IOWA STATE UNIVERSITY
Department of Mechanical Engineering

Nonlinear Model Predictive Control Based on Graph Search with Applications to Power & Energy, Flow Control, and Robotics

Emmanuel G. Collins

Department of Mechanical Engineering
Florida A&M University – Florida State University

Seminar on October 24, 2017 at 11:00 am in 2004 Black
Seminar host: Sourabh Bhattacharya

Abstract

Model Predictive Control (MPC) is a powerful paradigm for control as it enables optimal control based on predicted future behavior and can rigorously enforce constraints on the system's inputs and outputs. However, it has the drawback that it can be too computationally expensive to practically implement in some applications. Furthermore, Nonlinear MPC (NMPC) approaches can converge to local optima. This seminar introduces Sampling Based Model Predictive Control (SBMPC), a relatively new approach to NMPC that, unlike other NMPC methods, does not rely on linearizing the system or gradient based optimization. Instead, it discretizes the input space to the model via pseudo-random sampling and feeds the sampled inputs through the nonlinear model, producing a searchable graph. An optimal path is found using A*, an efficient graph search method. This optimization is complete, meaning that if the prediction horizon is sufficiently long, SBMPC is guaranteed to find the global minimum subject to the sampling. In line with this, SBMPC is shown using transparent examples to avoid the local minima to which gradient-based methods tend to converge. SBMPC can compute quickly by use of an appropriate "heuristic" or "cost-to-goal estimate" that can be learned from experience. In this seminar, SBMPC's application to problems in power and energy, flow control, and robotics are demonstrated with concrete examples, some of which are implemented in hardware.

Dr. **Emmanuel G. Collins, Jr.** is John H. Seely Professor of Mechanical Engineering, Director of the Center for Intelligent Systems, Control and Robotics (CISCOR), and Chair of the Department of Mechanical Engineering at the Florida A&M University - Florida State University College of Engineering. He received the M.S. in Mechanical Engineering and the Ph.D. in Aeronautics and Astronautics from Purdue University and also holds B.S. degrees from Morehouse College and the Georgia Institute of Technology. He spent 7 years in research and development at the Harris Corporation prior to joining the Department of Mechanical Engineering. Dr. Collins teaches courses in control, robotics and dynamics. His current research interests are in control and guidance of autonomous vehicles in challenging environments and situations; automated terrain classification; adaptive, nonlinear model predictive control; flow control; and control of energy systems.

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

www.me.iastate.edu