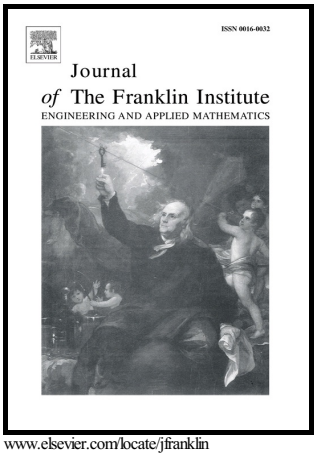
Author's Accepted Manuscript



www.elsevier.com/locate/jfranklin

An improved approach to controller design of positive systems using controller gain decomposition

Junfeng Zhang, Xudong Zhao, Ridong Zhang

PII: S0016-0032(16)30445-8
DOI: http://dx.doi.org/10.1016/j.jfranklin.2016.11.026
Reference: FI2815

To appear in: *Journal of the Franklin Institute*

Received date: 30 June 2016
Revised date: 27 September 2016
Accepted date: 27 November 2016

Cite this article as: Junfeng Zhang, Xudong Zhao and Ridong Zhang, An improved approach to controller design of positive systems using controller gain decomposition, *Journal of the Franklin Institute* http://dx.doi.org/10.1016/j.jfranklin.2016.11.026

An improved approach to controller design of positive systems using controller gain decomposition

Junfeng Zhang[a,b,*], Xudong Zhao[c], Ridong Zhang[b]

[a] *Institute of Information and Control, Automation, Hangzhou Dianzi University, 310018, China*

[b] *Key Lab for IOT and Information Fusion Technology of Zhejiang, Hangzhou Dianzi University, 310018, China*

[c] *Faculty of Electronic Information and Electrical Engineering, Dalian University of Technology, Dalian 116024, China*

Abstract

This paper aims to propose an improved controller design approach for positive systems in both continuous-time and discrete-time contexts. First, by decomposing the controller gain matrix into components, compact conditions that is simple and easy to be computed for guaranteeing the positivity and stability of positive systems is formulated. Based on the obtained conditions, new stabilization results and subsequent controller design are formulated with improvements in both the feasibility of conditions and the generality of the controller. All conditions are solvable in terms of linear programming. Compared with existing approaches in the literature, the new design approach constructs a controller with simpler forms and less restrictions. Meanwhile, the efficiency and advantage of the present approach are verified by application to the typically studied problems in the literature. Some discussions on the proposed approach are provided to show its potential applications on positive systems. Finally, three comparison examples are given to verify the merits of the theoretical findings.

Keywords: Positive systems, controller design, controller gain decomposition, linear programming

1. Introduction

Positive systems were first introduced in 1979 [1] and have drawn a lot of attention in the control community. Positive systems are a class of special systems with many interesting features since then. For instance, the state of a positive system is always confined in the positive orthant if the initial conditions are nonnegative; a positive system with bounded time-delay is stable if its corresponding system without time-delay is stable; a Lyapunov function of positive systems can be chosen as the linear form, etc. These features have attracted the attention of researchers and also pave the way for new approaches to appear for positive systems. In recent years, the topics on positive systems mainly focus on controllability [2, 3], reachability [4, 5], realization [6], and so on [7–10].

Like general systems, stabilization is still a fundamental issue for positive systems. However, there are relatively fewer results on the stabilization of positive systems [11]. In 2007, Ait Rami et al. presented a linear programming approach to controller design of positive systems [12, 13]. Subsequently, the linear programming approach was applied to output-feedback stabilization [14] of positive systems. These developments verify that linear programming is an effective approach to control synthesis of positive systems. The problem of ℓ_1-induced state-feedback controller design for positive systems was investigated by using a linear copositive Lyapunov function in [15]. In [16], a static output-feedback controller design was presented, where an iterative linear matrix inequality algorithm was provided

* *E*-mail address: jfz5678@126.com (J. Zhang).