Problem formulations of physical systems and processes can often lead to complex nonlinear systems, which may cause analysis and synthesis difficulties. Study 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 (typically linear models) are fuzzily combined to describe the global behavior of a nonlinear system. Based on the fuzzy model, the control design is carried out by using the parallel distributed compensation (PDC) scheme. The strategy is that a linear state-feedback controller or filter is designed for each local linear model. The obtained overall controller or filter is nonlinear in general, and is also a fuzzy ‘blending’ of each individual linear controller or filter.

Analysis and synthesis including state-feedback control, output-feedback control, tracking control, optical control, filtering, fault detection, and model reduction for a class of Interval Type-2 (IT2) T-S fuzzy systems are all thoroughly studied. Fresh novel techniques, including the linear matrix inequality (LMI) techniques, the slack matrix method, and so on, are applied to such systems. This monograph is divided into two sections. First, we focus on IT2 fuzzy controller and filter design for continuous-time IT2 T-S fuzzy systems. The following problems are investigated in this book: (1) the problem of stability and stabilization for IT2 fuzzy-model-based systems subject to parameter uncertainties; (2) the problems of state-feedback control and the output-feedback based control for IT2 T-S fuzzy systems under a new extended dissipativity performance; (3) the sampled-data control problem for IT2 fuzzy systems with actuator fault; (4) the output tracking control problem for nonlinear systems with actuator fault; (5) the switched output-feedback control problem for IT2 fuzzy systems; (6) the problem of filter design for IT2 fuzzy systems with \( D \) stability constraints and new performance index; (7) the fault detection problem for IT2 fuzzy systems subject to sensor
nonlinearities; (8) the model reduction problem for IT2 fuzzy systems. Secondly, the theories and techniques developed in the previous part are extended to the stability analysis and controller design problems of discrete-time IT2 T-S fuzzy systems. The below problems are studied: (1) the optimal control problem of discrete-time IT2 fuzzy time delay systems; (2) the fault-tolerant control problem for discrete-time IT2 fuzzy time delay systems with time-varying delay and actuator faults; (3) the static output-feedback control problem for discrete-time IT2 fuzzy systems; (4) the guaranteed cost output tracking control problem for IT2 fuzzy systems. Among the topics, simulation results including some typical real applications are presented to illustrate the effectiveness and the practicability of the fuzzy control design methods proposed in the previous parts.

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London, UK
Harbin, China
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Hongyi Li
Ligang Wu
Hak-Keung Lam
Yabin Gao
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