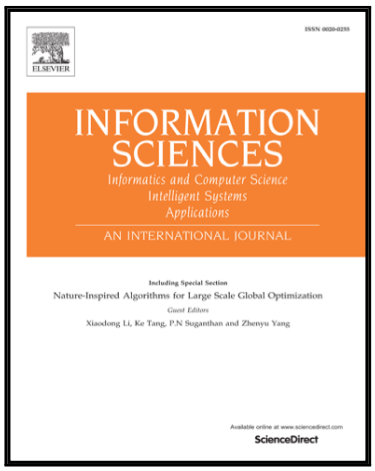

Event-triggered distributed fusion estimation with random transmission delays

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Abstract

Recently distributed fusion estimation problem has been widely studied because of better estimation accuracy, reliability and robustness. In this paper, an event-triggered distributed fusion estimation problem is investigated for multi-sensor nonlinear networked system with random transmission delays. For each communication channel, an event-triggered scheduling mechanism is introduced to reduce excessive measurement transmission, and a D-length buffer is used to retrieve partly delayed measurements. Based on a sequential covariance intersection fusion technique, a distributed fusion estimation algorithm is designed utilizing local estimations calculated by modified unscented Kalman filter (UKF). Sufficient conditions are established to ensure boudedness of fusion estimation error covariance. Finally, comparative simulations indicate that measurement transmission is reduced for each communication channel while still maintaining satisfactory estimation performance by the proposed technique.

Index Terms

Distributed fusion estimation, event-triggered scheduling mechanism, unscented Kalman filter, random transmission delays.

I. Introduction

With development of science and technology, performance of sensors has been greatly improved and variety of multi-sensor networked systems (MNSs) have been developed. Fusion estimation for MNSs, studying how to obtain exact system's state by utilizing measurements data contained in all sensors effectively, has found applications in a variety of areas such as fault detection, target tracking and localization [30, 34]. Generally, basic fusion structures are divided into centralized and distributed, which depends on whether measurements data are used directly for fusion or not. Compared with the centralized fusion structure, the distributed one has drawn much research interest because of better robustness, flexibility and reliability [14]. In this sense, developing distributed fusion estimation for MNSs is of great practical significance (see [6–8, 13, 15, 35]). On the other hand, since network communication bandwidth is usually limited [16, 31], excessive measurement transmission brings about network congestion and aggravates network burden in MNSs. Furthermore, frequent measurement transmission also accelerates consumption of sensors since sensor's service life is negatively related with its usage frequency. Thus, it is necessary to reduce network transmission by event-triggered scheduling mechanisms (see [3, 4, 10, 21–23, 36]). In addition, network transmission delays are almost inevitable during data exchange over communication networks owing to limited communication capacity [5, 17]. In general, based on different communication protocols and network environment, network transmission delays are mainly divided into random delays (see [11, 12, 18, 19] and time-varying delay (see [17, 27, 28, 31, 37], which leads to research of distributed fusion estimation for MNSs more challenging.

Motivated by aforementioned analysis, the objective of this paper is to resolve an event-triggered distributed fusion estimation problem for bandwidth-constrained multi-sensor nonlinear networked system with random transmission delays. In order to reduce excessive measurement transmission, an event-triggered scheduling mechanism is introduced to decide whether measurements are transmitted to local estimators. To decrease effect of transmission delays on estimation performance, D-length buffers are used to retrieve partly delayed measurements. Then a modified unscented Kalman filter with transmission delays compensation is proposed. Based on a sequential covariance intersection (SCI) fusion technique, a distributed fusion estimation algorithm is designed utilizing local estimations calculated by the modified unscented Kalman filter. Finally, boundedness of fusion estimation error covariance is analyzed. Main contributions of the paper are summarized as below:

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