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Fuzzy Control Systems with Time-Delay and Stochastic Perturbation: Analysis and Design

Abstract: Mathematical modelling of physical systems and processes can often lead to complex nonlinear systems, causing synthesis and analysis difficulties. Research of nonlinear systems is often problematic due to their complexities. One effective way of representing a complex nonlinear dynamic system is the so-called Takagi-Sugeno (T-S) fuzzy model, which is governed by a family of fuzzy IF-THEN rules that represent local linear input-output relations of the system. It incorporates a family of local linear models that smoothly blend together through fuzzy membership functions. This in essence, is a multi-model approach in which simple sub-models are fuzzily combined to describe the global behaviour of a nonlinear system. Within these fuzzy models, local dynamics in different state space regions are represented by linear models. An overall fuzzy model of the system is created by fuzzily 'blending' these linear models. Based on the fuzzy model, the control design is carried out by using the parallel distributed compensation scheme. The strategy is that a linear state feedback controller is designed for each local linear model. The obtained overall controller is nonlinear in general, and is again a fuzzy 'blending' of each individual linear controller. Practical systems are commonly fraught with time-delays such as chemical processes and communication, generally lowering the system's performance and may lead to instability. The prevalent use of stochastic systems is largely contributed to the numerous applications stochastic modelling has in branches of science and engineering. This talk will present some developments and innovative methodologies on optimal synthesis of T-S fuzzy systems with time-delay and stochastic perturbation in a unified matrix inequality setting.