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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 an 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.

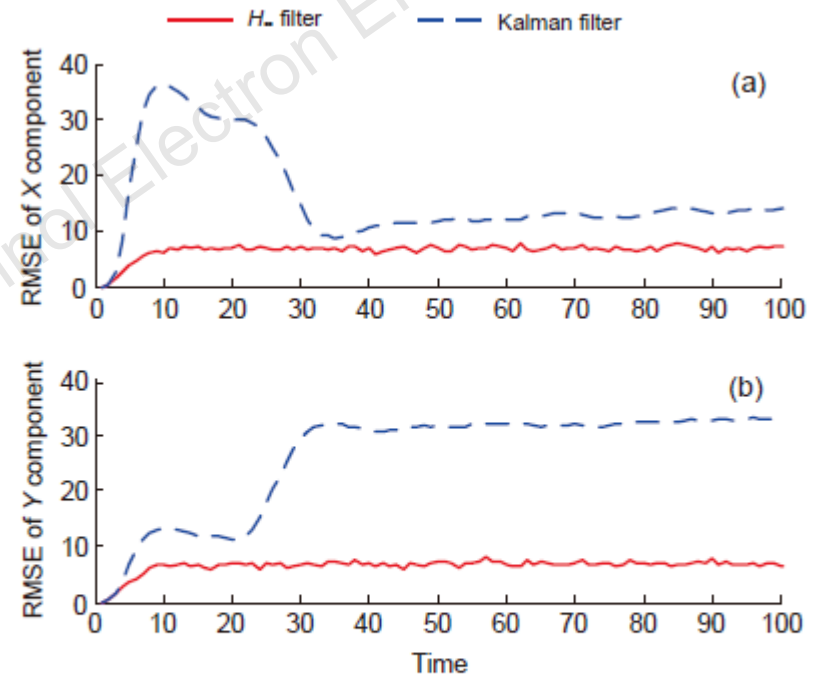


Fig. 4 Root mean square errors (RMSEs) between the system state and the estimated state: (a) X component of the position; (b) Y component of the position

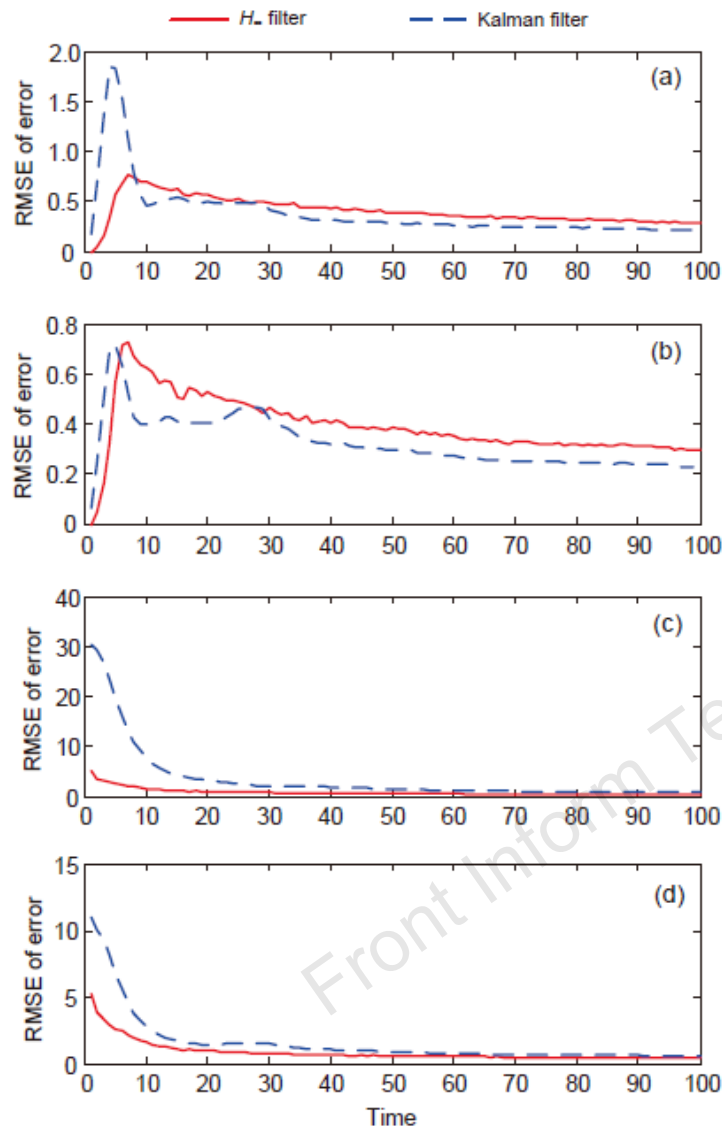


Fig. 5 Root mean square errors (RMSEs) between the process noise mean estimates and the actual values for w_1 (a) and w_2 (b), and the RMSEs between the measurement noise mean estimates and the actual values for v_1 (c) and v_2 (d)

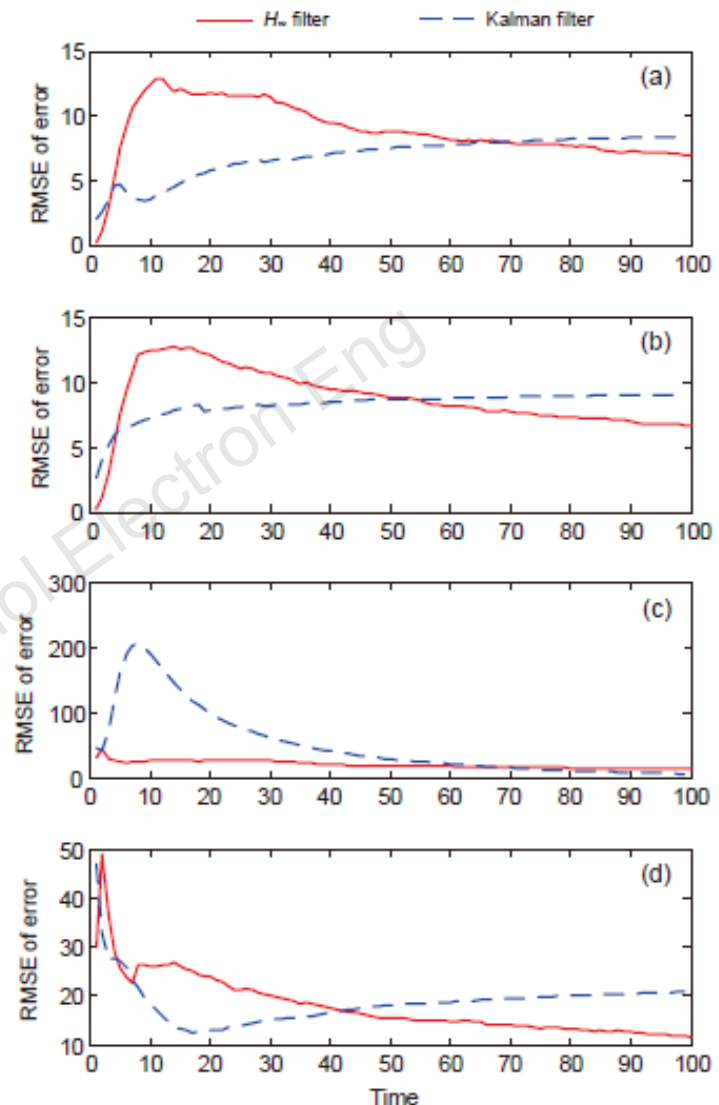


Fig. 6 Root mean square errors (RMSEs) between the process noise covariance estimates and the actual values for Q_{11} (a) and Q_{22} (b), and the RMSEs between the measurement noise covariance estimates and the actual values for R_{11} (c) and R_{22} (d)

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.