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ON STABILITY AND PERFORMANCE ANALYSIS OF DISCRETE UNCERTAIN SYSTEMS

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Abstract. This paper presents a new linear matrix inequality based stability result for uncertain discrete-time linear systems, which is derived by defining a multiple-Lyapunov function and by using a new bounding technique. This new bounding technique has two advantages: (1) possible to yield less conservative results, which is shown via a numerical example; and (2) flexible to cope with more complicated problems, which is illustrated by presenting a new H_∞ performance condition. It is anticipated that the idea behind this paper can be further extended to deal with synthesis problems.

Keywords. Discrete-time systems, linear matrix inequality, multiple Lyapunov function, uncertain systems, robust stability.

1 Introduction

In recent years, the issue of parameter-dependent stability has attracted much attention from researchers in the world. The main reason is that the widely used quadratic stability [2, 8, 13, 14, 17] can sometimes lead to very conservative results, though it greatly facilitates the analysis and synthesis of uncertain linear systems. Some important works concerning parameter-dependent idea have been reported in the literature, see, for instance, [4, 5, 7, 10, 11, 16] and the references therein.

Recently, a new result for the stability analysis of discrete-time systems with polytopic uncertain parameters was reported in [11], where multiple-Lyapunov function has been exploited to derive stability of such systems. The idea behind this paper has been further extended to cope with other related problems in their series of works, such as robust stability of polynomial matrix polytopes and robust D-stability of uncertain polytopic systems. A common feature in these works can be found that in deriving the final linear matrix inequality (LMI) conditions, an analytical technique has been used, which leads to results to be of the following form

$$\begin{aligned} [\text{Inequality 1}] &< -I, \\ [\text{Inequality 2}] &< \frac{1}{(N-1)^2} I, \\ [\text{Inequality 3}] &< \frac{6}{(N-1)^2} I \end{aligned}$$