

Mechanical Engineering Doctoral Defense

Swarm Robotic Consensus Strategies for Multi-Target Tracking And Feature Reconstruction

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Abstract

Technological milestones in the fields of sensing, design, fabrication and availability of open-source software frameworks like ROS have made the development of applications in swarm robotics from mere toy problems to reality. However, several challenges that need to be met. Swarms of robots have been used in various applications such as surveillance, precision agriculture, search and rescue, mining. All these applications will need controllers and system architectures to scale. One of the approach to accommodate this paradigm is to do design control and navigation frameworks that follow stochastic policies. Such stochastic framework can be designed to be identity agnostic and attribute similar computation, sensing, mobility and communication capability. A swarm of such robots can be designed to navigate the environment by only using the information available at the current location for deciding future possible locations that can be navigated by or reached by the swarm in the next instant.

This dissertation provides novel approaches for agreement or consensus in swarms.

Each swarm robot navigates the environment according to the time homogeneous transition probabilities associated with Discrete-Time-Discrete-State (DTDS) Markov random walk. This navigation framework assumes the environment is bounded, empty and any obstacles that can hinder the motion of the robots are absent. This dissertation extends the research in connected, dynamic and random networks for multi-robot consensus and generalizes it to swarms that reach consensus under a Markovian switching framework in a discrete time and discrete space domain. We show the applicability of such a swarm consensus strategy for detecting single, multiple static targets that represent the features in the environment. Additionally, we also propose an occupancy grid based distributed mapping strategy using a decentralized fusion algorithm. The proposed consensus approaches are validated numerically and in 3D robot simulations using a multi-robot testbed designed with simulated quadrotors in Gazebo. The scalability of the proposed approaches is examined through extensive numerical studies against the changes in robot population and the environment size.



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Zoom Link: <https://asu.zoom.us/j/86598148915>