SPECIALIZATION PROJECTS PROPOSALS

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1. **FAST NONLINEAR MPC OF AN UNCERTAIN DISTILLATION PROCESS**

Model predictive control (MPC) of industrial chemical processes involve solving of nonlinear optimization problem at every discrete time step. The controller has a great ability to handle operational constraints. Nonlinear MPC (NMPC) has high complexity hence the computations take longer than in linear problems leading to significant computational delay. This delay must be reduced to increase efficiency by for example fast methods including use of nonlinear program (NLP) sensitivities. In addition, NMPC assumes perfect prediction but the actual plant is not deterministic. There are uncertainties that occur in the model in the form of parameter and/or measurement uncertainty. NMPC has some inherent robustness but it may not be enough to handle huge uncertainties. Stochastic NMPC schemes that are robust such as scenario (multistage) NMPC have been developed. These robust schemes increase the problem size exponentially and therefore one must sacrifice computational efficiency for robustness.

A picture containing game, table

Description automatically generated

Figure 1. Reactor and distillation column process

This work aims at finding robust methods for NMPC that are computationally efficient by performing simulation studies on a typical distillation process in chemical industry. The expected tasks in this project are but not necessarily limited to:

* Building a dynamic model for a distillation process (e.g. a reactor and a column in Figure 1)
* Identifying uncertain parameters and measurements.
* Implementing an ideal standard NMPC to:
  + Minimize a setpoint tracking cost objective and/or
  + Minimize an economic cost objective (energy efficiency)
* Introducing plant-model mismatch and/or measurement noise and compare the performance
* Selection of a robust MPC formulation to implement.
* Applying fast-NMPC methods based on NLP-sensitivities (e.g. adaptive horizon method) on the robust MPC scheme for delay reduction.