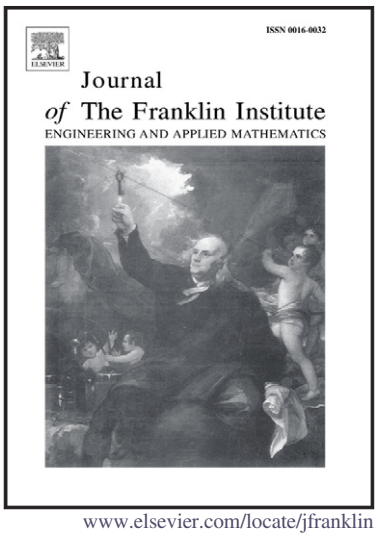


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Guang-Xin Zhong, Guang-Hong Yang

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# Fault detection for uncertain switched systems with time-varying delays

Guang-Xin Zhong*, Guang-Hong Yang

**Abstract**

This paper focuses on the fault detection (FD) problem for a class of uncertain switched systems with time-varying delays. The FD framework consists of the fault detection filters (FDFs) and a switching law. The resulting FDFs are with varying gains, which are expressed in the form of a linear parameter-varying (LPV) switched system. In special case, the proposed FDFs can be converted into the existing ones with fixed gains. The switching law satisfies the mode-dependent average dwell time (MDADT), which guarantees that each subsystem of the overall switched system is allowed to have its own average dwell time (ADT). Thus, the proposed design method leads to less conservatism and provides more flexibility. Delay-dependent conditions for the existence of the FDFs associated with the corresponding MDADT switching are formulated in terms of a set of linear matrix inequalities (LMIs), which ensure the exponential stability as well as a prescribed weighted $L_2$-gain for the errors between the residuals and faults. Two examples are given to illustrate the effectiveness of the theoretical results.



## I. Introduction

In the last decades, fault detection (FD) problem has been extensively studied due to the increased demands of safety and reliability of the industrial processes [1–6]. The classical method of FD is to design the detection observer, which generates a signal called residual. According to the difference of residual in fault-free and faulty cases, the fault of control systems can be detected [7, 8]. Many approaches have been applied in FD area such as robust $H_\infty$ optimisation scheme [9], minimum sensitivity realization [10], mixed $H_\infty/H_-$ approach [11].

On the other hand, the study of switched systems has been of great interest because of their practical applications in the area of system and control [12–14]. Up to now, many results on switched systems have covered a wide range of research problems including those for stability analysis [15, 16], $L_2$-gain and $H_\infty$ control [17, 18], filter design [19], etc. The FD problem for switched systems has also attracted considerable attention. For instance, in [20–23], the detection

Guang-Xin Zhong is with the College of Information Science and Engineering, Northeastern University, Shenyang, Liaoning, 110004, China. Corresponding author. zhongguangxin84@163.com

Guang-Hong Yang is with the College of Information Science and Engineering, Northeastern University, Shenyang, Liaoning, 110004, China. He is also with the Key Laboratory of Integrated Automation of Process Industry (Ministry of Education), Northeastern University, Shenyang 110004, China. yangguanghong@ise.neu.edu.cn