A Reduced Basis Kalman Filter for Certified and Rapid State Estimation of Parametrized PDEs

B. Haasdonk[1] and M. Dihlmann[1]

[1]Institute of Applied Analysis and Numerical Simulation, University of Stuttgart, Stuttgart, Germany

The Kalman filter is a widely known tool in control theory for estimating the state of a linear system disturbed by noise. However, when applying the Kalman filter on systems described by parametrized partial differential equations (PPDEs) the calculation of state estimates can take an excessive amount of time and real-time state estimation may be infeasible. In a recent article [1] we presented a low dimensional representation of a parameter dependent Kalman filter for PPDEs via the reduced basis method. This allows rapid state estimation, and in particular the rapid estimation of a linear output of interest. It is also possible to derive a posteriori error bounds for evaluating the quality of the output estimations. Additionally, the stability of the filter can be verified using an observability condition. We will demonstrate the performance of the reduced order Kalman filter and the error bounds with a numerical example modeling the heat transfer in a plate.

References

[1] M. Dihlmann and B. Haasdonk. A reduced basis kalman filter for parametrized partial differential equations. *ESAIM: Control, Optimisation and Calculus of Variations, in press*, 2015.