Real-Time Motion Planning for Uncertain Hybrid Mechanical Systems

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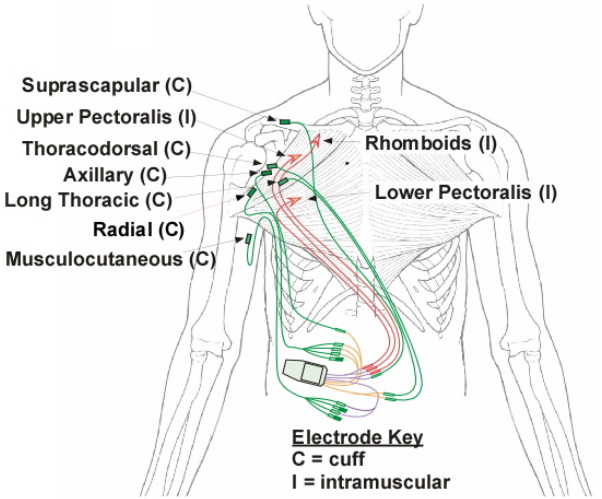
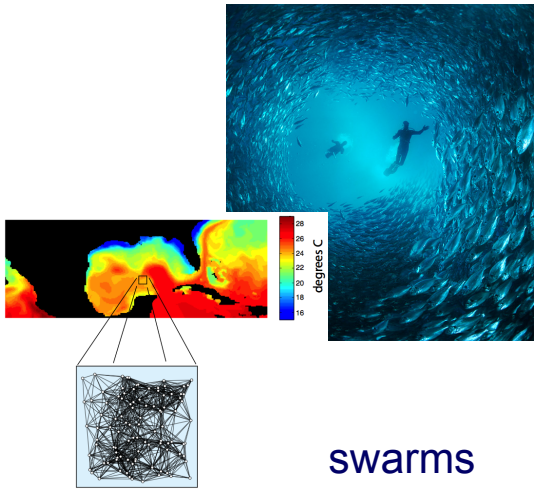
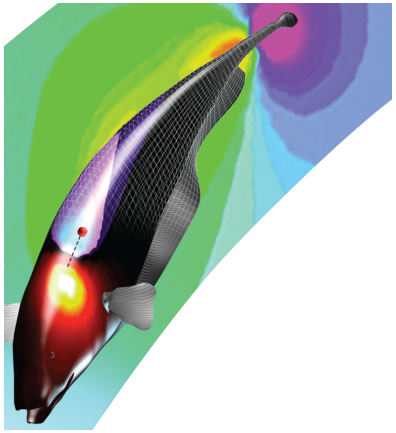
Ongoing Research



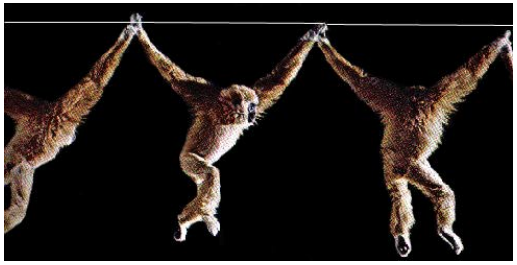
human motor control,
functional electrical stimulation



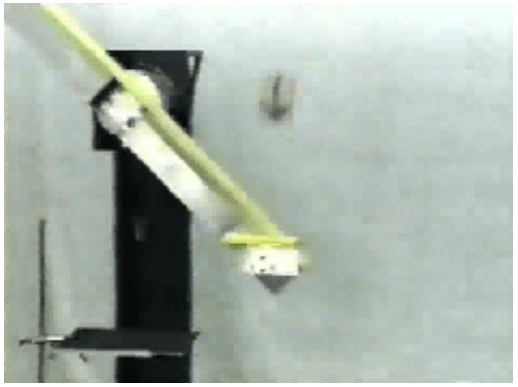
swarms
and self-organization

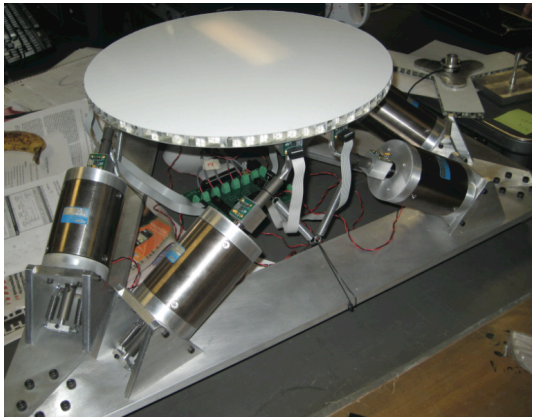


bio-inspired sensing and control;
electrosense



dynamic locomotion,
legged locomotion





robot manipulation

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Hybrid Locomotion

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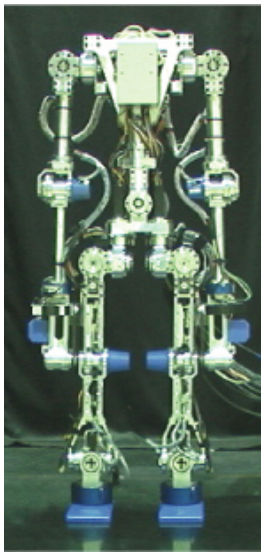

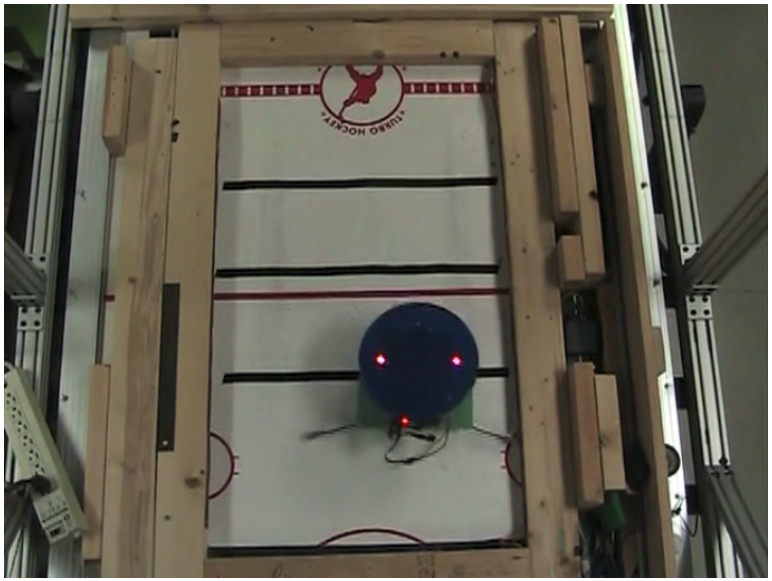

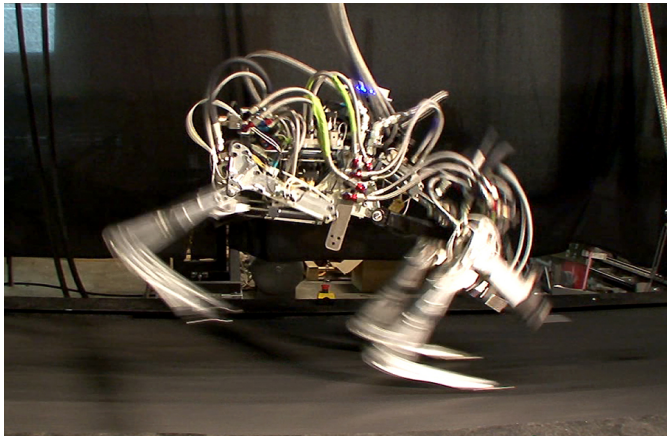

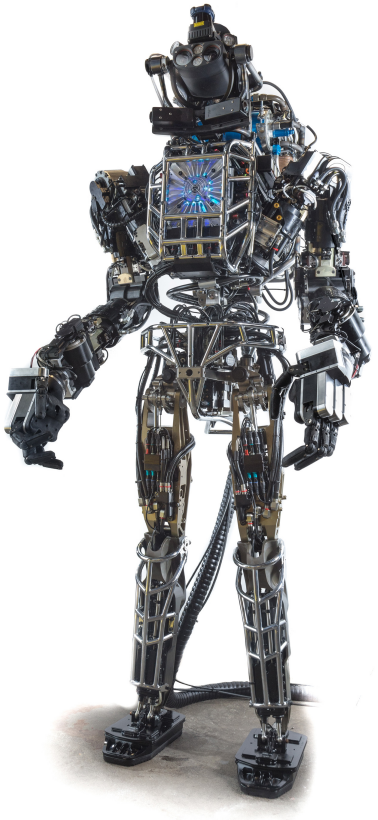

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robot parkour

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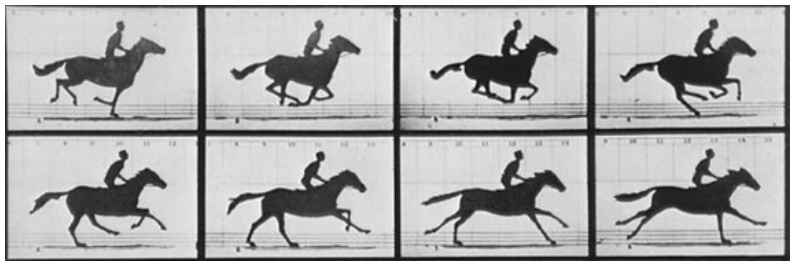
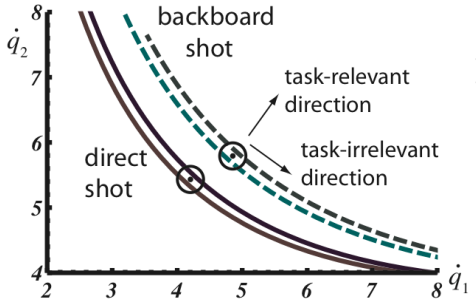
hybrid

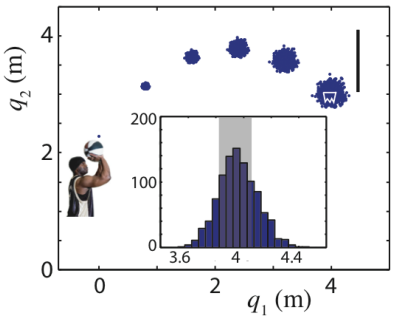


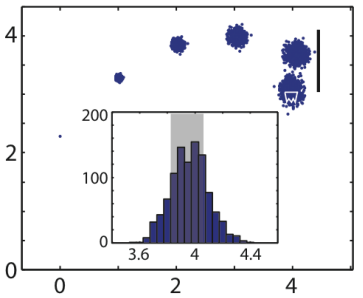
mechanical

$$M(q)\ddot{q} + \dot{q}^T\Gamma(q)\dot{q} + \frac{\partial U}{\partial q}(q) = T(q)u + A_i^T(q)\lambda_i$$
$$A_i(q)\dot{q} = 0$$

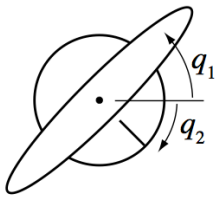
uncertain

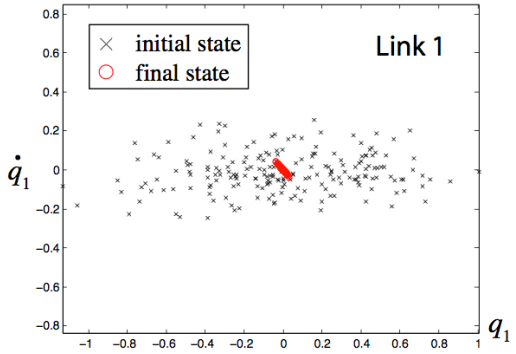


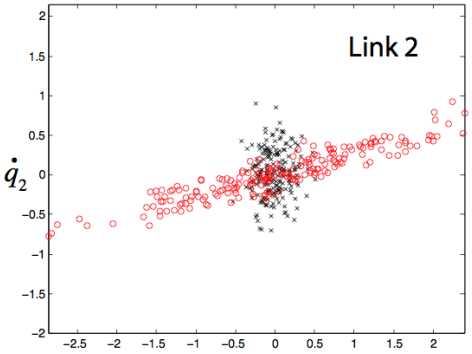




real time







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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