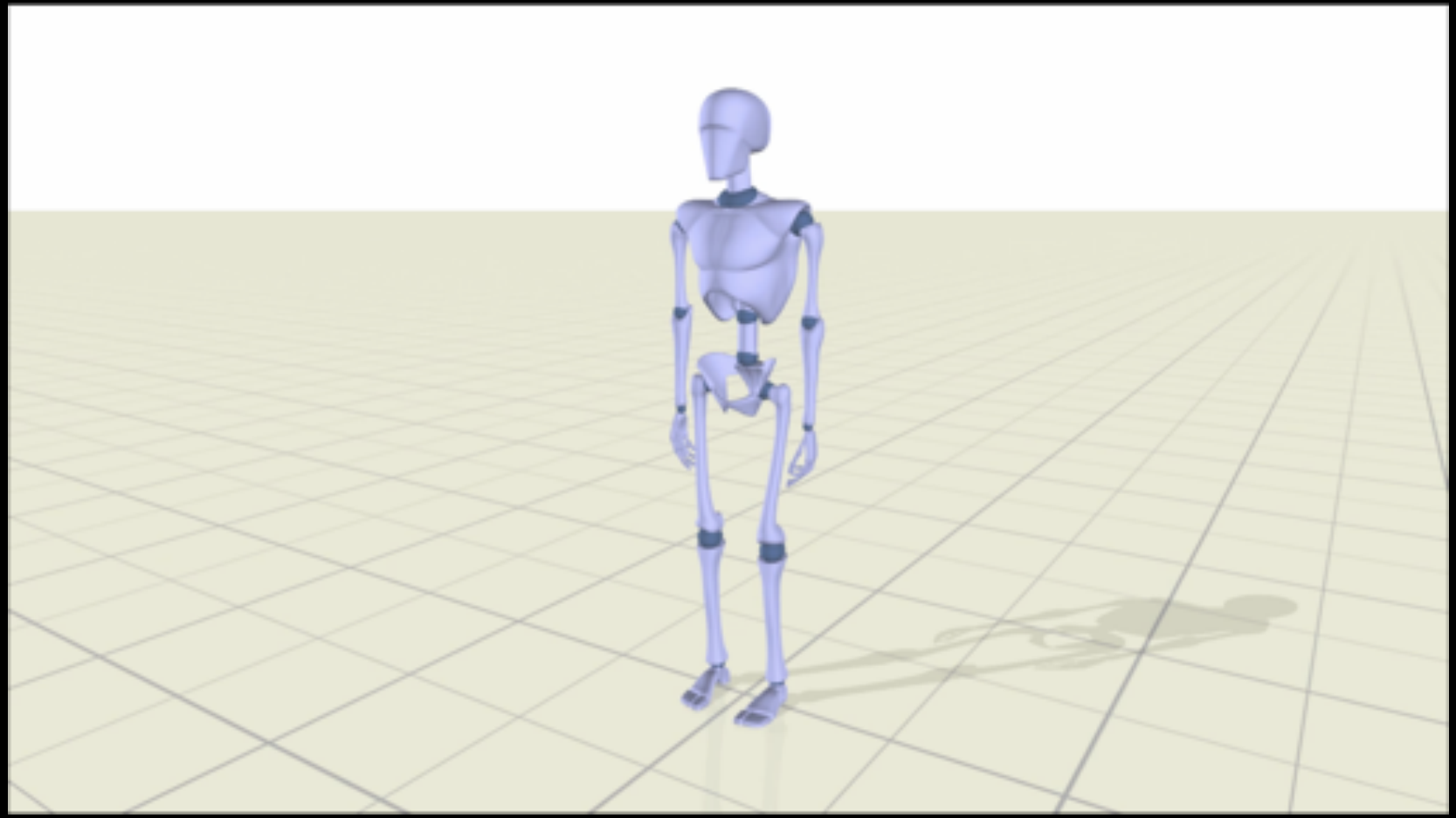
$$\min (Ax - b)^T (Ax - b)$$

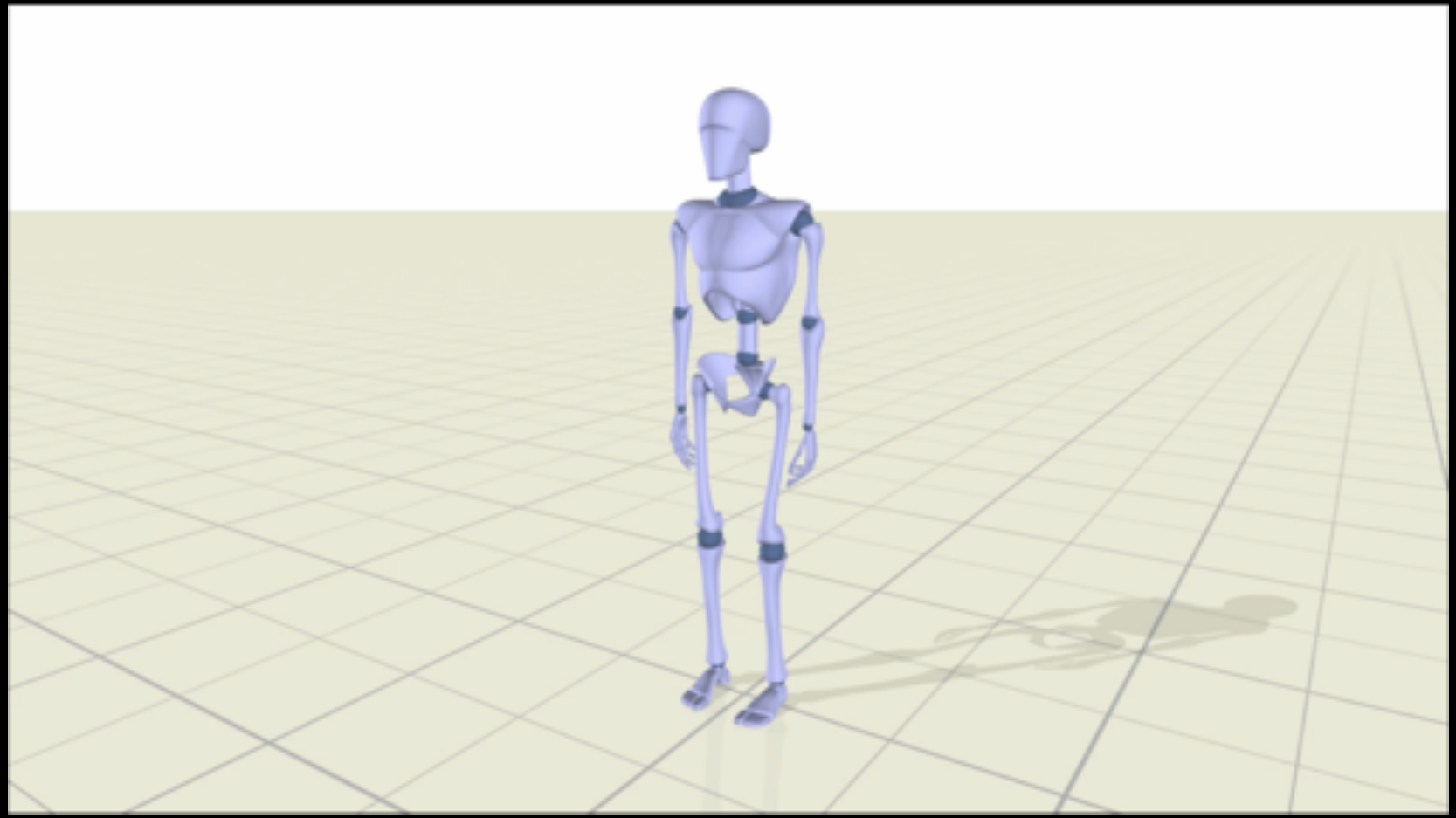
$$\text{subject to} F_i^n \geq F_{\min}^n$$

$$-\mu F_i^n \leq F_i^t \leq \mu F_i^n$$



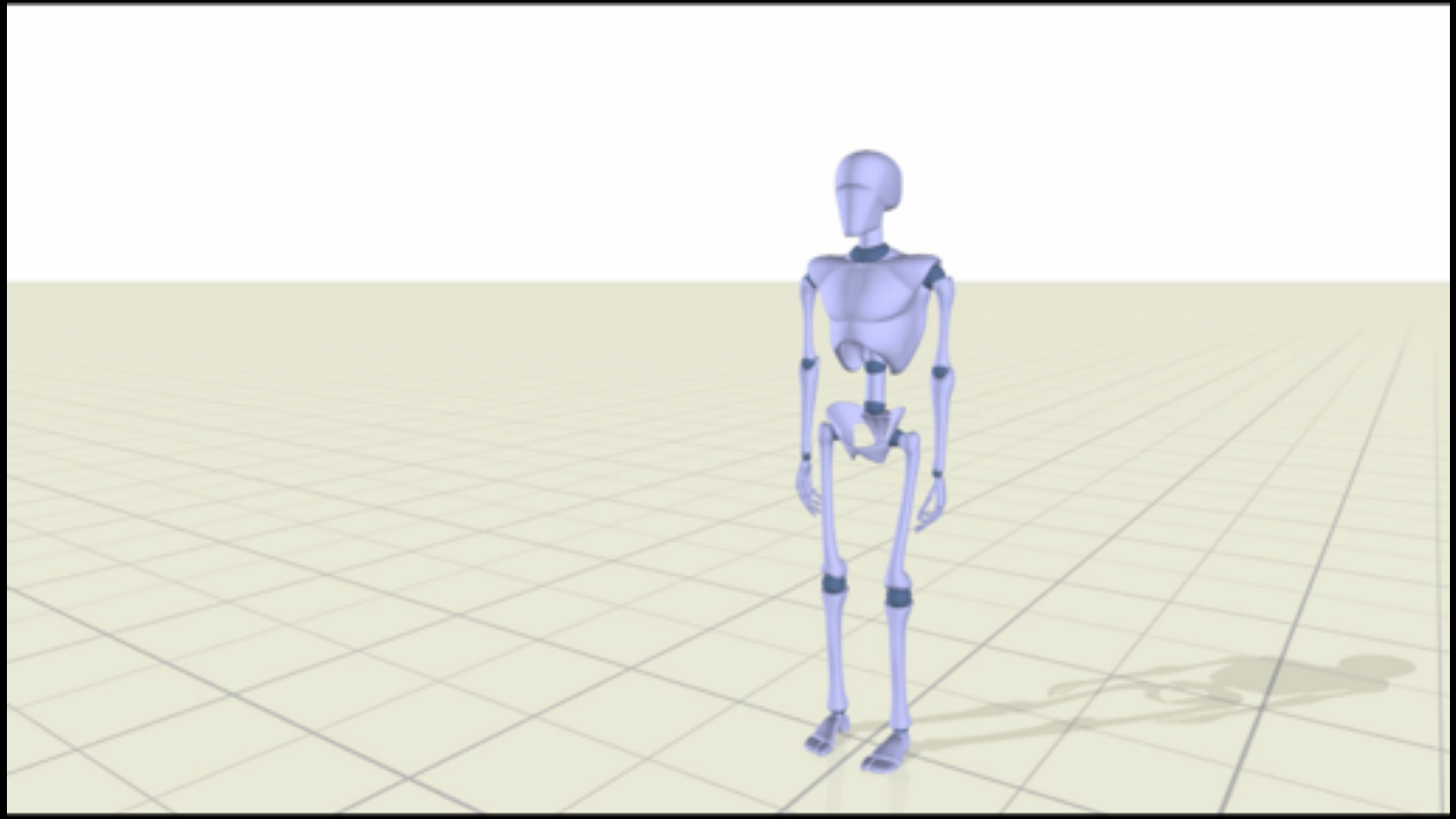
$$\boldsymbol{\tau} = J^T \boldsymbol{F}$$





Walking

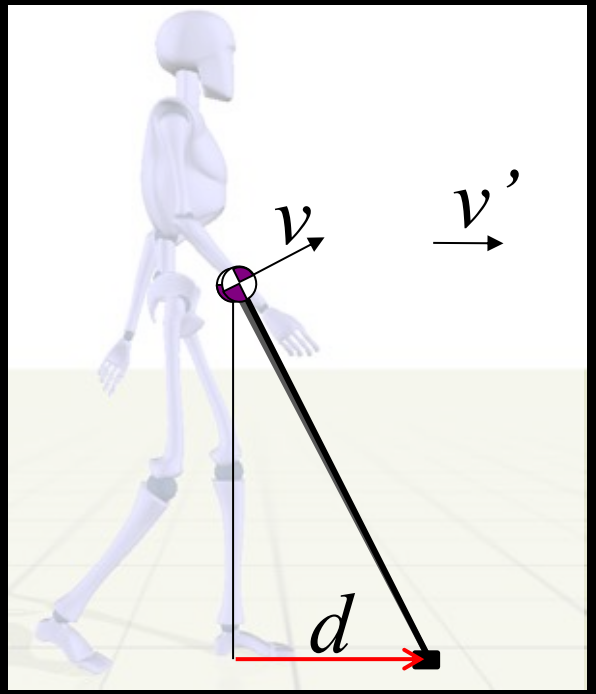
- Described temporally in terms of stride duration and its two components per leg, swing time and stance time



Walking

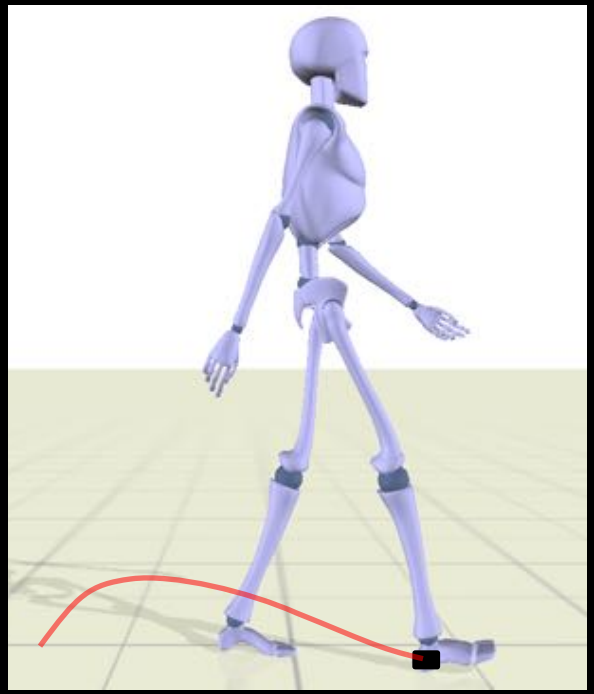
- Described temporally in terms of stride duration and its two components per leg, swing time and stance time, and spatially in terms of foot placement locations

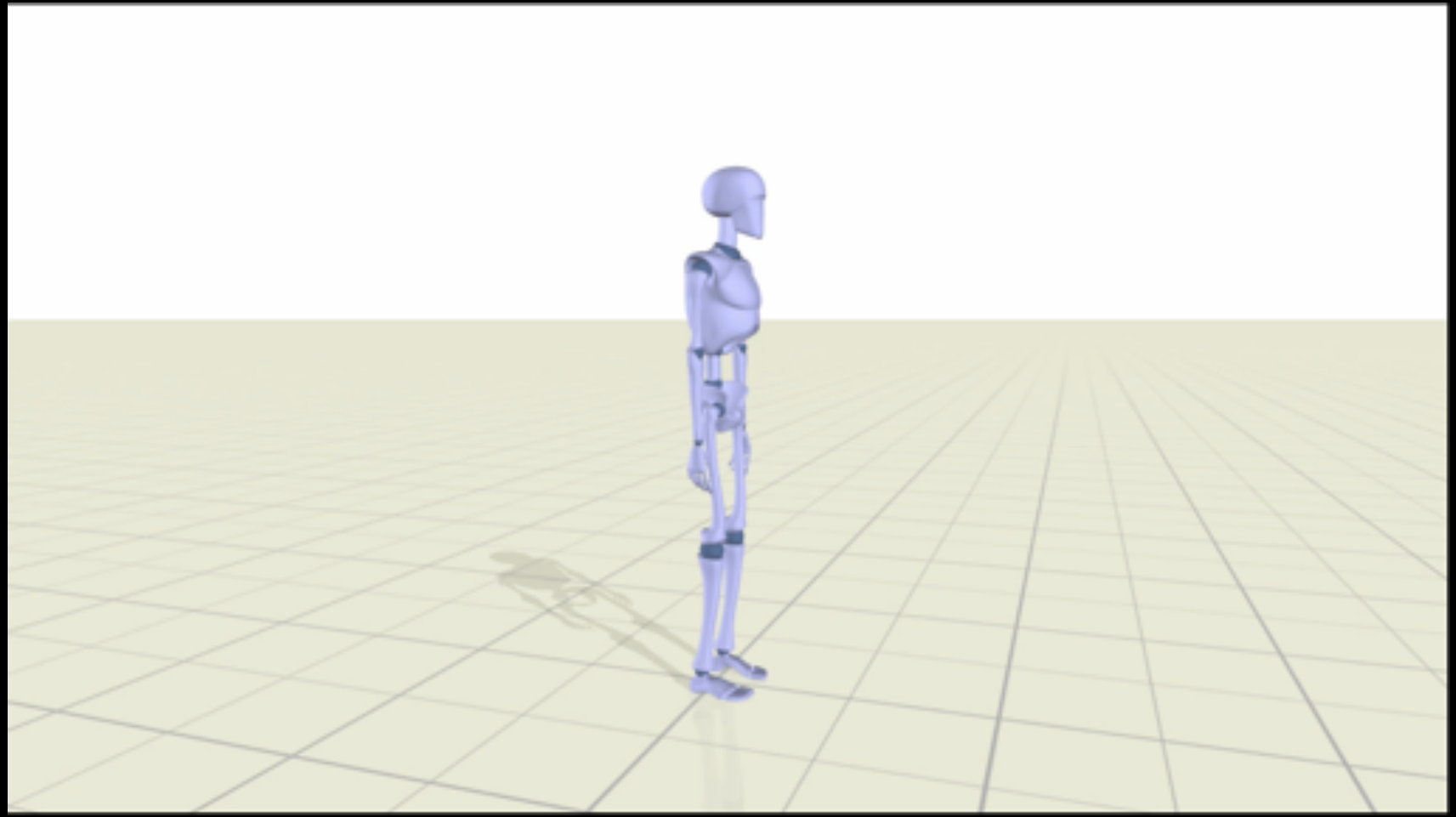
Foot Placement Control



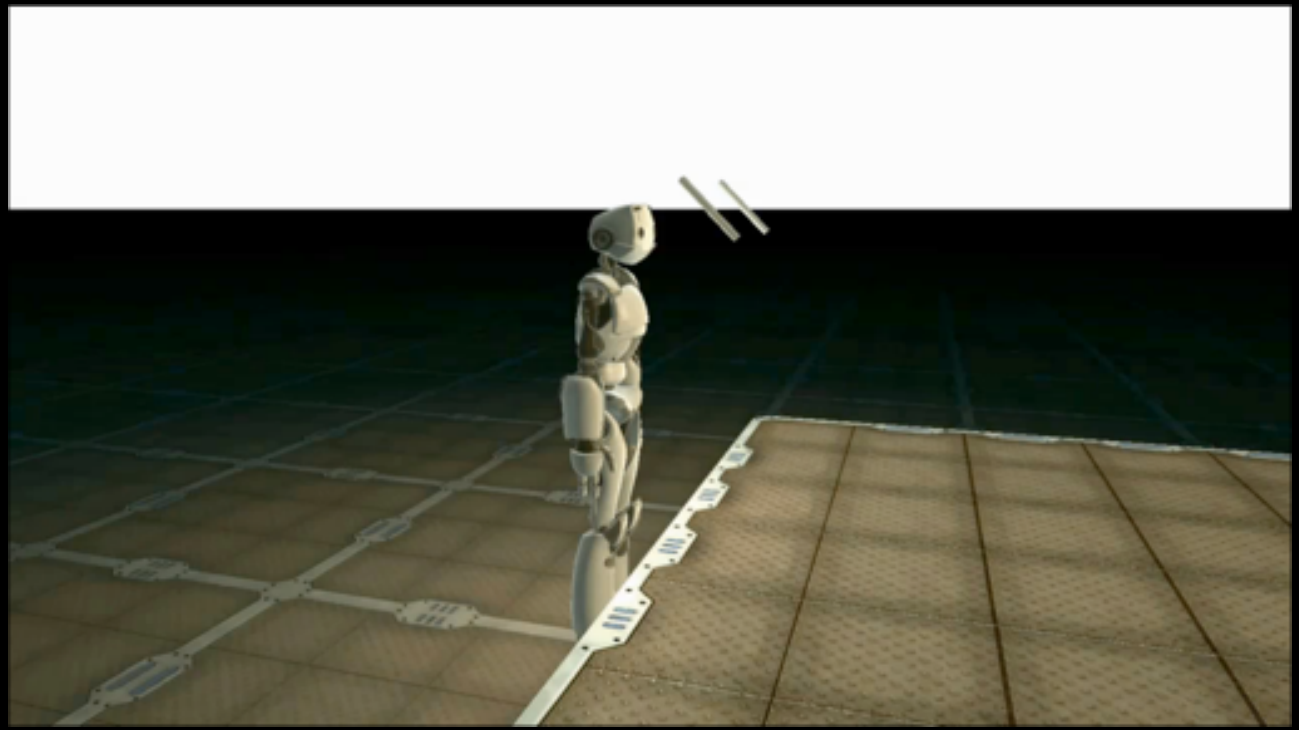
$$d = d_f(v_d) + (v - v_d)\sqrt{\frac{h}{g}}$$

Foot Placement Control





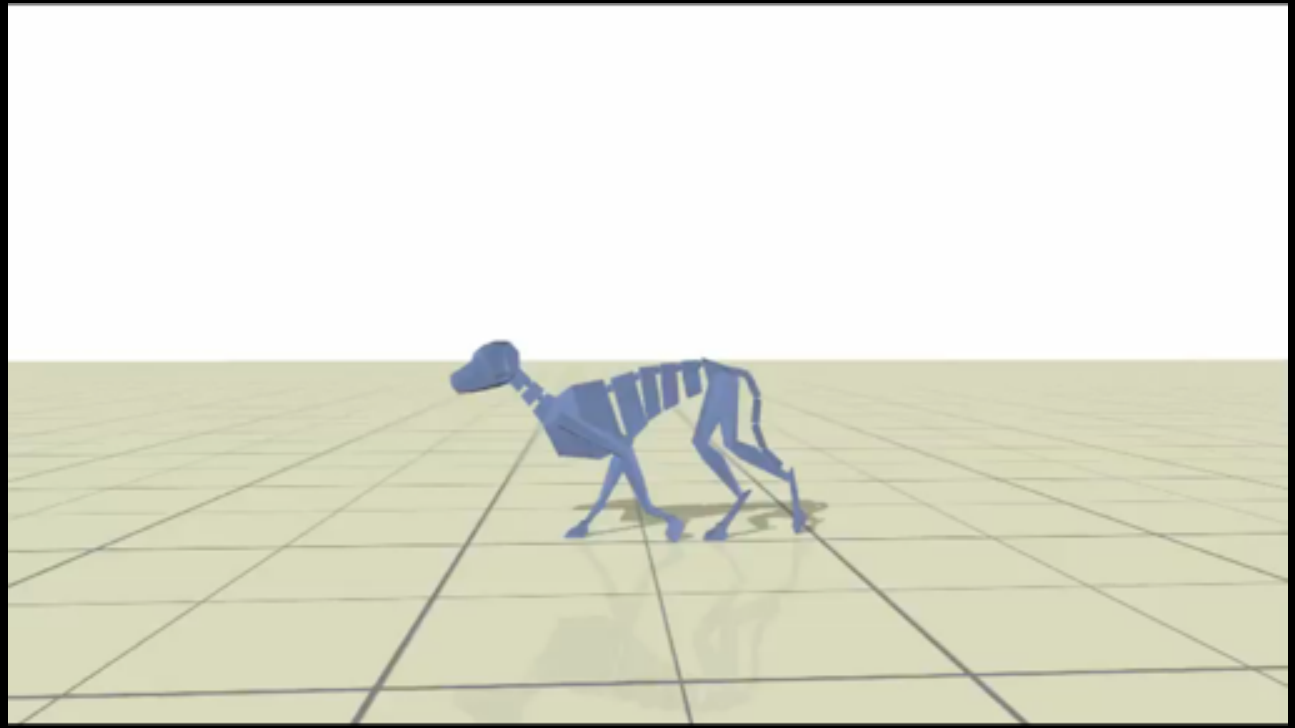
Towards Increasingly Complex Motor Skills



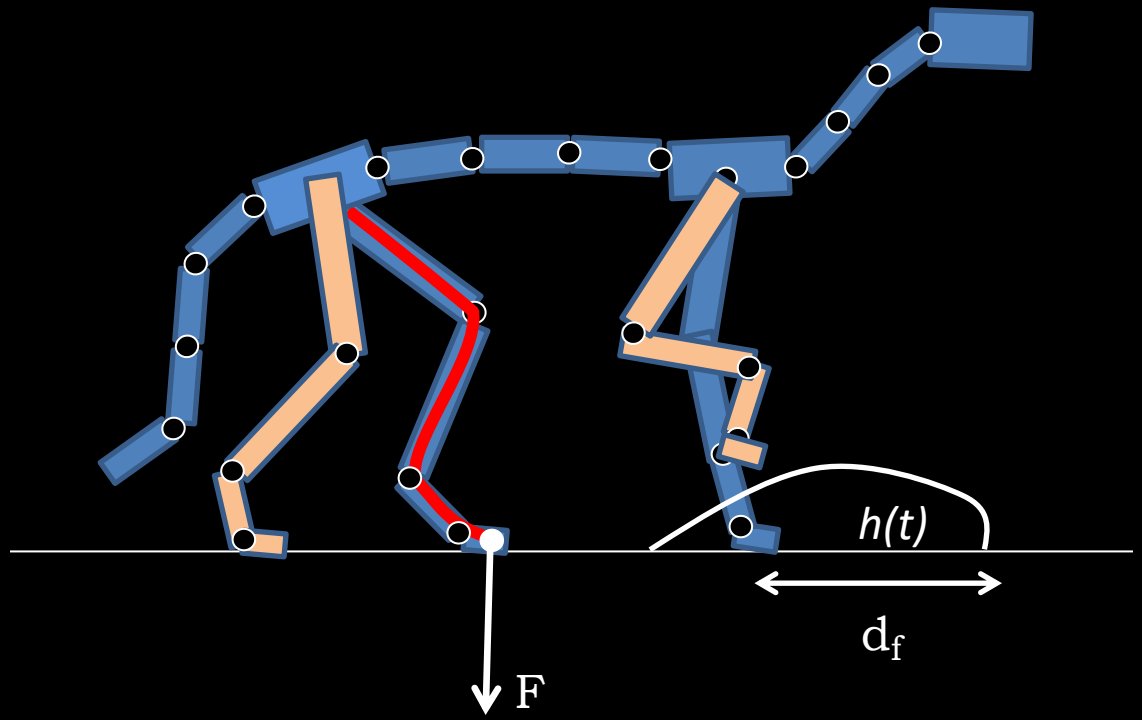
Quadrupedal Gaits

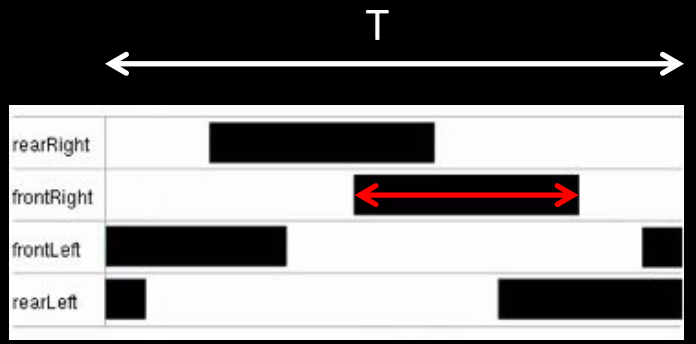
Trot

Canter

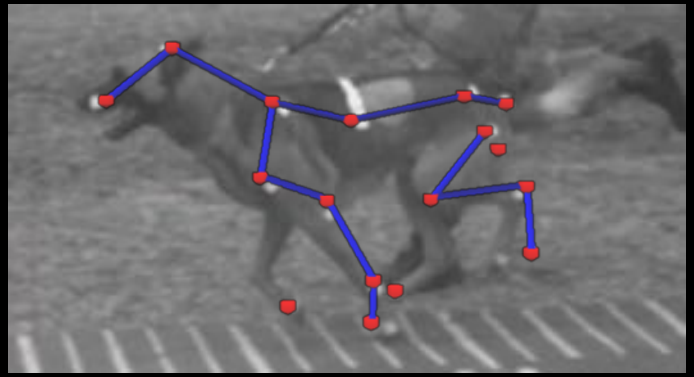


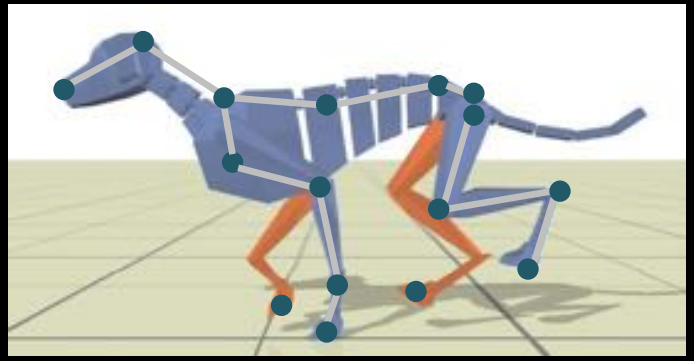
Controller Parameterization





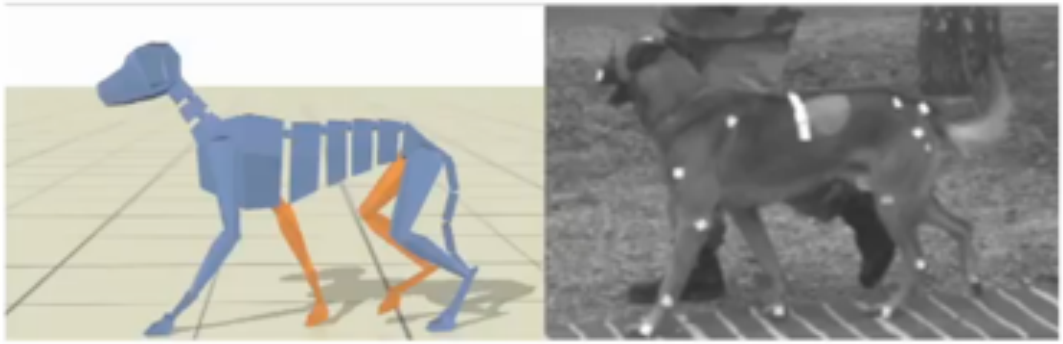
Motion Data

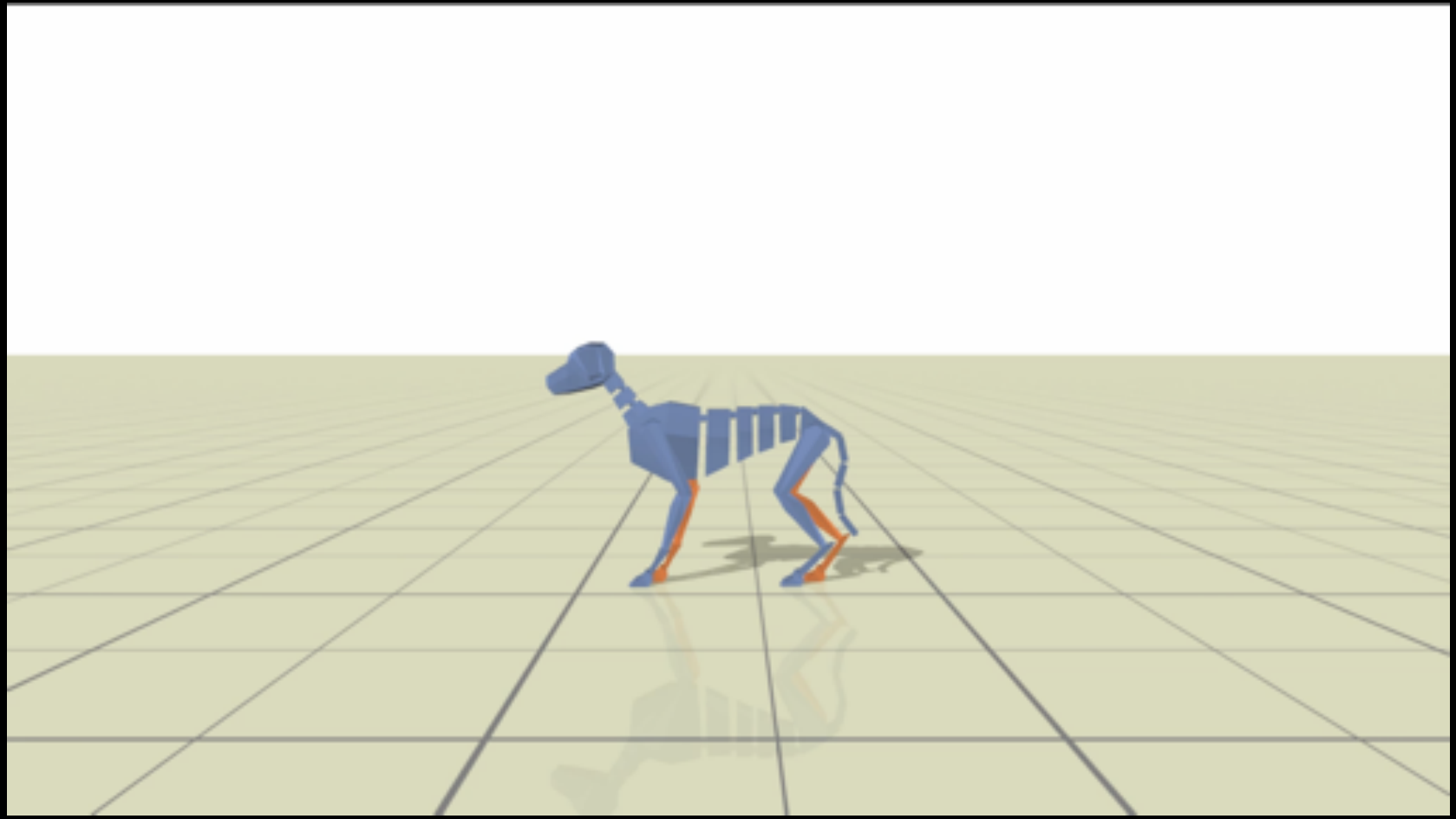




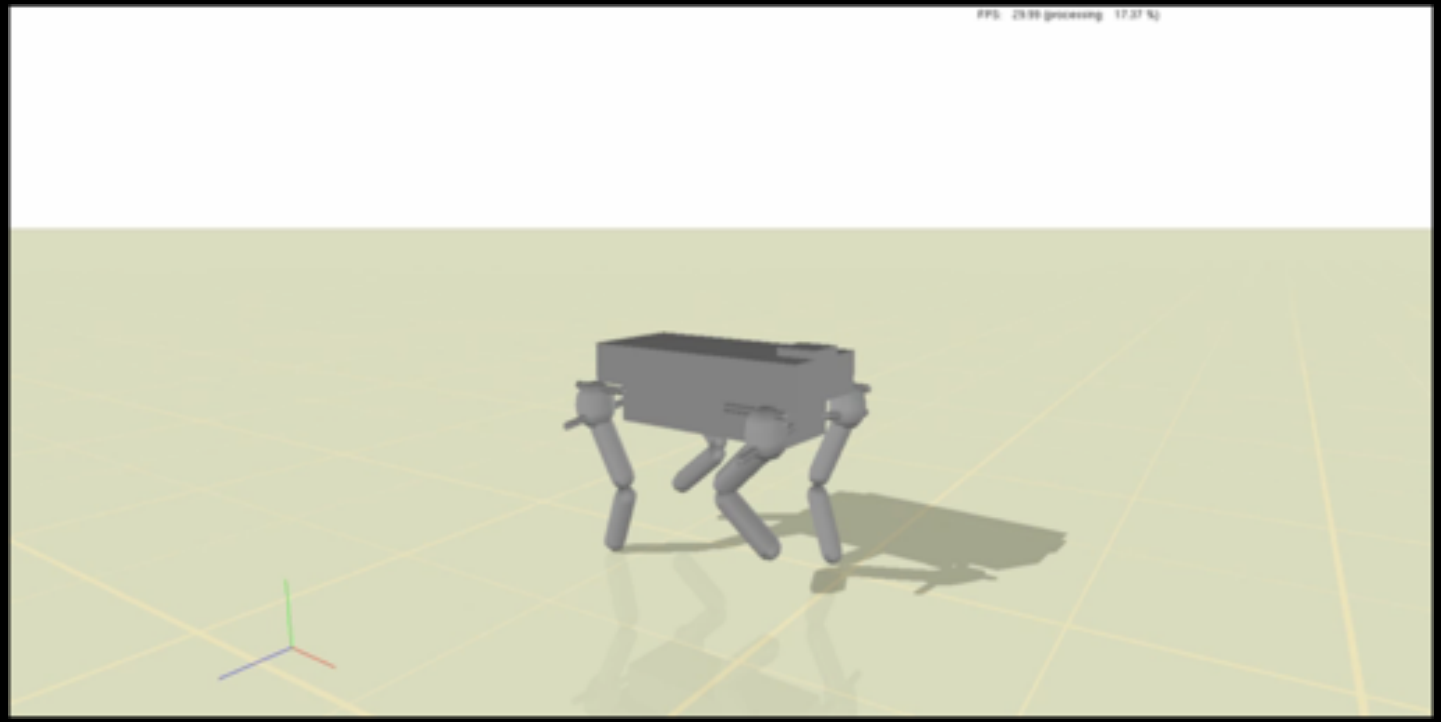
After Learning

walk





Locomotion Control for Legged Robots



Locomotion Control for Legged Robots

Towards increasingly accurate biomechanical models

Flexible Muscle-Based Locomotion for Bipedal Creatures

SIGGRAPH ASIA 2013

Thomas Geijtenbeek
Michiel van de Panne
Frank van der Stappen

Towards increasingly accurate biomechanical models

Realistic Biomechanical Simulation and Control of Human Swimming

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Questions?