# Robustness in the Presence of Task Differentiation in Robot Ensembles

T. William Mather and M. Ani Hsieh
Drexel University, Mechanical Engineering & Mechanics

Abstract

In the last ten years, there has been significant interest in applying a swarming paradigm towards the control and coordination of large teams of robots where individual robots are programmed with simple behaviors that can be realized with limited on-board computational, communication, and sensing resources. Despite some success, most swarming strategies have been limited to the motion coordination and/or consensus forming domain focused on teams of homogeneous robots. While these works lend themselves to sophisticated analysis, the analysis often ignore the practical effects due to robots operating within a complex and dynamic environment. The deployment of a team of robots to complex tasks inevitably leads to small numbers of locally-interacting robots. The presence of these smaller scales motivates the need for multi-robot-style techniques that remain amenable to whole-team analysis.

In this talk, we present an ensemble framework for the synthesis of distributed control and communication strategies for the dynamic allocation of a team of robots to a set of tasks. Our approach uses a class of stochastic hybrid systems to represent the robot ensemble dynamics that can be modeled as continuous-time Markov jump process. Using this framework, we show how team-level analysis can be used to analyze the trade-offs between performance and robustness in the presence of task differentiation. This gives us the ability to design and optimize individual robot control policies to ensure overall system robustness given some likelihood of resource failures.