Carlos Elorza Casas

Prof. L. Ricardez-Sandoval

Multi-Scenario and Multi-Stage Robust NMPC with State Estimation Application on the Tennessee-Eastman Process

This study presents the implementation of two discrete robust approaches to Non-linear Model Predictive Control (NMPC), multi-scenario NMPC

(MSc-NMPC) and multi-stage NMPC (MS-NMPC), to the benchmark Tennessee-Eastman

(TE) challenge, with Extended Kalman Filter (EKF) and Moving Horizon Estimation (MHE) as state estimators. The robust NMPC formulation results in closed-loop responses that prevent constraint violation and closely track the process set-point under parameter uncertainty, even in scenarios where traditional NMPC results in an unstable response for this process.

Additionally, unconstrained state estimators such as EKF are unsuitable because the parameter uncertainty may cause estimations to fall outside the feasible region of the process, which ultimately destabilizes the process.

MHE was able to overcome this challenge because it considers process constraints in its formulation. The additional computational time required to solve the robust NMPC formulations and MHE does not cause significant delays for the sampling time considered, demonstrating their applicability to challenging large-scale industrial chemical processes.

