Chair of Automatic Control

FAU

Announcement for Bachelor/Master Thesis/Research project

Online Parameter Estimation for Model Predictive Control in Building Energy Systems

Motivation

The modeling of energy systems of residential or office buildings is a challenging task, due to their growing complexity and the dependency on many parameters that are typically estimated from measured data e.g. with the least squares method. Estimating the parameters in an online fashion simplifies this work significantly, since only first estimates of the parameters have to be supplied and generic models can be flexibly generated for a given building or floor layout.

The online adaptation of the model can be directly utilized within a model predictive control (MPC) scheme that iteratively solves a dynamic optimization problem subject to the system dynamics to compute the optimal control law for the building energy systems. However, the MPC performance directly depends on the accuracy of the modeled system dynamics. In this regard, the accurate and reliable parameter estimation is essential in order to ensure an optimal and energy efficient control of the building and in general to pave the way for MPC in building energy systems in a generic and flexible way.

The online parameter estimation can e.g. be achieved with a disturbance observer based on the Kalman Filter. In this work, the state-of-the-art Unscented Kalman Filter shall be used as the underlying system dynamics are partially nonlinear.

Task description

Starting from a physical nonlinear model of a given building energy system, a first online estimation scheme with an Unscented Kalman Filter (UKF) shall be derived. The performance of this parameter estimation will be analyzed under the impact of noise and other disturbances. Finally the UKF shall be coupled to an existing MPC scheme and evaluated in simulation studies with respect to a highly accurate simulation model.

Requirements

Basic knowledge of MATLAB and linear state-space control design (e.g. by having attended the course “Regelungstechnik B”) is required. First experiences with Kalman filtering and MPC are advantageous but are not mandatory. The thesis can be written in either English or German.

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