Systematic Estimation of Noise Statistics for Nonlinear State Estimators by Parametric Uncertainty

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Abstract

An easy-to-implement noise estimation method for tuning state estimators is proposed. It outperforms benchmark methods in terms of accuracy or computational cost both in theory and in a case study. We assume parametric uncertainty in the process model, which we transform into noise statistics using the generalized unscented transformation (GenUT). While most other methods estimate only the noise covariance, we also estimate the mean. Our tuning method is suitable for input-output models, demonstrated through a case study involving process simulators and industrial data. We present a theoretical analysis of our method, which is based on splitting one large GenUT to two smaller GenUTs. This results in two theorems: i) mean approximations for the two systems are equal and ii) covariance approximations are similar under certain mild conditions. These theorems confirm the validity of our method, and we discuss their potential to realize a numerically stable GenUT for high-dimensional systems.

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