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Automation Engineering

Optimal Control of Uncertain Systems Using Dual Model Predictive Control

Colloquium talk by

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Abstract

Maintaining a good model of a controlled plant is an important challenge in the process industries, model quality being one determining factor for the performance of a model predictive controller (MPC). Feldbaum was the first to recognize that an optimal controller for a system with unknown parameters has two conflicting tasks: directing the output toward a reference, and exciting the system for learning purposes so that better control decisions can be made in the future. A dual controller is optimal in the sense that it finds the correct balance between control and excitation, often referred to as exploitation versus exploration in operations research and machine learning.

In this talk we look at adaptive MPC for plants with uncertain model parameters. Inspection of the objective function shows that the adaptive MPC must include caution and probing in order to generate optimal controls since they are functions of the current and future parameter-estimate error covariances. We demonstrate the application of dual MPC (DMPC) to a finite impulse response (FIR) system and present the deterministic equivalent of the associated stochastic optimal control problem. We also present two approximate DMPC methods for the more general autoregressive with exogenous input (ARX) system formulation.

Curriculum Vitae

Tor Aksel Heirung received his Master's degree in Control Engineering (Engineering Cybernetics) from the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway in 2010, and his Master's degree in Chemical Engineering from Carnegie Mellon University in 2010. For both degrees he focused on optimal control. He is currently a PhD candidate at NTNU.

His main research interests include control, uncertainty, and learning. Most of his recent work has focused on dual control, which concerns control design for uncertain systems. Dual controllers find an optimal balance between excitation and control so that the uncertainty is resolved faster with the goal of improving control performance over time.

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