Abstract

Nonlinear Model Predictive Control (NMPC), which is an extension of the Model Predictive Control (MPC) for the nonlinear case, is a control technique with increasing industrial applications in the recent times. However, it demands a high computational effort due to the arising nonlinear programming problem (NLP). The computational demand of NMPC is a barrier in its application to processes with fast dynamics. To make the NMPC applicable to fast processes, efficient online optimization methods are required, which have been a center of research in the last couple of decades. A promising online optimization method known as Multi-Level Iteration (MLI) scheme, developed for real-time applications, is proposed in Bock et al., 2007. MLI scheme is comprised of four modes, which differ in the performance and speed mainly due to the set of information required for solving a quadratic programming (QP) subproblem. It has been successfully tested on theoretical case studies, and the advantages have been pointed out. Furthermore, MLI software has been developed at IWR Heidelberg, which is an efficiently programmed combination of NMPC and Moving Horizon Estimator (MHE). MHE is a well-established optimization based state estimation technique which also requires a solution to an optimization problem. In this work, the MLI scheme is initially investigated for solving the optimal control problems arising in MHE and NMPC on the mathematical model of a nonlinear fed-batch process consisting of a pseudo chemical reaction system. Additionally, the MLI scheme, for the first time, is applied to a physical nonlinear fed-batch process. The behavior of the MLI scheme is studied under different modes using different frequencies of the individual modes, and the performance and capabilities for real-time control is compared.