A NOVEL SIMULTANEOUS FAULT DETECTION AND CONTROL APPROACH BASED ON DYNAMIC OBSERVER

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Abstract. The problem of simultaneous fault detection and control (SFDC) for linear continuous-time systems is addressed in this paper. A mixed $H_2/H_\infty$ formulation of the SFDC problem using dynamic observer is presented. In essence, a single unit called detector/controller is designed where the detector is a dynamic observer and the controller is a state feedback controller based on the dynamic observer. Hence, the detector/controller unit produces two signals, i.e., the detection and control signals. It is shown that the dynamic observer can be used effectively to tackle the drawbacks of the existing methods of SFDC design. Indeed, the idea presented in this paper is based on applying the advantages of dynamic observers, which leads to some sufficient conditions for solvability of the SFDC problem in terms of LMI feasibility conditions. Simulation results illustrate the effectiveness of the proposed design technique.

Keywords: Simultaneous fault detection and control (SFDC), Dynamic observer, Linear matrix inequality (LMI)

1. Introduction. Model-based fault detection and isolation (FDI) has attracted considerable interest over the past decades (see, e.g., [1, 2, 3] and the references therein). Among model-based approaches, the most common one is to use state observers or filters to construct residual signal and compare it with a predefined threshold. When the residual evaluation function has a value larger than the threshold, an alarm is generated [4]. However, noises and disturbances may result in significant changes in the residual, leading to false alarms [5]. Hence, fault detection observers have to be sensitive to faults and simultaneously robust to noise and disturbances. Therefore, it is of great significance to design a robust FDI scheme. In [6], different performance indices are given for optimal selection of post-filters as well as optimization of fault detection filters. In [7], the fault detection filter design is formulated as an $H_\infty$-filtering problem, where the errors between residuals and faults are minimized. In [8], the problems of $H_\infty$ index and multiobjective $H_\infty/H_\infty$ fault detection observer design via LMI conditions are considered. In [9], the problem of robust fault detection filter design for discrete-time switched systems with state delays is investigated.

It should be mentioned that most of the existing fault detection observers have been simply confined in traditional static observers (classic Kalman-Luenberger observer) [10]. In order to distinguish from static observer, the term dynamic observer is used, which is