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ANALYSIS OF FAULT TOLERANT CONTROL BY USING RANDOMIZED ALGORITHMS

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Abstract. Active Fault Tolerant Control Systems (FTCS) can be modeled as stochastic systems with Markov parameters. This paper addresses the performance analysis of such systems by using the randomized algorithms. It firstly discusses the relations between the FTCS model and the imperfect FDI parameters. Then, by combining the stationary distribution of the Markov process and probabilistic performance at each mode of the integrated Markov process, it presents two algorithms to estimate the probability level of satisfying the performance requirement and the performance level given the probability requirement. The performance analysis can reveal some valuable results on the influence of imperfect FDI and properties of integrated design, as illustrated in the examples.

Keywords. Fault-tolerant control, performance analysis, randomized algorithms, jump linear systems, control systems.

1 Introduction

Fault Tolerant Control Systems (FTCS) usually employ the Fault Detection and Isolation (FDI) scheme and the reconfigurable controller to eliminate the effects of the component faults, also known as active FTCS [1, 2]. In this area, much research work is focused on the FDI imperfectness and its effects on the stability and performance of FTCS. For example, Mariton studied the effects of FDI delays on stability by modeling FTCS as Markov stochastic systems [3]; by using two Markov processes to represent the faults and FDI results, Srichander et al. developed the necessary and sufficient conditions for exponential stability in the mean square [4]. Mahmoud et al. derived the stability of FTCS in the presence of noise in [5] and summarized the related results in [6]. Although the Markov process modeling of FDI may be restrictive, the state combinations of two Markov processes gives a direct and clear description of FDI detection correctness. Furthermore, the simplicity of Markov process and the availability of analysis tools make it a valid model for FTCS.

In the design of FDI, False Alarm Rate (FAR) and Missing Detection Rate (MDR) are two common parameters to characterize the imperfect FDI. They can be estimated from FDI history data or the analytical model with