USC Viterbi School of Engineering
Ming Hsieh Department of Electrical and Computer Engineering

Ming Hsieh Institute **Seminar Series**

Center for Systems and Control – CommNetS

Robust and Relaxed Temporal Logic Planning for Robot Systems

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Abstract: Robots are deployed in an increasing number of environments and applications, and tasked with ever complex missions with temporal, logical, and timing constraints. Practical and safety considerations impose that solutions are robust to perturbations and noise, and able to handle infeasible scenarios as best as possible. A planner for a self-driving car may not just return without a solution, it still needs to steer the car as best possible. A multi-agent team should not abandon a mission if one robot fails during deployment. A delivery robot should find alternatives and swap unavailable groceries based on the user's preferences. In this talk, we present and clarify the robustness and relaxation of temporal logic specifications. We present automata- and mixed integer linear programming (MILP) methods to address them in various mission settings for single- and multi-robot systems. We use automata to capture multiple relaxation semantics and provide a model for abstraction of rich user-preferences. We achieve scalability with respect to number of agents and specification complexity in multi-robot missions via MILP encodings while ensuring robust satisfaction in case of feasibility and partial satisfaction otherwise. We apply these techniques to coordinate heterogeneous teams of robots, robot swarms, and modular aerial robotic systems.

Bio: Cristian-Ioan Vasile is an assistant professor in the Mechanical Engineering and Mechanics department, and Computer Science and Engineering (courtesy) at Lehigh University. He leads the Explainable Robotics Lab (ERL) as part of the Autonomous and Intelligent Robotics Lab (AIRLab) at Lehigh University. Previously, he was a postdoctoral associate in the Laboratory for Information and Decision Systems (LIDS), and the Computer Science and Artificial Intelligence Laboratory (CSAIL) at Massachusetts Institute of Technology (MIT). He obtained his PhD in 2016 from the Division of Systems Engineering at Boston University, where he worked in the Hybrid and Networked Systems (HyNeSs) Group of the BU Robotics Laboratory. He obtained a BS degree in Computer Science in 2009, a MEng in Intelligent Control Systems in 2011, and a second PhD in Systems Engineering in 2015, all from the Faculty of Automatic Control and Computers, Politehnica University of Bucharest. His research goal is to enable robot autonomy via scalable automated synthesis of explainable plans using motion planning and machine learning. His work employs techniques from sampling-based motion planning, formal methods, automata and graph theory, optimization, control theory, and machine learning.a Professor in the Department of Aerospace and Mechanical Engineering and the Department of Physics and Astronomy at the University of Southern California, where she also holds the named chair “Z. H. Kaprielian Fellow in Engineering”". Kanso earned PhD and Masters degrees in Mechanical Engineering (1999, 2003) and Applied Mathematics (2002) from UC Berkeley, followed by a post-doctoral training at Caltech (2003-2005). She served as a Program Director at the National Science Foundation (2021-2023). Kanso's research focuses on studying fundamental problems in the biophysics of cellular and subcellular processes and the physics of animal behavior, both at the individual and collective levels. A central theme in her work is the role of the mechanical environment, specifically the fluid medium and fluid-structure interactions, in shaping and driving biological functions.

Host: Lars Lindemann, llindema@usc.edu

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