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DESIGN OF STABLE AND QUADRATIC-OPTIMAL STATIC OUTPUT FEEDBACK CONTROLLERS FOR TS-FUZZY-MODEL-BASED CONTROL SYSTEMS: AN INTEGRATIVE COMPUTATIONAL APPROACH

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Abstract. *By integrating the stabilizability condition, the orthogonal-functions approach (OFA) and the hybrid Taguchi-genetic algorithm (HTGA), an integrative computational method is presented in this paper to design the stable and quadratic-optimal static output feedback parallel-distributed-compensation (PDC) controller such that (i) the Takagi-Sugeno (TS) fuzzy-model-based control system can be stabilized, and (ii) a quadratic finite-horizon integral performance index for the TS-fuzzy-model-based control system can be minimized. In this paper, the stabilizability condition is proposed in terms of linear matrix inequalities (LMIs). By using the OFA and the LMI-based stabilizability condition, the stable and quadratic-finite-horizon-optimal static output feedback PDC control problem for the TS-fuzzy-model-based dynamic systems is transformed into a static constrained-optimization problem represented by the algebraic equations with constraint of LMI-based stabilizability condition, thus greatly simplifying the optimal static output feedback PDC control design problem. Then, for the static constrained-optimization problem, the HTGA is employed to find the stable and quadratic-optimal static output feedback PDC controllers of the TS-fuzzy-model-based control systems. A design example of stable and quadratic-optimal static output feedback PDC controller for a nonlinear inverted pendulum system controlled by a separately excited direct-current (DC) motor is given to demonstrate the applicability of the proposed integrative computational approach.*
Keywords: Quadratic optimal control, Static output feedback PDC controller, Takagi-Sugeno fuzzy model, Orthogonal-functions approach, Hybrid Taguchi-genetic algorithm, Linear matrix inequalities

1. **Introduction.** Recently, it has been shown that the fuzzy-model-based representation proposed by Takagi and Sugeno [1], known as the TS fuzzy model, is a successful approach for dealing with the nonlinear control systems, and there are many successful applications of the TS-fuzzy-model-based approach to nonlinear control systems [2-15].