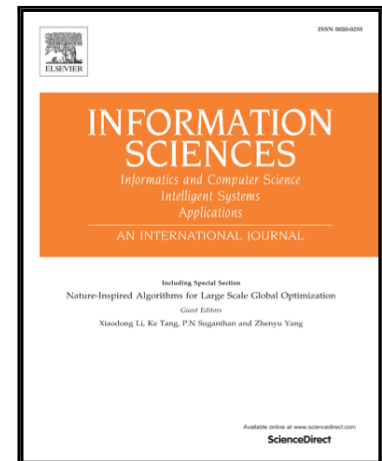


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Switched Systems Approach to State Bounding for Time Delay Systems*

Yong Chen[†] James Lam[†] Yukang Cui[‡] Ka-Wai Kwok[†]

Abstract

This paper investigates the problems of reachable set estimation for dynamic systems with time-varying delay and random delay. Different from the traditional Lyapunov-Krasovskii functional method, a switched systems approach is adopted to study the reachable set estimation problem for time-varying delay systems. Through augmentation, time-varying delay systems can be transformed into switched delay-free systems. The reachable set of a time-varying delay system is estimated based on its corresponding augmented switched system. The number of decision variables in the obtained reachable set estimation condition is small compared with the Lyapunov-Krasovskii functional method. In addition, the problem of mean square estimation of the system state for random delay systems is also studied. The effectiveness of the theoretical findings is verified through several simulation examples.

Keywords: Markov jump systems; Random delay; Reachable set estimation; Switched systems; Time-varying delay.

1 Introduction

Time delay, whether occurs in the system state, the control input, or the measurement, is often inevitable in practical systems and can be a source of instability and poor performance. The future evolution of the system state of a time delay system depends not only on its current value, but also on its past values. Many processes have time delay characteristics in their dynamics. For example, it takes time for the reactants in slow chemical processes to produce the required products. In networked control systems, the components are connected over networked media, the signal transmission from one place to another takes time. In addition, sensors and actuators in feedback loops usually introduce time delay even sometimes the influence of such delay can be ignored. For readers who are interested in time delay systems, please see monographs [1, 2, 3, 4].

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