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STABILITY ANALYSIS AND ROBUST CONTROLLER DESIGN FOR UNCERTAIN DISCRETE-TIME SINGULARLY PERTURBED SYSTEMS

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Abstract. In this paper, the stability analysis and controller design for uncertain discrete-time singularly perturbed system are investigated via a matrix inequality approach. In analysis, the stability condition under which the singularly perturbed system is quadratically stable for sufficiently small singular perturbation parameter is derived in the formulation of linear matrix inequality (LMI). In synthesis, the stabilization condition turns out to be in the formulation of nonlinear matrix inequality and is solved by the proposed heuristic two-stage procedure. The reduced controller is also developed using the similar approach. Finally, some numerical examples are used to demonstrate the effectiveness of the proposed analysis and design techniques.

Keywords. Discrete-time, LMI, robust stabilization, singular perturbations, uncertain systems

AMS (MOS) subject classification:

1 Introduction

In the last thirty years, a number of papers have been devoted to the study of the control problem of linear singularly perturbed systems. The reduced technique and the descriptor system approach have been proposed for continuous-time singularly perturbed systems [4,21]. Ref.[20] has studied the robust stabilization problem of singularly perturbed systems in which structured uncertainties enter into both state and input matrices by using the Riccati equation approach. Recently, linear matrix inequality (LMI)-based methods were also utilized in the analysis and design of singularly perturbed systems[2,5,6,12,15,18]. The advantages of LMI approach are that it is numerically tractable and it can be easily applied to the uncertain systems[9,10,11].

The above results appear to be restricted to the continuous-time cases. On the other hand, significant progress has been made toward the control of discrete-time singularly perturbed systems. The method for evaluating the stability bounds using the critical stability criteria was developed by [13]. The optimal control has been investigated using the Riccati equation approach by [4,17]. It is known that the resulting Riccati equation usually