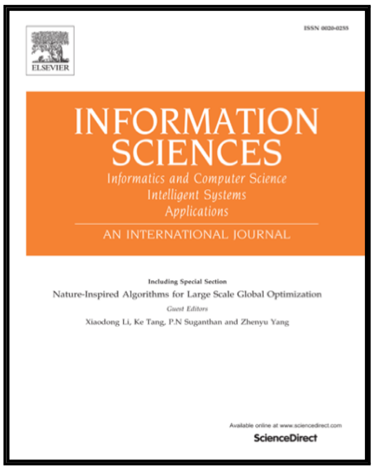

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Stability analysis of two-dimensional Markovian jump state-delayed systems in the Roesser model with uncertain transition probabilities

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Abstract

This paper is concerned with the problem of stochastic stability analysis of discrete-time two-dimensional (2-D) Markovian jump systems (MJSs) described by the Roesser model with interval time-varying delays. The transition probabilities of the jumping process/Markov chain are assumed to be uncertain, that is, they are not exactly known but can be estimated. A Lyapunov-like scheme is first extended to 2-D MJSs with delays. Based on some novel 2-D summation inequalities proposed in this paper, delay-dependent stochastic stability conditions are derived in terms of linear matrix inequalities (LMIs) which can be computationally solved by various convex optimization algorithms. Finally, two numerical examples are given to illustrate the effectiveness of the obtained results.

Keywords: Markovian jump systems, Roesser model, time-varying delay, stochastic stability, uncertain transition probabilities.

1. Introduction

Two-dimensional systems appear in a large number of practical and physical processes where the information propagation occurs in each of the two independent directions such as thermal processes, gas absorption or water stream heating [19]. During the last decade, the study of 2-D systems both in theory and practice has attracted an increasing attention from researchers due to their extensive applications, for example, in circuit analysis, image data processing and transmission, seismographic data processing, multi-dimensional digital filtering, repetitive processes or iterative learning control (see, for example, [1, 8, 26] and the references therein).

In modeling of many physical processes, 2-D systems can be represented by different state-space models such as the Roesser model, the first and the second Fornasini–Marchesini (FM) models, Attasi model or Kurek model [19]. Roesser model uses two independent state variables, namely horizontal state and vertical state, to describe dynamics of 2-D systems, and thus it is suitable to model many control processes of partial differential equations [3]. Although Roesser model can be recast into second FM model in some special cases (usually without delays), it is often studied separately in the literature due to its wide applications and special structure [36]. In general, with special structure, better results can be achieved.

It has been well recognized that time-delay frequently occurs in practical systems and particular in 2-D systems due to finite speed of information processing and data transmission among various parts of the system. In addition, the reaction of realistic systems to exogenous signals is never instantaneous and always infected by time delays. The existence of time-delay often degrades the system performance and even causes the system instability [28]. Therefore, the investigation of stability and control of time-delay systems plays an important role in applied models which has

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