STEVENS INSTITUTE OF TECHNOLOGY
DEPARTMENT OF MECHANICAL ENGINEERING

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A Framework for Designing Robot Ensemble Behaviors

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The ubiquity of inexpensive embedded processor, sensor, and actuator technology in the last twenty years has spurred the demand for teams of robots in various application domains. Multi-agent robotic systems are poised to play an integral part in the next generation of manufacturing technology, urban transportation systems, and agricultural technology. Despite recent advances in the fields of distributed control, optimization, and algorithm design, the execution of complex tasks by a robot ensemble still poses significant challenges. In this talk, I will present a chemical reaction network inspired approach to the modeling and analysis and eventual design of robotic ensemble behaviors. Chemical reaction network theory (CRNT) has been used by chemists and chemical engineers to describe the population dynamics of the various chemical species mixed within a reactor vessel. At the microscopic level, these processes, dictated by the laws of thermodynamics, are stochastic, similar to a collection of robots interacting in a dynamic environment subject to sensing and actuation noise. At the macroscopic level, CRNT allows us to describe the ensemble dynamics as a set of ordinary differential equations (ODEs) derived from simple mass-action kinetic principles. I will show how CRNT can be used to model the assignment of an ensemble of robots to a collection of tasks and to predict the average behavior of a robot ensemble. Furthermore, I will show how we can extend these macroscopic models to account for various microscopic effects such as task execution times.

Ani Hsieh is currently an Assistant Professor in the Mechanical Engineering & Mechanics Department at Drexel University. She received a B.S. in Engineering and B.A. in Economics from Swarthmore College in 1999 and her PhD in Mechanical Engineering from the University of Pennsylvania in 2007. Her work in the Scalable Autonomous System Laboratory at Drexel University focuses on fundamental research in robotics, specifically cooperative and decentralized control and automation. Her research interests include coordination and control strategies for robotic swarms, motion planning for large robot teams, and distributed control systems.

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