Non-Fragile Asynchronous Filtering for Markov Jump Systems with Randomly Occurring Filter Parameters Fluctuation

ISIKM2020
December 12-13, 2020

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Abstract

This paper investigates the problem of non-fragile $l_2 - l_\infty$ asynchronous filtering for discrete-time Markov jump systems with time-varying delays and randomly occurring filter parameters fluctuation. A non-fragile filter with randomly occurring parameters fluctuation is constructed whose modes are asynchronous with the system modes. The sufficient conditions are derived based on the Lyapunov-Krasovskii functional method, which ensure the corresponding filtering error system is stochastically stable with specified $l_2 - l_\infty$ performance index. By solving the LMIs obtained from sufficient conditions, the filter parameters can be determined.

Mathematical Formulas

System (3)is stochastically stable with a given $l_2 - l_\infty$ performanceγ for given scalars $\gamma > 0,\ \mu > 0$, if there exist matrices $P_i = \begin{bmatrix} P_{i1} & P_{i2} \\ * & P_{i3} \end{bmatrix}, W_{is}, R, Q_{is}, G_{is} > 0$ and scalars $\rho > 0, \varepsilon > 0$ to guarantee (4), (5), (6) hold.

$$\sum_{s=1}^{t} \pi_{is} W_{is} - P_i < 0 \qquad (4)$$

$$\begin{bmatrix} -P_{i1} & -P_{i2} & L_i^T & 0 & 0 & 0 \\ * & -P_{i3} & -\tilde{C}_{fs}^T & 0 & 0 & \varepsilon H_c^T \\ * & * & -\gamma^2 I & 0 & -\mu M_c & 0 \\ * & * & * & -\gamma^2 I & -\tau M_c & 0 \\ * & * & * & * & -\varepsilon I & 0 \\ * & * & * & * & * & -\varepsilon I \end{bmatrix} < 0 \qquad (5)$$

$$\begin{bmatrix} \Sigma_1 & \bar{M} & \rho \bar{H}^T \\ * & -\rho I & 0 \\ * & * & -\rho I \end{bmatrix} < 0 \qquad (6)$$

Figures

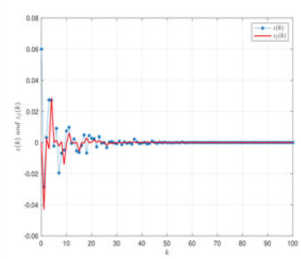

FIGURE 1. $z(k)$ and $z_f(k)$.

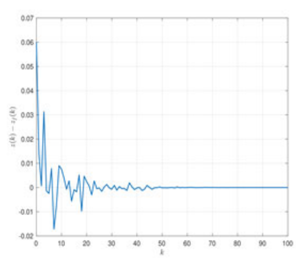

FIGURE 2. $z(k) - z_f(k)$

Research Questions

Think of the following MJS:

$$\begin{cases} x(k+1) &= A(\alpha(k))x(k) + A_d(\alpha(k))x(k-d(k)) \\ & \quad +B(\alpha(k))\omega(k) \\ y(k) &= C(\alpha(k))x(k) + C_d(\alpha(k))x(k-d(k)) \\ & \quad +D(\alpha(k))\omega(k) \\ z(k) &= L(\alpha(k))x(k) \\ x(k) &= \phi(k) \quad k = -d, -d+1, \ldots, 0 \end{cases} \qquad (1)$$

Think of the following state-space filter:

$$\begin{cases} \hat{x}(k+1) &= (A_f(\beta(k)) + \mu_t \Delta A_{fs})\hat{x}(k) \\ & \quad +(B_f(\beta(k)) + \mu_t \Delta B_{fs})y(k) \\ \hat{z}(k) &= (C_f(\beta(k)) + \mu_t \Delta C_{fs})\hat{x}(k) \end{cases} \qquad (2)$$

From (1) and (2), we can construct the following augmented filtering error system:

$$\begin{cases} \bar{x}(k+1) &= \bar{A}_{is}\bar{x}(k) + \bar{A}_{dis}x(k-d(k)) + \bar{B}_{is}\omega(k) \\ \bar{z}(k) &= \bar{C}_{is}\bar{x}(k) \\ \bar{x}(k) &= \bar{\phi}(k) = \begin{bmatrix} \phi(k) \\ 0 \end{bmatrix} \quad k = -d, -d+1, \ldots, 0 \end{cases} \qquad (3)$$

Methodologies

Solving the LMIs (4), (5), (6), the filter (2) can be determined as:

$$A_{fs} = (Q_s^{(2)})^{-1}\tilde{A}_{fs}$$
$$B_{fs} = (Q_s^{(2)})^{-1}\tilde{B}_{fs}$$
$$C_{fs} = \tilde{C}_{fs}$$

Conclusion

This paper has investigated the problem of non-fragile $l_2 - l_\infty$ asynchronous filtering for discrete-time MJSs with time-varying delays. Sufficient conditions have been derived from Lyapunov-Krasovskii functional method, which guarantee the stochastic stability of the filtering error system with a given $l_2 - l_\infty$ performance **γ**. The filtering gains have been acquired by solving a series of LMIs. The validity of the proposed filter has been certified through a numerical example. The simulation results prove the feasibility and effectiveness of our filter design method, and provide us with ideas for further research. That is, the method we proposed has its shortcomings. It is only suitable for stable systems. Solving the asynchronous filtering problem of unstable systems will be our future work.