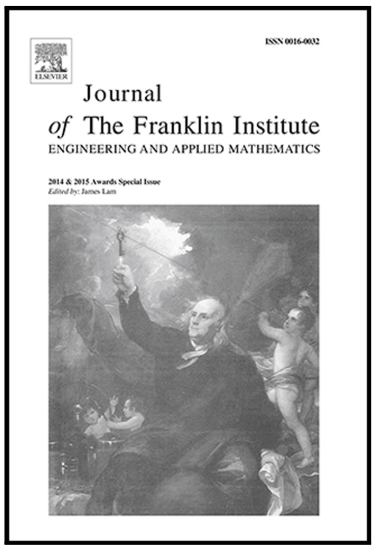

Two novel general summation inequalities to discrete-time systems with time-varying delay

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PII: S0016-0032(17)30301-0
DOI: 10.1016/j.jfranklin.2017.06.008
Reference: FI 3026

To appear in: *Journal of the Franklin Institute*

Received date: 23 November 2016
Revised date: 5 April 2017
Accepted date: 16 June 2017

Please cite this article as: Jun Chen, Shengyuan Xu, Qian Ma, Yongmin Li, Yuming Chu, Zhengqiang Zhang, Two novel general summation inequalities to discrete-time systems with time-varying delay, *Journal of the Franklin Institute* (2017), doi: 10.1016/j.jfranklin.2017.06.008

Two novel general summation inequalities to discrete-time systems with time-varying delay

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Abstract

This paper presents two novel general summation inequalities, respectively, in the upper and lower discrete regions. Thanks to the orthogonal polynomials defined in different inner spaces, various concrete single/multiple summation inequalities are obtained from the two general summation inequalities, which include almost all of the existing summation inequalities, e.g., the Jensen, the Wirtinger-based and the auxiliary function-based summation inequalities. Based on the new summation inequalities, a less conservative stability condition is derived for discrete-time systems with time-varying delay. Numerical examples are given to show the effectiveness of the proposed approach.

Keywords: Lyapunov–Krasovskii functional; stability; summation inequalities; time-varying delay.

1 Introduction

It is known that time delay widely exists in various dynamic systems in the real world [1]. It usually brings poor performance or even causes instability. Therefore, stability analysis for time-delay systems has been one of the hot research topics in the past decades [1–31].

The input-output method is a good choice to analyze the stability of time-delay systems [1–3]. This method is based on the model transformation from an original time-delay system to a closed-loop system composed of the nominal system and the system with uncertainty depending on delay. The Lyapunov–Krasovskii (L–K) method is another commonly used approach. Owing to its simplicity and straightforwardness, the L–K method has been attracting more and more attention [4–27]. In this case, how to construct an appropriate L–K functional becomes very important since it makes a direct impact on the conservatism of the resulting stability conditions. In order to achieve less conservative conditions, multiple integral/summation functions have been added into the existing L–K functional [6, 17, 21].

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