Abstract

Nonlinear Model Predictive Control (NMPC) is becoming increasingly popular in the process and chemical industries. However, the system state vector must be completely known before NMPC can be applied. Extended Kalman Filter (EKF) is one of the most widely used state estimators for nonlinear systems. In a past work, it has been formulated such that it can be applied to nonlinear systems which are represented by differential algebraic equations (DAE), and the measurements from the algebraic states can be accommodated. Recently, adjustments were made in EKF for multirate sampling cases. Particle Filter (PF) is a full nonlinear state estimator on which a lot of research has be directed. The multi-rate algorithm has also been previously proposed for PF for purely small scale ODE system. This work is focused towards the state estimation of DAE systems using EKF and PF in the single-rate sampling scenario as well as multi-rate sampling scenario. The case studies employed vary in complexity from a simple DAE system with two states (galvanostatic process) to a complex DAE system (reactive distillation column) with 241 states. The mentioned state estimators are also applied to different settings of reactive distillation column to find a configuration which suits better for the state estimation task. The effect of varying the number of particles in the state estimation using PF is demonstrated. Plant-model mismatch is introduced in the case study of reactive distillation column and the state estimation results obtained using EKF and PF are examined.