Sensor Location Selection for Continuous Pulp Digesters with Delayed Measurements

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Abstract

The state estimation and sensor placement for a continuous pulp digester with delayed measurements are investigated. The underlying model of interest is heat transfer in a pulp digester modeled by two coupled hyperbolic partial differential equations and an ordinary differential equation. Output measurements are considered with delay due to the possible low sampling rate. The Cayley-Tustin transformation is utilized to realize model time discretization in a late lumping manner which does not account for any type of spatial approximation or model reduction. The discrete Kalman filter is applied to estimate the system states using the delayed measurements. The selection of sensor location is addressed along with estimator design accounting for the delayed measurements and investigated by minimizing the variance of estimation error. The performance of the state estimator is evaluated, and the sensor placement is analyzed through simulation studies, which provide guidance for sensor location selection in industrial applications.