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Dipartimento di Ingegneria Industriale e dell'Informazione

SEMINAR

Stochastic Nonlinear Model Predictive Control with Probabilistic Constraints

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Abstract

Stochastic uncertainties are ubiquitous in complex dynamical systems and can lead to undesired variability of system outputs and, therefore, a notable degradation of closed-loop performance. This work investigates model predictive control of nonlinear dynamical systems subject to probabilistic parametric uncertainties due to plant-model mismatch. A nonlinear model predictive control framework is presented for control of the probability distribution of system states while ensuring the satisfaction of constraints with some desired probability levels. To obtain a computationally tractable formulation for real control applications, polynomial chaos expansions are utilized to propagate the uncertainties through the system model. The paper considers individual probabilistic constraints, which are converted explicitly into convex second-order cone constraints for a general class of probability distributions. An algorithm is presented for receding horizon implementation of the finite-horizon stochastic optimal control problem. The capability of the stochastic model predictive control approach in terms of shaping the probability distribution of system states and fulfilling state constraints in a stochastic setting is demonstrated for optimal control of polymorphic transformation in batch crystallization.

Biography

Joel Paulson is currently a PhD student with the Braatz group in the Department of Chemical Engineering at the Massachusetts Institute of Technology (MIT). He received his Master of Science in Chemical Engineering Practice from MIT and his Bachelor of Science in Chemical Engineering from the University of Texas at Austin. His research lies in the intersection of systems, control, and applied mathematics. His primary thesis work includes first principles modeling of carbon nanotube-based photovoltaic devices, fast stochastic model predictive control of high-dimensional systems with applications in continuous manufacturing of pharmaceuticals, control theory for infinite-dimensional systems, and active fault diagnosis (input design) for nonlinear systems with stochastic uncertainties.

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