IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Collaborative Robotic Autonomy with Bayesians in the Loop

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Seminar host: Soumik Sarkar

Abstract

Modern robotics has made the inevitable leap toward autonomy. From applications as diverse as wilderness search and rescue, military surveillance, and space exploration, there is an intense drive to develop intelligent software to match and exceed human decision-making and sense-making for complex task execution. More than just replacing humans for "dull, dirty and dangerous" work, autonomous robots are expected to cope with a whole host of uncertainties, particularly when working in concert with human counterparts in new or unexplored situations. The recent revolution of autonomous reasoning in robotics firmly established the primacy of Bayesian methods for tackling challenging robotic perception, learning and decision-making problems. The next generation of Bayesian reasoning algorithms must not only explicitly capitalize on opportunities for exploiting human interaction to achieve their goals, but also opportunistically leverage the capabilities of multiple autonomous agents, in order to gather information across time and space that is beyond the reach of a single autonomous agent for increasingly complex tasks. This talk will describe two related research fronts towards these goals. The first part concerns generalizable algorithms for harnessing information in autonomous human-robot teams. I will describe recent and ongoing work on the problem of "soft-hard" data fusion for collaborative information gathering tasks, where the goal is to enable humans to perform live natural language "chats" with robotic perception algorithms to improve online performance. In the context of target search problems, I will demonstrate novel solutions and open challenges toward the key problems of modeling human natural language for sensor fusion and performing difficult online hybrid Bayesian inference operations to support optimal planning. In the second part, I will discuss the important issue of scaling autonomous Bayesian reasoning to large distributed robotic vehicle networks. I will discuss some new challenges and results towards addressing the problem of generalized Bayesian Decentralized Data Fusion (DDF). In particular, I will put forward some new insights about the fundamental DDF problem that enable efficient information sharing between Bayesian robots that maintain their own private (possibly heterogeneous) models of the world. These results have many interesting implications for robotics applications and beyond, e.g. multi-target/multi-platform tracking, cooperative localization, and decentralized online machine learning, to name a few.

Nisar Ahmed is an assistant professor of aerospace engineering sciences at the University of Colorado Boulder. His research interests are in the modeling and estimation for intelligent control of dynamical systems, especially for applications involving human-robot interaction, distributed sensor networks, and information fusion. He received the Ph.D. degree in mechanical engineering from Cornell University in 2012 and was a postdoctoral research associate in the Cornell Autonomous Systems Lab from 2012 to 2014. He was awarded an NSF Graduate Research Fellowship in 2007; the 2011 AIAA Guidance, Navigation, and Control Conference Best Paper Award; and an ASEE Air Force Summer Faculty Fellowship in 2014. He has also led/coorganized several well-received workshops on autonomous robotics and sensor fusion, including the Workshop on Distributed Control and Estimation for Robotic Vehicle Networks at the 2014 Robotics: Science and Systems Conference (for which he guest edited a corresponding two-part special in IEEE Control Systems) ; the IEEE MFI 2015 Workshop on Large-Scale Distributed Data Fusion and Consensus; the RSS 2015 Workshop on Realistic Rapid Repeatable Robotic Simulation (R4Sim); and the 2016 ACC Workshop on Collaborative Sensing, Learning and Control in Human-Machine Systems. He is a Member of the IEEE and an associate member of the AIAA Intelligent Systems Technical Committee.

This seminar counts towards the ME 600 seminar requirement for Mechanical Engineering graduate students.

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