technische universität
dortmund

Fakultät Bio- und Chemieingenieurwesen

LS für Systemdynamik
und Prozessführung

Diplomarbeit / Masterarbeit

Scenario-based Dual Nonlinear Model Predictive Control

Abstract:

Nonlinear model predictive control (NMPC) finds wide range of application in process industry. Besides the efficacy of modern optimization solvers that provide fast and reliable resolutions to constrained optimization problems, the handling of uncertainties, present in parameters of the process models, remains the most challenging problem of real-life applications of NMPC.

One of the possible approaches, in sake for establishing an optimizing control resistible to the presence of uncertain parameters present in the process model, is the utilization of robust control. Various schemes have been presented in this framework whereas different levels of conservativeness of the resulting robust optimizing control were achieved. Use of multi-stage robust NMPC, suggested by Lucia and Engell represents recent approach that was shown to achieve least degree of conservativeness compared to state-of-the-art robust approaches. The strength of this approach lies in exploitation and prediction of the information available via feedback (measured outputs) at each sampling time of the process run. In particular, a scenario tree of possible realizations of uncertainties is considered to represent possible deviations of the process from nominal predictions. The robustly optimizing control is then found by recursive resolution of the NMPC problem over the set of generated scenarios on the prediction horizon subject to operational constraints where each scenario is assigned with the different probability of occurrence.

By reducing the uncertainty in the parameter range, a dramatic improvement can be achieved in terms of conservativeness of resulting robustly optimal control policy. Dual control approach has been formulated in this framework. The aim of the dual control is to strike the balance between finding the optimizing inputs for the economical (process control) criterion and inputs that excite process enough to devise bounds on uncertain parameter with minimal uncertainty. Minimization of the uncertainty range can be, in principle, achieved via tools of optimal design of dynamic experiments.

Diplomarbeit / Masterarbeit

Objectives:

The aim of this master thesis is to study an optimal dual control in the framework of

multi-stage (scenario-based) NMPC applied to selected control engineering problems.

Steps:

- Evaluation of the effect of reduction of the range of uncertainty in scenario-based NMPC by means of simulation.
- Subsequent theoretical derivation (approximation) of this effect.
- Study of the methods of optimal experiment design. Study of dual control. Choice of an appropriate approach for realization of scenario-base dual NMPC.
- Simulation studies of dual control applied in the context of scenario-based NMPC for selected engineering problems.

Begin and duration:

Immediately, 6 month full time

Prerequisites:

- Simulation and programming skills (MATLAB or C/C++)
- Good knowledge of process dynamics and control
- Interest in optimal control of chemical processes

Literature:

S. Lucia and S. Engell. Multi-stage and Two-stage Robust Nonlinear Model Predictive Control. In *Proc. 4th IFAC Nonlinear Model Predictive Control Conference*, Noordwijkerhout, pages 181–186, 2012.

Contact:

Radoslav Paulen,

Tel.: 0231 / 755-5166, G2-525a, radoslav.paulen@bci.tu-dortmund.de

Sergio Lucia,

Tel.: 0231 / 755-3959, G2-332, daniel.hasskerl@bci.tu-dortmund.de