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ROBUST FAULT DETECTION USING SLIDING MODE AND ADAPTIVE OBSERVERS FOR UNCERTAIN NONLINEAR SYSTEMS

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Abstract. In this paper, a class of nonlinear systems with uncertainty and Lipschitz features is considered. The nonlinear part of the system satisfies Lipschitz condition, while the uncertain part is described as a bounded function. A fault detection strategy involving the application of two types of observers is proposed for the specific system. With the aid of a nonlinear sliding mode observer, the system state observation is performed, and then, on the appearance of actuator faults, another adaptive observer enables reconstruction of faults. Simulation studies demonstrate the effectiveness of the presented scheme.

Keywords. Fault detection, Nonlinear, Observers, Sliding mode, Adaptive

1 Introduction

Detecting and isolating system faults on industrial process have attracted considerable interest during the last two decades [1, 2]. Researches are still under way into the development of more effective solutions for fault detection and isolation (FDI) in automatic control systems. The fundamental purpose of an FDI scheme is to generate an alarm when a fault occurs and to identify its location. Among various FDI methods, the observer-based technique is the one that has been studied the most extensively. The basic idea of observer-based methods consists of reconstructing the outputs of considered system with the aid of observers or Kalman filters, and using estimation error as the residual. An observer feedback gain enters the calculation of residual generating and the gain design problem provides freedom for achieving the required performance [3,4]. Although FDI methods for linear systems have been well developed, those linear approaches may not work efficiently for strongly nonlinear systems. Because many industrial processes are of a nonlinear nature, special attention must be paid when applying FDI to nonlinear systems. On the basis of nonlinear observer theory, some FDI approaches with respect to nonlinear system have been developed. The BJDF method using a Thau-type nonlinear observer is generalized in [5] for a class