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ROBUST CONTROL FOR FAST-SAMPLING DISCRETE-TIME FUZZY SINGULARLY PERTURBED SYSTEMS

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Abstract. *Robust control problem is investigated in this paper for a class of discrete-time fuzzy singularly perturbed systems with uncertainty. Unlike the nonlinear matrix inequalities (NMIs) condition put forward by the existing results for the same problem, in this paper, by introducing some new matrix variables, the control synthesis is parameterized in terms of a set of linear matrix inequalities (LMIs). Furthermore, the reduced-control law, which is only dependent on the slow variables, is also discussed. Finally, examples are given to illustrate the design procedure less conservative than the existing results.*

Keywords: Fuzzy system, Fast-sampling discrete-time singularly perturbed systems, LMI, Uncertainty, Parallel distributed compensator (PDC)

1. **Introduction.** Singular perturbation has its birth in the boundary layer theory in fluid dynamics due to Prandtl [1]. In a paper, given at the Third International Congress of Mathematicians in Heidelberg in 1904, he pointed out that, for high Reynolds numbers, the velocity in incompressible viscous flow past an object changes very rapidly from zero at the boundary to the value as given by the solution of the Navier-Stokes equation. In studying singular perturbation problems in fluid dynamics, much attention is drawn to the important work. The main purpose of the singular perturbation approach to analysis and design is the alleviation of high dimensionality and ill-conditioning resulting from the interaction of slow and fast dynamics modes, and also find wide applications in applied mathematics, engineering, fluid dynamics, etc.

In state space, such systems are commonly modeled using the mathematical framework of singular perturbations, with a small parameter, denoted by ε, determining the degree of separation between the "slow" and "fast" modes of the system [2]. In the past three decades, singularly perturbed systems have been intensively studied by many researchers, referring to literatures [3-12]. In the framework of singularly perturbed systems, a conventional approach is the so-called reduction technique, which is a two-step design methodology [6,13,14]. Also, the LMI-based methods are utilized in the analysis and design of singularly perturbed systems [15-17]. However, almost all of the results in the literatures seem to be restricted to the linear singularly perturbed systems in continuous-time cases.

In 1980s, several researchers have considered the stabilization problem involved in nonlinear singularly perturbed systems [18-20]. Despite of the fact that some progress has