Robust Fuzzy Linear Control of a Class of Stochastic Nonlinear Time-Delay Systems

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Abstract: This paper presents the fuzzy linear control design method for a class of stochastic nonlinear time-delay systems with state feedback. First, the Takagi and Sugeno fuzzy linear model is employed to approximate a nonlinear system. Next, based on the fuzzy linear model, a fuzzy linear controller is developed to stabilize the nonlinear system. The control law is obtained to ensure stochastic exponential stability in the mean-square, independent of the time-delay. The sufficient conditions for the existence of such a control are proposed in terms of a certain linear matrix inequality. Finally, a simulation example is given to illustrate the applicability of the proposed design method.

Keywords: Fuzzy linear control; linear matrix inequality; time-delay systems; stochastic systems; exponential stability.

Mathematics Subject Classification (2000): 93C42, 93E15, 34K50.

1 Introduction

Most of the systems, which are encountered in control engineering, contain various nonlinearities and are affected by random disturbance signals. Nonlinear systems with time-delay constitute basic mathematical models of real phenomena, for instance in biology, mechanics and economics, see e.g. [8, 18]. Control of time-delay systems has been a subject of great practical importance, which has attracted a great deal of interest for several decades. On the other hand, it turns out that the delayed state is very often the cause for instability and poor performance of systems. Moreover, considerable attention has been given to both the problems of robust stabilization and robust control for linear systems with unavoidable time-varying parameter uncertainties in modelling of dynamical systems and certain types of time-delays [14].