Real-Time Motion Planning for Uncertain Hybrid Mechanical Systems

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Ongoing Research

human motor control, functional electrical stimulation

dynamic locomotion, legged locomotion

swarms and self-organization

bio-inspired sensing and control; electrosense

robot manipulation
Hybrid Locomotion
robot parkour
hybrid

Mechanical

\[ M(q)\ddot{q} + \dot{q}^T \Gamma(q) \dot{q} + \frac{\partial U}{\partial q}(q) = T(q)u + A_i^T(q)\lambda_i \]

\[ A_i(q)\dot{\lambda} = 0 \]

uncertain

real time
Problem Statement

Given

- an uncertain dynamic model of the robot
- a well characterized environment
- a goal expressed as constraints on the state

find

- an offline hybrid sequence and nominal motion planner considering approximate models of uncertainty propagation
- a real-time gradient-based multi-step fine-tuning planner to shape the evolving belief distribution to maximize likelihood of success
Subproblems

- optimal belief filtering
- belief derivatives with respect to control actions (using structure of hybrid mechanical equations of motion)
- hybrid mechanical local belief controllability
- equivalence of mechanical and geometric curvature
- second-order effects of bio-inspiration