Graduate Student Research Seminar

Spring 2026

Physics-Informed Modeling and Control of Agile Robotic Systems

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Monday, February 23rd

3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Agile robotic systems operate in regimes characterized by rapid transitions, strong nonlinearities, and tight coupling between actuation, contacts, and constraints. Designing controllers for such systems requires models that accurately capture the underlying physics.

This work focuses on two such robotic systems, a tethered drone and a pendulum driven jumping robot. For the tethered drone system, the coupled dynamics of the aerial vehicle, tether, and ground vehicle are derived from first principles, capturing the interaction between flexible tether, and drone motion. A structure preserving simulation framework based on Lie Group Variational Integrators is developed to ensure accurate time evolution and consistency with the underlying mechanics, enabling forward simulation.

The second system is a pendulum driven jumping robot designed to achieve locomotion and maneuverability using internally actuated rotating masses. Using fundamental principles of mechanics, the system dynamics are formulated to capture the coupling between internal actuation, and contact interactions. The robot is designed, fabricated, and experimentally validated, demonstrating controlled jumping, steering, and maneuverability across different terrains.

These systems highlight the importance of physics informed modeling for complex robotic platforms where simplified models and standard simulation tools fail to capture essential dynamics. By grounding modeling and control design in fundamental physical principles , accurate predictionand reliable control can be achieved for highly constrained and nonlinearrobotic systems.

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