



MECHANICAL ENGINEERING GRADUATE STUDENT SEMINAR SERIES

Sunday, January 4, 2026, at 12:30, D. Dan and Betty Kahn Building, Room 217 and [ZOOM](#)

Towards fast learning of robotic locomotion

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Robots are a key part of our future; they will need to be able to move and work in various environments and with changing interactions with objects and environment. A big part of today's research focuses on different aspects of making robots part of our lives. One aspect is the ability of a robot to move in various terrains, on slopes, slippery terrain, and even dynamically changing terrain like sand and gravel. Our research shows a method for robots to rapidly learn their new environments using geometric mechanics concepts. A geometric mechanics analysis of robotic locomotion has provided valuable insights into how biological and robotic systems use changes in their internal shape in order to generate net movement by exploiting mechanical interaction with the environment. This perspective produced an approach for obtaining simplified data-driven models of locomotion systems directly from motion tracking data. In our research, we work with several robotic locomotion systems: a swimmer, a remote-controlled car, and multi-legged robots, interacting with a granular fluid- a regime we intentionally selected because it is hard to model. One system is the locomotion of an under-actuated robotic swimmer with passive shape degrees of freedom (DoF). We compared four modeling approaches, predicting the relation between shape changes to body velocity, both within gait and across gaits. Switching our model from a phase-dependent linear model to a manifold learning approach reduced velocity prediction error by 55% but required 6 times as much data; including the passive DoF in the models reduced prediction errors by 4%. These improvements compound, and yield overall R^2 values above 90%, demonstrating that our data-driven geometric mechanics models for locomotion systems can produce highly predictive models even where no first-principle equations of motion are known. We continue to work on and develop the method to work on other robotic locomotion systems. We are currently working on the fast-learning model of an RC car in a granular terrain in order for it to get out of a pit by applying aggressive maneuvers exploiting momentum. We plan to extend this approach, which will enable fast data-driven learning of general locomotion models across various environments.

Note: the seminar will be given in English