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Preface

In recent decades, singular systems have been widely studied due to their extensive applications in various practical systems such as electrical systems, economics, chemical processes and mechanics, etc. Many fundamental results based on the state space representation have been successfully extended to singular systems. When the dynamics of practical systems modeled by singular systems change abruptly, singular Markovian jump systems (SMJSs) have the advantage of better representing such systems. These abrupt changes are usually caused by phenomena such as random failures or repairs, changes in subsystem interconnections, sudden environmental changes, and so on. Such a class of systems involves both time-evolving and event-driven mechanisms. The former is the state vector which is continuous in time, and the latter is the operation mode, which is driven by a Markov process and takes values in a finite space. It should be noted that many important results on analysis and design of singular systems have been achieved. However, SMJSs have not been thoroughly investigated and the results obtained for SMJSs are considerably limited.

The objective of this monograph is to present up-to-date research development and literature review on the analysis and design of SMJSs. Problems such as stability, stabilization, H_∞ control, observer design, H_∞ filtering, and adaptive control for SMJSs and applications of Markov process are to be studied using Lyapunov theory, linear matrix inequality (LMI), S-procedure and the stochastic Barbalat's Lemma, etc. This monograph contains valuable reference material to help the relevant researchers to explore SMJSs and carry on further research in the area. The contents are also suitable for a one-semester graduate course.

In this monograph, the stability problem of SMJSs with general transition rate matrices (TRMs) is first studied. Basic concepts and results on stability and robust stability are presented. Based on these fundamental results, the robust stabilization for SMJSs with uncertain TRMs via mode-dependent or mode-independent controller is introduced. Then, stabilization results via TRM design, noise control, proportional-derivative control, and partially mode-dependent control are obtained in terms of LMIs or LMIs with some equation constraints. Within an LMI framework, the problem of H_∞ control in terms of mode-independent and

mode-dependent control are considered, where a disordered H_∞ controller is developed as well. Specifically, the mode-independent H_∞ control problem is solved by several different methods. Sufficient LMI conditions on generally observer-based feedback stabilization are developed, where either of the designed controller or observer can be mode-dependent or mode-independent. Furthermore, based on an LMI approach, the problem of robust H_∞ filtering is considered, while a method for partially mode-dependent filtering is proposed. In the case when bounds of TRMs of SMJSs are unknown or inaccessible, an adaptation law is developed to estimate the upper bounds of these parameters. LMI-based conditions for a class of adaptive state feedback controllers are presented such that not only the estimated error is bounded almost surely but also the corresponding closed-loop system are asymptotically stable almost surely. Finally, applications of the Markov process in singular systems with norm bounded uncertainties and time-varying delays are studied.

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Contents

Acronyms

BRL	Bounded real lemma
CCL	Cone complementarity linearization
DC	Direct current
MD	Mode-dependent
MDC	Mode-dependent controller
MI	Mode-independent
MIC	Mode-independent controller
MJS	Markovian jump system
MJSPS	Markovian jump singularly perturbed system
NOM	New operation mode
SLPM	Sequential linear programming matrix
SMJS	Singular markovian jump system
LMI	Linear matrix inequality
TRM	Transition rate matrix
ODEs	Ordinary differential equations
OM	Operation mode
OOM	Original operation mode
PD	Proportional-derivative
PDSFC	Proportional-derivative state feedback controller
PMD	Partially mode-dependent
QNQSS	Quadratically normal and quadratically stochastically stable
SSMJS	Stochastic singular Markovian jump systems