Bipedal Locomotion with Nonlinear Model Predictive Control: Online Gait Generation using Whole-Body Dynamics

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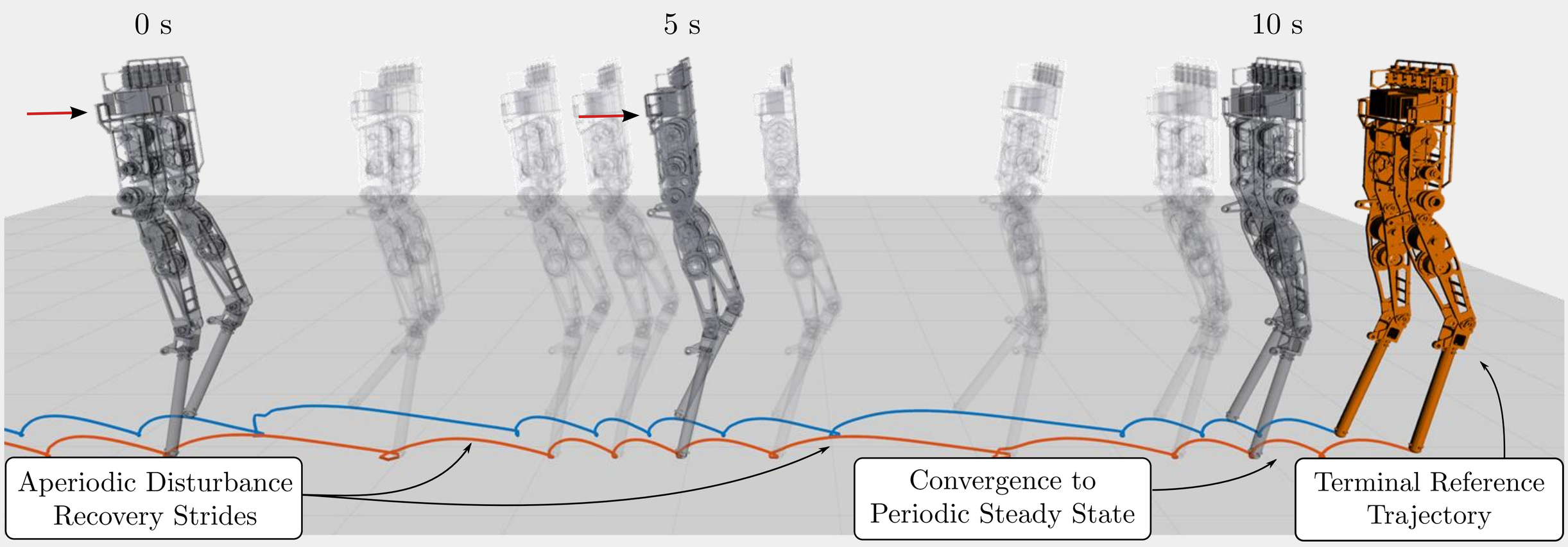
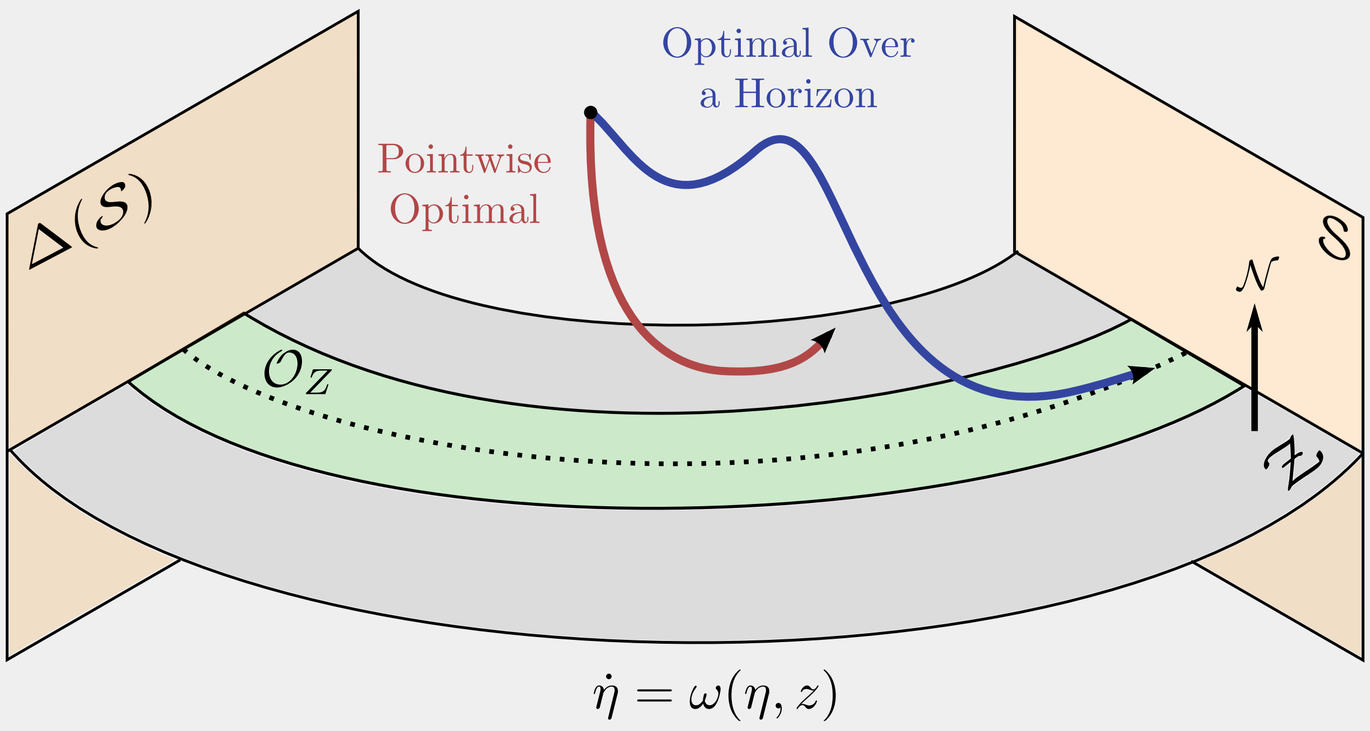
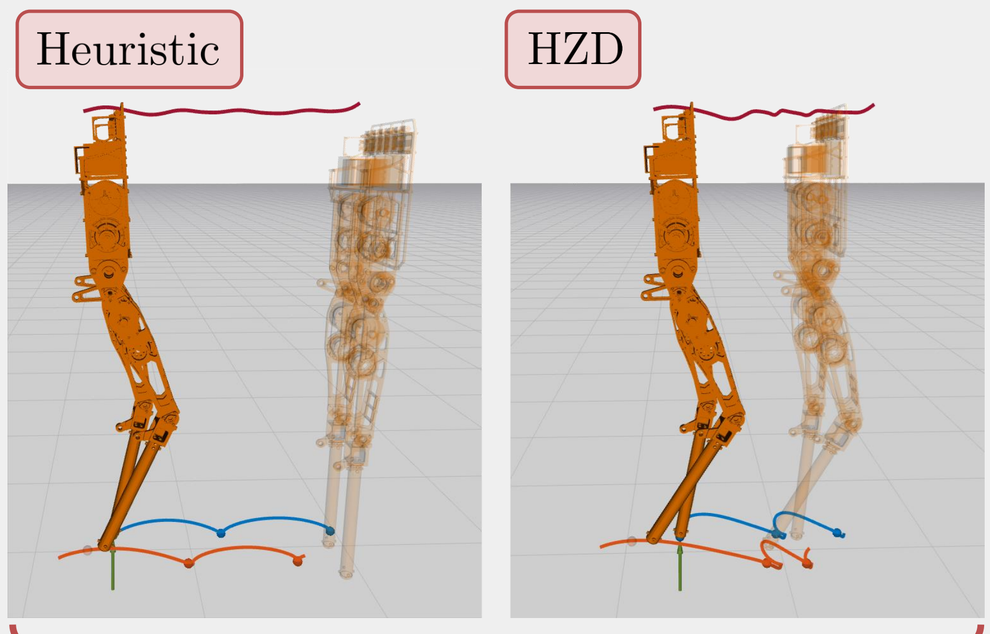
Push Recovery



Hybrid Zero Dynamics (HZD)



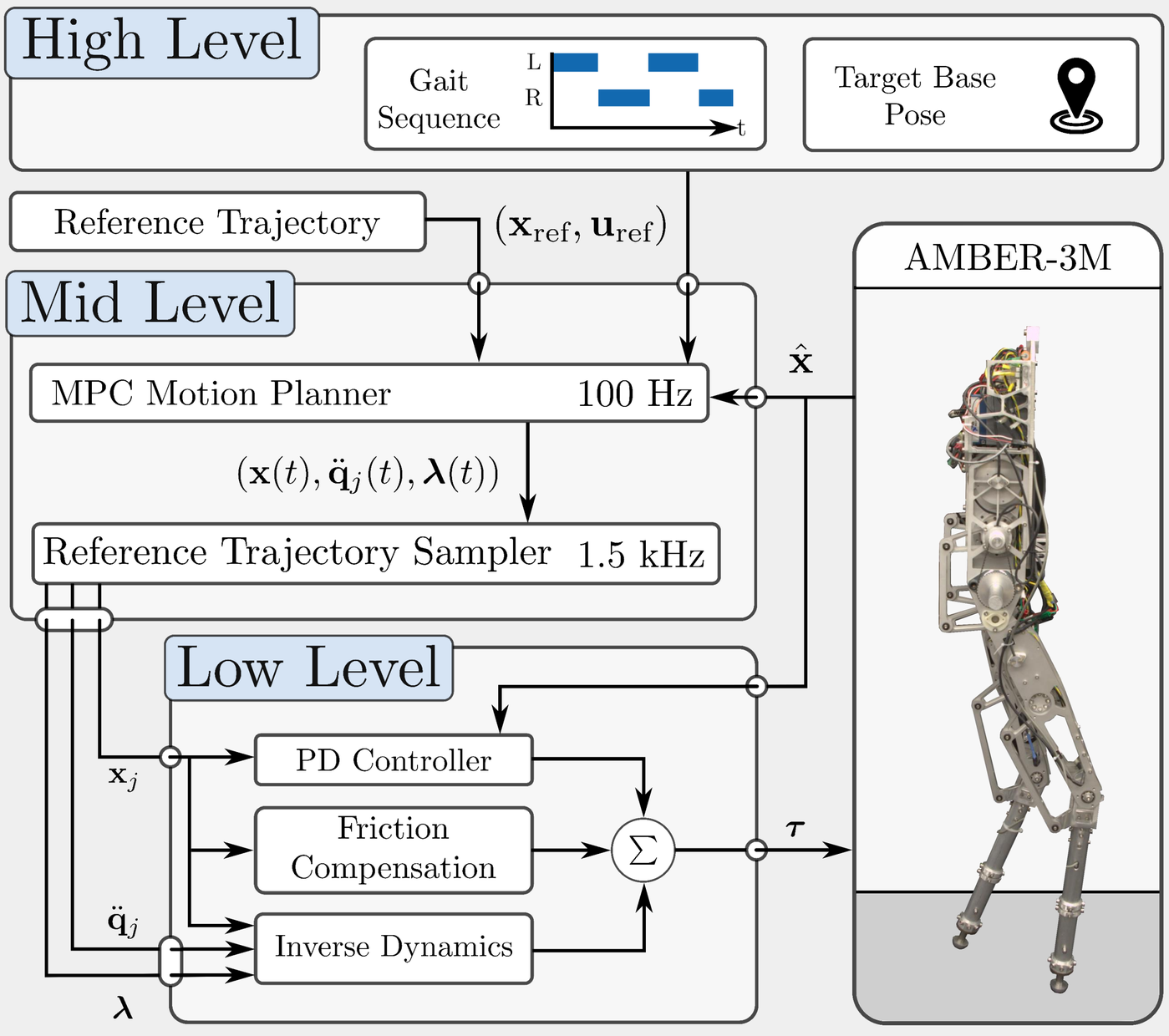
Model Predictive Control (MPC)



$$\underset{\mathbf{u}(\cdot)}{\text{minimize}} \quad \phi(\mathbf{x}(t_H)) + \int_0^{t_H} l(\mathbf{x}(t), \mathbf{u}(t), t)\mathrm{d}t,$$

$$\text{subject to:} \quad \mathbf{x}(0) = \mathbf{x}_0,$$
$$\dot{\mathbf{x}} = \mathbf{f}(x) + \mathbf{g}(x)\mathbf{u},$$
$$\mathbf{x}(t_i^+) = \Delta_c(\mathbf{x}(t_i)),$$
$$\mathbf{h}_{eq}(\mathbf{x}, \mathbf{u}, t) = \mathbf{0},$$
$$\mathbf{h}_{in}(\mathbf{x}, \mathbf{u}, t) \geq \mathbf{0},$$

Control Architecture



Performance Metrics

Table 1: Maximum Disturbance Rejection [N]

Horizon Length [s]	2	0.5	0.2
Lumped Mass MPC	2	-	-
MPC + No Terminal	22	-	-
MPC + Heuristic	22	22	-
MPC + HZD	22	22	20
HZD + PD	30		

Paper

Video

Website