RBE Colloquium Series Presents

Joshua Mangelson

Robotics in the Real World: Developing Reliable Field-Robotic Systems via Mathematical Guarantees and In-Field Testing

Abstract: In manufacturing, teams of robotics systems, working in coordination with one another, have led to dramatic increases in safety, efficiency, and profit. Collaborative teams of robotic vehicles working together in unstructured environments have the potential to yield similar gains in a variety of application areas including automatic inspection of underwater structures. However, autonomous collaboration in real-world environments is significantly more difficult than in the factory. The main reason for this is because in an unstructured environment, fundamental information such as the position of the robotic agent, its relationship to other agents, and a model of the robot's surroundings all have to be estimated by the robotic vehicle online, while their estimation can be simplified or engineered out of the problem in a structured one. In addition, in unstructured environments, failure of a navigation or perception algorithm that estimates the above quantities can result in significant damage or the loss of a vehicle. As such, the design of reliable, real-world, multi-agent systems requires the development of navigation and perception solutions that consistently return valid results.

In this talk, we propose two methods that bring us closer to consistent multi-agent autonomous inspection. The first is a method for handling outlier measurements when merging maps generated by two agents collaboratively inspecting a structure. The proposed method uses graph theory to enforce that the selected set of measurements are consistent with one another resulting in more consistent maps than existing methods. The second is a way of formulating the simultaneous localization and mapping (SLAM) problem as a convex polynomial optimization problem. This enables us to guarantee that the trajectory estimated by the robotic vehicle is the true solution to the posed optimization problem. We conclude with a discussion of "reliable autonomy" by describing a set of additional problems that need to be solved to enable reliable, large-scale, fully-autonomous, multi-agent inspection of underwater structures.

Bio: Joshua Mangelson is a Ph.D. Candidate in Robotics at the University of Michigan. His interests lie in the development of navigation, mapping, and perception algorithms that enable the design of reliable field robotic systems that can operate consistently in unstructured environments. He is especially interested in the development of large-scale multi-agent teams for autonomous inspection of underwater structures. He is the recipient of the IEEE ICRA Best Multi-Robot Paper Award and the IEEE OCEANS Best Poster Award both in 2018.

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Foisie 203