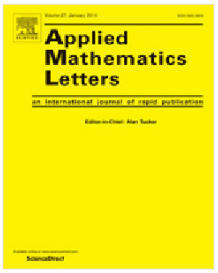
Accepted Manuscript



A new double integral inequality and application to stability test for time-delay systems

Nan Zhao, Chong Lin, Bing Chen, Qing-Guo Wang

PII: S0893-9659(16)30293-2
DOI: http://dx.doi.org/10.1016/j.aml.2016.09.019
Reference: AML 5104

To appear in: *Applied Mathematics Letters*

Received date : 23 August 2016
Revised date : 28 September 2016
Accepted date : 28 September 2016

Please cite this article as: N. Zhao, et al., A new double integral inequality and application to stability test for time-delay systems, Appl. Math. Lett. (2016), http://dx.doi.org/10.1016/j.aml.2016.09.019

A new double integral inequality and application to stability test for time-delay systems*

Nan Zhao[a], Chong Lin †,[a], Bing Chen[a], and Qing-Guo Wang[b]

[a] *Institute of Complexity Science, Qingdao University, Qingdao 266071, China*
[b] *Institute for Intelligent Systems, University of Johannesburg, Johannesburg, South Africa*

Abstract: This paper is concerned with stability analysis for linear systems with time delays. Firstly, a new double integral inequality is proposed. Then, it is used to derive a new delay-dependent stability criterion in terms of linear matrix inequalities (LMIs). Two numerical examples are given to demonstrate the effectiveness and merits of the present result.

Keywords: time-delay system, integral inequality, stability analysis, Lyapunov-Krasovskii functional

1 Introduction

Consider the following system with state and distributed delays:

$$\begin{aligned} \dot{x}(t) &= Ax(t) + A_d x(t-h) + A_D \int_{t-h}^{t} x(s)ds, \\ x(t) &= \phi(t), \quad t \in [-h, 0] \end{aligned} \tag{1}$$

where $x(t) \in \mathbb{R}^n$ is the state vector, A, A_d, $A_D \in \mathbb{R}^{n\times n}$ are constant matrices, h is a constant time delay satisfying $h > 0$, and $\phi(t)$ is a continuous vector-valued initial function.

The stability of system (1) keeps attracting researchers for many years. In order to reduce conservatism of stability criteria, a number of techniques are presented, including for instance, the free-weighting matrix method [1–4], reciprocally convex approach [5, 6] and various integral inequality methods [7–15]. The well-known Jensen's inequality is commonly adopted as it could lead to a stability test with fewer matrix variables. Recently, a so-called Wirtinger-based integral inequality developed in [8] is shown more powerful than Jensen's inequality. Later, some other types of integral inequalities have been reported in [3, 4, 10–14] to further reduce the conservatism of the stability test.

*This work is supported in part by the National Natural Science Foundation of China (61673227, 61473160, 61573204)

†Corresponding author: C. Lin. *E-mail addresses*: zhaonan2726@126.com (N. Zhao), linchong_2004@hotmail.com (C. Lin), chenbing1958@126.com (B. Chen), wangq@uj.ac.za (Q.-G. Wang).