Machine Learning-based modeling of a pharmaceutical production process using the Koopman-Operator for Model Predictive Control

Master thesis

TECHNISCHE UNIVERSITÄT DARMSTADT

Problem

Tablet manufacturing requires granulation and drying – previously separate processes. New machines integrate both steps, but their complex nonlinear dynamics make control challenging. Traditional control methods reach their limits in this scenario.

Challenge

Model Predictive Control (MPC) enables the control of such systems but relies on an accurate model of system dynamics. Approaches like neural networks are used for system identification but they often lead to non-convex optimization problems, which can only be solved locally optimally.

Approach

The Koopman Operator offers a way to transform nonlinear systems into a higher-dimensional but linear representation. This could allow modern Machine Learning methods to enable linear MPC for highly complex processes. The aim of this thesis is an investigation, whether recent Koopman-inspired methods applied to production data from this process equipment lead to a model of the process dynamics suitable for model-based control (e.g. MPC).

Requirements: Very good mathematical skills, very good knowledge of control engineering (SDRT 1+2, MPC and Machine Learning) and process modelling, programming with Matlab/Simulink or Python.

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