Xie Wang, Mei-qin Liu, Zhen Fan, Sen-lin Zhang, 2016. A novel approach of noise statistics estimate using H_∞ filter in target tracking. *Frontiers of Information Technology & Electronic Engineering*, **17**(5):449-457
http://dx.doi.org/10.1631/FITEE.1500262

A novel approach of noise statistics estimate using H_∞ filter in target tracking

Key words: Noise estimate, H_∞ filter, Target tracking

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Motivation

- Noise statistics is essential for estimation performance. In practical situations, the information of noise statistics is often unknown.
- In modern industrial embedded real-time systems, recursive estimators are in serious need under the computational limits.
- Previous studies on noise statistics identification in linear systems are still constrained by the Kalman filter or Bayesian method, which require a priori knowledge about the noise statistics.

Main idea

- Apply the H_∞ filter to obtain the system state estimates without a priori knowledge of the noise statistics.
- By applying state estimates obtained from the H_∞ filter, we can achieve better estimates of the noise mean and covariance.

Method

1. Without a priori knowledge of the noise statistics, employ the H_∞ filter to obtain the system state estimates.
2. Based on the measurement sequence and the system state estimates obtained from the H_∞ filter, achieve the residual sequences first , then construct a estimator to obtain the mean and the covariance of process noise and measurement noise.
3. Carry out several numerical simulations based on the proposed approach.

Major results

- Compared with the same framework based on Kalman filter, our approach can provide more precise noise statistics estimates.

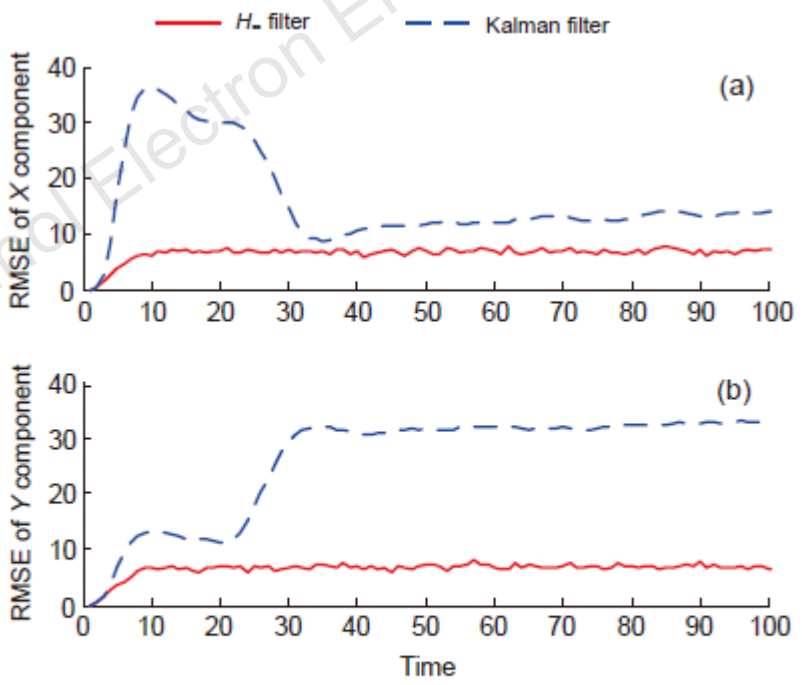

Fig. 4 Root mean square errors (RMSEs) between the system state and the estimated state: (a) X component of the position; (b) Y component of the position

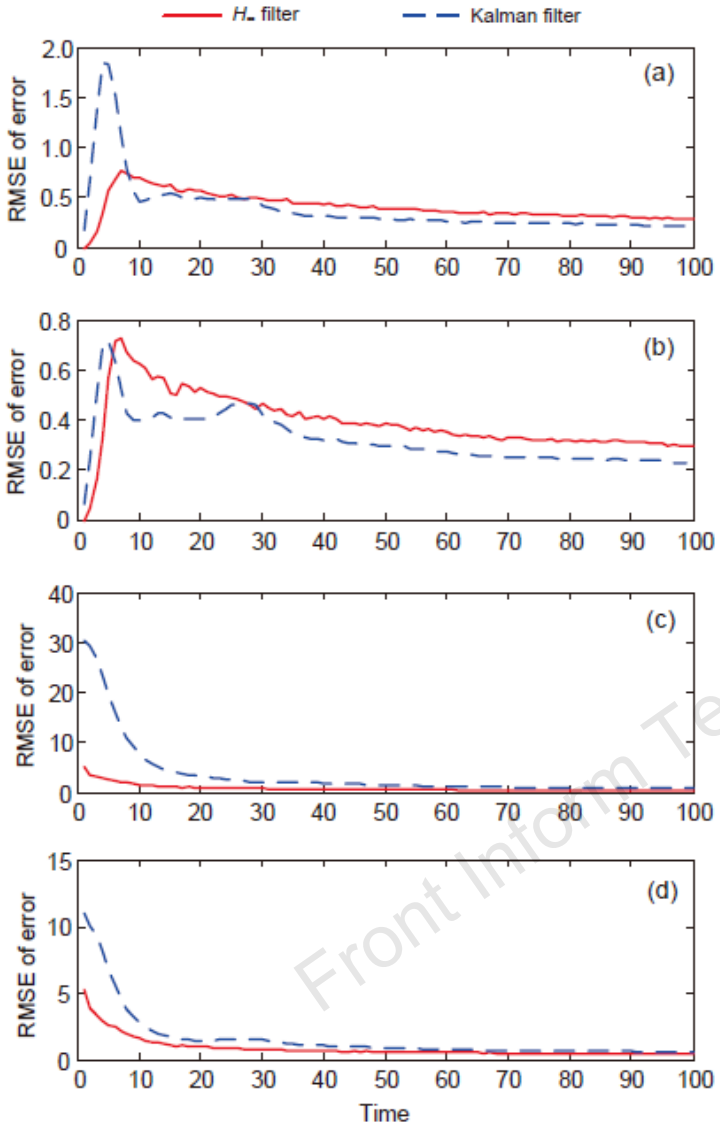

Fig. 5 Root mean square errors (RMSEs) between the process noise mean estimates and the actual values for w_1 (a) and w_2 (b), and the RMSEs between the measurement noise mean estimates and the actual values for v_1 (c) and v_2 (d)

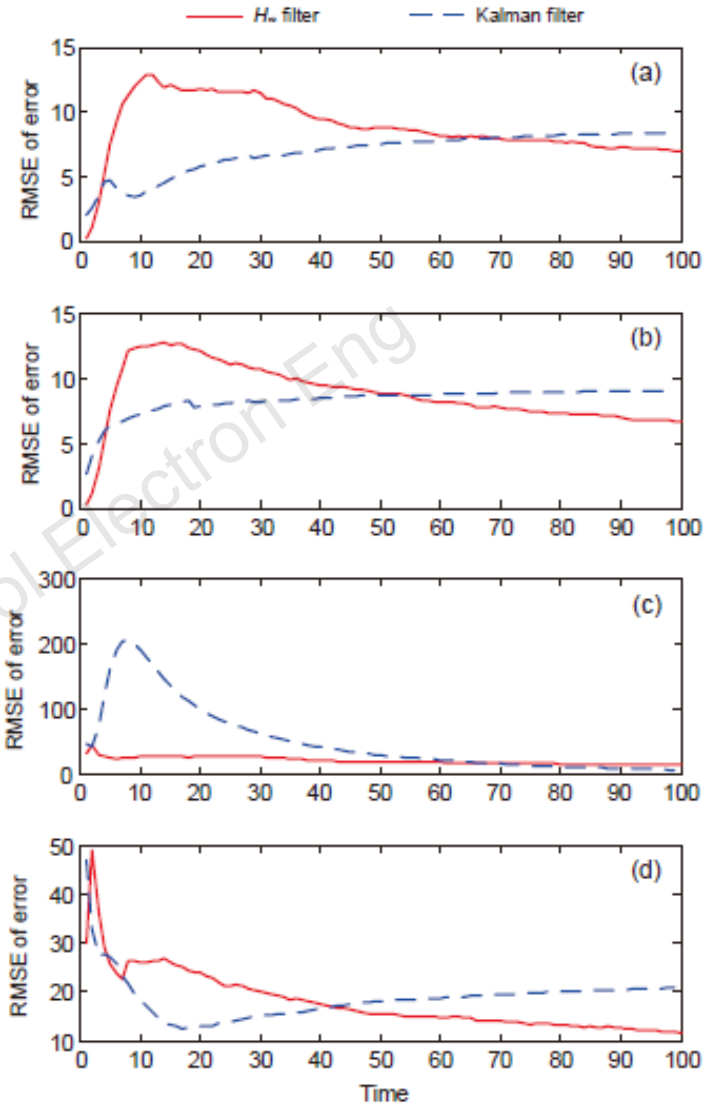

Fig. 6 Root mean square errors (RMSEs) between the process noise covariance estimates and the actual values for Q_{11} (a) and Q_{22} (b), and the RMSEs between the measurement noise covariance estimates and the actual values for R_{11} (c) and R_{22} (d)

Conclusions

- Without a priori knowledge of noise statistics, a novel approach is presented to estimate the process noise and measurement noise statistics in linear discrete system.
- The H_∞ filter is introduced to construct the estimation approach. Based on the system estimates obtained from H_∞ filter, better residual samples can be achieved to estimate the noise statistics.
- Compared with the same framework based on Kalman filter, the estimation performance is demonstrated through several simulations.