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Learning observer based and event-triggered control to spacecraft against actuator faults

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Abstract

This paper addresses the attitude control problem to spacecraft against actuator faults. A novel observer based event-triggered control (OETC) approach is proposed to cope with external disturbances, actuator faults and reduce the control updating frequency. First, a learning observer (LO) is utilized to reconstruct actuator faults and disturbances. Then, based on the LO, an event-triggered control (ETC) scheme is designed to achieve attitude stabilization from the reconstructed knowledge. The innovation is that the integrated OETC possesses resource-saving advantages of both LO and ETC, which haven't been used before. Moreover, the design method is simple and easy to operate. Simulations are given to demonstrate the validities of the proposed algorithm.

Key words: attitude control; fault tolerant; learning observer; event triggered;

1. Introduction

The development of spacecraft research has made it possible for many space missions, such as surveillance, communications, etc. [1]. Attitude control is a fundamental issue for spacecraft manoeuvring, which has drawn great attention [2], [3]. They are required to maintain a certain prescribed attitude in space during their service life [4]. Although the performance of spacecraft loaded-equipment has been improving, the mission requirements are also on the rise. Hence, the embedded resources onboard are always limited (energy, memory space, computing power, etc.) [5]. Therefore, designing a cost-effective controller is of significant necessity. Meanwhile, spacecraft may suffer certain actuator faults which cannot be fixed with replacement parts after being launched and may lead to mission failure or a series of potential problems, such as excess fuel consumption, on-orbit collision, etc. [6]. Thus, the ability of accommodating actuator faults is also required which makes the attitude control systems that maintain stability, reliability, and required performance properties.

Fault tolerant control (FTC) contains two categories, the passive FTC and active FTC [7]. The former method does not require any online fault information however has a very limited fault tolerance capability [8]. The active FTC involves the online fault detection and diagnosis (FDD) procedure [9] , and reacts to the faults by reconfiguring them so that the stability and acceptable performance can be maintained. It accepts a graceful degradation in overall system performance in the presence of faults, such as in [10], [11] and [12], Xiao et al. use observers to accommodate system uncertainties and actuator faults and

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