A general approach to application of reliable array square-root Kalman filtering methods in dynamic system identification

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This paper addresses the class of array square-root Kalman filtering (KF) algorithms with a J-orthogonal transformation. Such methods are currently preferable for practical implementation of H^2, H^∞ filters and include two main families: square-root array algorithms, which are typically numerically more stable than the conventional one, and fast array algorithms which, when system is time-invariant, typically offer an order of magnitude reduction in the computational cost.

Using this important class of numerically stable KF schemes, we extend its functionality and develop an elegant and simple method of computation of sensitivities of the system state to unknown parameters required in a variety of applications. For example, applications include system identification, optimal input design and so on. This new result generalizes the approach proposed by Bierman et al. in [1]. Our method replaces the standard approach based on the conventional Kalman filter (and its derivatives) with its inherent numerical instabilities and, hence, improves the robustness of computations against roundoff errors. To illustrate the proposed approach, the method of maximum likelihood is used for parameter estimation in linear discrete-time stochastic systems.

References

[1] G.J. Bierman, M.R. Belzer, J.S. Vandergraft and D.W. Porter, "Maximum likelihood estimation using square root information filters", *IEEE Trans. Autom. Control*, vol. 35, pp. 1293–1298, Dec. 1990.