Department of Mechanical Engineering Seminar

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Robust Control of Heterogeneous Underactuated Vehicle Networks in Uncertain Environments

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ABSTRACT

Heterogeneous networks are multi-agent systems that contain different dynamical models. A multi-vehicle system usually contains different types of vehicles that may possess different parameters and dynamics. For instance, a combination of ground, marine, and aerial vehicles can be used for military operations to increase the striking force from multiple sources. Nevertheless, efforts to develop cooperative control approaches applicable to *heterogeneous* multi-vehicle systems have been limited. Moreover, *nonholonomicity* and *underactuation* are two main obstacles in the control design for multi-vehicle systems. The problem of cooperative control of underactuated networks is far more complicated than control of fully-actuated networks.

This talk is devoted to introducing several distributed control approaches that are applicable to multi-vehicle systems. We shall present the following problems for *heterogeneous underactuated* and *nonholonomic* multi-vehicle systems:

1) *Robust formation control*. By exploiting the structural properties of the planar vehicle model, a robust formation control framework is proposed for planar underactuated vehicle networks.
2) *Formation stabilization and tracking control*. A time-varying control strategy is presented to solve the simultaneous formation stabilization and tracking control problem for planar vehicles based on persistency of excitation.
3) *Source seeking control*. We propose a source seeking scheme for generic force-controlled underactuated vehicles by surge force tuning. The controller requires only real-time measurements of the source signal and ensures practical stability with respect to the linear motion coordinates for the closed-loop system.

In addition to the above theoretical analysis and control designs, we also apply these theoretical tools to real vehicle systems, including nonholonomic mobile robots, underactuated surface vessels, and quadcopters, to validate our control algorithms.

BIO

Bo Wang is an Assistant Professor of Mechanical Engineering at the City College of New York. He received the Master of Science (MSc.) degree in Control Theory and Engineering from the University of Chinese Academy of Sciences, China, in 2018, and the Ph.D. degree in Mechanical Engineering from Villanova University in 2022. After receiving his Ph.D., he was a postdoctoral fellow at the University of Illinois Urbana-Champaign. His research interests include nonlinear control theory (robust, adaptive, and passive), underactuated systems, nonholonomic systems, geometric control theory, networked control systems, extremum seeking control, learning-based control, and robotics.