



Input–output finite-time stabilization of Markovian jump systems with convex polytopic switching probabilities

Zhongyi Tang^{*}, Fei Liu

Key Laboratory of Advanced Control for Light Industry Processes, Ministry of Education, Jiangnan University, China

Received 8 January 2015; received in revised form 9 April 2016; accepted 29 June 2016

Available online 1 July 2016

Abstract

In this paper, the problem of input–output finite-time stabilization of Markovian jump systems with convex polytopic switching probabilities is addressed. First, a new criterion for testing the input–output finite-time stabilization of such systems is established. Then, in terms of linear matrix inequalities, a sufficient condition is proposed for the design of robust state-feedback controllers. A numerical example is presented to illustrate the effectiveness and potential of the developed theoretical results.

© 2016 The Franklin Institute. Published by Elsevier Ltd. All rights reserved.

1. Introduction

Markovian jump linear systems (MJLSs) have attracted a great deal of attention since MJLSs are a suitable mathematical model to represent a class of dynamic systems subject to random abrupt variations in their structures, such as changes in the interconnections of subsystems, sudden environment changes, stochastic failures and repairs of the components, and so on. In the last few decades, many results and a large variety of control problems have been widely studied, such as stability and stabilization [1–3], robust control [4], H_2 control [5], H_∞ control [6–8], H_∞ filtering design [9,10], guaranteed cost control [11], sliding mode control [12–14] and sampled-data control [15,16].

^{*}Corresponding author.

E-mail address: 001tzy@163.com (Z. Tang).

It is worth noticing that most of the achievements made in the literature related to the assumption that switching probabilities are known precisely a priori. However, the probability of the system mode jumping from one state to another may not be known exactly because the mode transition rates are almost beyond to estimate in real physical systems. In the last literature, three different types of descriptions about uncertain transition jump rates have been considered. One is the partially known transition probabilities. In practical applications, a part of transition probabilities can be determined by physical experiments or numerical simulation. The proposed systems are therefore more general, by which much more complex switching phenomena can be modeled. The MJS with partially known transition probabilities were extensively studied in many issues [17,18]. Another is uncertain switching probabilities. In [19], Xiong considered the element-wise uncertainties in the switching probabilities matrix. Recently, Luan studied discrete-time markov jump systems with uncertain transition probabilities [8]. The uncertain information of transition probabilities was quantized by Gaussian transition probability density function [20]. In this paper, the third kind of Markovian jump systems with uncertain transition probabilities is studied.

The idea of finite time stability (FTS) in the literature was known from Dorato [21]. LAS and FTS are independent concepts. A system can be LAS but not FTS, and vice versa. Classic Lyapunov asymptotic stability (LAS) pays more attention to state behavior of control dynamic over an infinite-time interval, while a specify bound on the trajectories in finite interval is considered in the FTS. The study of FTS has been developed intensively in the last few years [22,23]. Consistent with FTS, input–output finite time stability (IO-FTS) [24,25] means that the outputs of the system are norm bounded over $[0, T]$ if the input signals are norm bounded over a specified time interval $[0, T]$. Amato studies the IO-FTS of linear systems in [24–27]. Guo [28] presents linear system IO-FTS method under FTB constraint. To the authors' knowledge, no work on IO-FTS of MJS with convex polytopic switching probabilities has been done at the present stage.

This paper is organized as follows. In Section 2, the definition of IO-FTS is recalled and specialized to the MJS, and the problem we deal with is formally stated. In Section 3, two different classes of input signals are discussed. The sufficient condition for the existence of a state feedback controller guaranteeing IO-FTS of the closed-loop system is provided. In Section 4, a numerical example is given to show the effectiveness. The conclusions are drawn in Section 5.

In the sequel, the notation used in this paper is standard. The superscript “T” stands for matrix transposition. $\mathbb{R}^n$ and $\mathbb{R}^{n \times m}$ denote respectively, the n dimensional Euclidean space and the set of all the $n \times m$ real matrices. $\|A\|$ denotes the Euclidean norm of matrix A . $P > 0$ stands for a positive definite matrix and $\text{diag} M_1, M_2 \dots M_n$ represents a block-diagonal matrix continued by $M_1, M_2 \dots M_n$. In addition, I is the unit matrix with appropriate dimensions, “*” is used as an ellipsis for the terms that are introduced by symmetry.

2. Problem formulation and preliminaries

Given a probability space $(\mathbb{U}, \mathbb{E}, \mathbb{P})$ where $\mathbb{U}$ is the sample space, $\mathbb{E}$ is the algebra of events and $\mathbb{P}$ is the probability measure define on $\mathbb{E}$. The random form process $\{r_t, t \geq 0\}$ is a markov stochastic process which takes values on a finite set $\mathcal{N} = 1, 2, \dots, N$ with transition probability

Download English Version:

<https://daneshyari.com/en/article/560030>

Download Persian Version:

<https://daneshyari.com/article/560030>

[Daneshyari.com](https://daneshyari.com)