EFFICIENT LMI-BASED QUADRATIC STABILITY AND STABILIZATION OF PARAMETER-DEPENDENT INTERVAL SYSTEMS WITH APPLICATIONS

GUANGBIN CAI¹,², CHANGHUA HU¹ AND GUANGREN DUAN²

¹Unit 302, Department of Automation
Xi’an Research Institute of High-Tech
Hongqing Town, Xi’an 710025, P. R. China
cgb0712@163.com; hch6603@263.net

²Center for Control Theory and Guidance Technology
Harbin Institute of Technology
No. 92, West Da-Zhi Street, Harbin 150001, P. R. China
g.r.duan@hit.edu.cn

Received December 2010; revised May 2011

Abstract. This paper is concerned with the problem of quadratic stability and stabilization for continuous-time linear parameter-dependent interval systems. Differing from previous results in the analysis and control design of interval systems, the new necessary and sufficient conditions proposed in this paper for the quadratic stability, quadratic stabilization and \( \mathcal{D} \)-stabilization are based on parameter-dependent model representation of interval systems. In the quadratic framework, an approach based on a vertex result on interval uncertain parameters is proposed. This allows the solvability conditions to be presented in terms of a set of parameterized linear matrix inequalities which can be efficiently solved by using standard numerical softwares. A linearized longitudinal dynamic model of the flight control system of a supersonic cruise missile is presented to illustrate the effectiveness and advantage of the proposed methods.

Keywords: Parameter-dependent interval systems (PDIs), Quadratic stability, Quadratic stabilization, \( \mathcal{D} \)-stabilization, Linear matrix inequalities (LMIs), Flight control

1. Introduction. It is well known that linear interval systems are a class of dynamic linear systems whose state-space matrices depend on a set of uncertain parameters which are not constant, but are variable on some fixed intervals. As one of the complex system models with uncertain parameters, robust control of dynamic interval systems have been studied intensively in the last two decades and significant progress has been made in this area (see, for example, [1-16]). This is mainly due to the fact that many real-world physical systems with various uncertainties are well characterized by dynamic interval systems. Moreover, both the stability analysis and the stabilization control are fundamental requirements of the most of designed control systems, certainly including interval control systems. Recently, lots of results about the robust stability and stabilization of interval systems are readily available in the existing literature (see, for example, [1, 2, 5-8, 10-16]). In [1], Mao and Chu presented effective, less conservative, necessary and sufficient conditions for the quadratic stability and stabilization of dynamic interval systems. Jetto and Orsini considered the efficient LMI-based quadratic stabilization of the interval LPV systems with noisy parameter measures [2]. In [4], a sufficient condition for quadratic stabilizability and root clustering was given via the way of an auxiliary convex problem. Myszkorowski discussed the stability of discrete-time linear interval systems [5]. Different conditions of robust stabilization of the linear time-invariant interval systems via