FAULT DETECTION FOR STATE-DELAY FUZZY SYSTEMS SUBJECT TO RANDOM COMMUNICATION DELAY

XIAOMEI ZHANG, ZHENJUAN ZHANG AND GUOPING LU

School of Electronics and Information
Nantong University
No. 9, Seyuan Road, Nantong 226019, P. R. China
{zhang.xm; zhang.zj; lu.gp}@ntu.edu.cn

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ABSTRACT. This paper is concerned with the problem of fault detection for discrete-time state-delay fuzzy systems. It is assumed that the output measurements are subject to random communication delay. The random communication delay is modeled as a finite state Markov process, and it is assumed that the transition probabilities are partially known. The problem addressed is the design of a delay-mode-dependent fuzzy fault detection filter, which is used as a residual generator, such that the estimation error between residual and fault (or, more generally, weighted fault) is as small as possible. Based on a fuzzy Lyapunov functional and Finsler’s Lemma, a delay-dependent sufficient condition for the solvability of the problem is established. The fault detection filter parameters can be obtained by solving a set of linear matrix inequalities. A numerical example is given to illustrate the efficiency of the proposed approach.

Keywords: Fault detection, State-delay fuzzy system, Random communication delay, Fuzzy Lyapunov functional, Partially known transition probabilities

1. Introduction. Fault detection and isolation (FDI) for many dynamic systems have attracted great attention. One of the most popular methods to FDI is model-based fault detection one, which is to design a fault detection filter or observer generating a residual to decide whether a fault has occurred in the system [1, 2, 3, 4]. In many real systems, unknown inputs, control inputs and faults are usually coupled. In order to design a robust FDI system, which is sensitive to faults and simultaneously robust to unknown inputs and control inputs, an $H_{\infty}$-filtering formulation of an FDI problem has been presented [5, 6, 7, 8, 9]. More recently, a great amount of effort has been devoted to the problem of FDI for both continuous-time systems and discrete-time systems in a networked environment [10, 11, 12, 13, 14]. The authors in [10] have studied the design of robust fault detection for networked control systems with large transfer delays, where the networked control system was modeled as a Markovian jump system based on the multirate sampling method together with the augmented state matrix method. The authors in [11] have dealt with the fault detection problem for a class of linear discrete-time systems in a networked environment. In [12], the problem of robust fault estimation has been investigated for a class of uncertain continuous-time linear networked control systems with random communication network-induced delays, which are described by Markov processes. The fault detection problem for continuous-time linear time-invariant systems over IP-based networks has been investigated in [13], in which the statistical characteristics of the network-induced delay are utilized. In [14], the problem of fault detection has been studied for continuous-time linear networked control systems with non-ideal network quality of service, which includes network-induced delay, data dropout and error sequence.