DEPARTMENT OF MECHANICAL ENGINEERING

SEMINAR SERIES

Learning Stability Certificates and Enforcing Safety in Robotics and Autonomous Systems

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Abstract

Reliable robotic autonomy raises two fundamental questions: From which initial conditions will a nonlinear system converge to a desired equilibrium? And how can robots operate safely without compromising their assigned tasks? In this talk, I will discuss recent work addressing these questions through learning-based stability analysis and safety-critical control. First, I will present a framework for learning neural Lyapunov functions for dynamical systems evolving on the special orthogonal group SO(n), which is particularly relevant in robotics, where rigid-body orientations evolve on SO(3). The approach combines a geometry-aware neural architecture with a Zubov-type characterization to estimate maximal regions of attraction. Next, I will discuss decentralized safety-critical control for multiple quadrotors navigating intersecting spatial paths. By integrating transverse feedback linearization with control barrier functions, we develop a framework that enforces collision avoidance while preserving path-following and heading objectives. A key feature is that safety is achieved by adjusting only the agents' speeds, without compromising adherence to their assigned paths. Together, these results illustrate how learning-based methods and nonlinear control theory can contribute to establishing stability and safety guarantees for robotic and autonomous systems.

Speaker Bio

Adeel Akhtar is an Assistant Professor in the Department of Mechanical and Industrial Engineering at the New Jersey Institute of Technology (NJIT), where he directs the Geometry, Robotics, and Dynamical Systems (GRaDS) Lab. He received his Ph.D. in Mechanical and Mechatronics Engineering from the University of Waterloo, Canada. Before joining NJIT, he held postdoctoral research positions at the University of Toronto and the University of California, Santa Cruz. His research interests lie at the intersection of nonlinear and geometric control, hybrid dynamical systems, optimization, learning-based control, and stochastic optimal control, with applications to robotics and autonomous systems. His Ph.D. student received the 2026 Best Student Paper Award at the IEEE Conference on Control Technology and Applications (CCTA) for their joint research on trajectory tracking of unicycle robots with singularity avoidance.

Date: Thursday, November 5, 2026 **Time: 2:00 PM**
Location: Steinman 254 **Host: Bo Wang**

Attendance open to all interested persons

The City College of New York

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