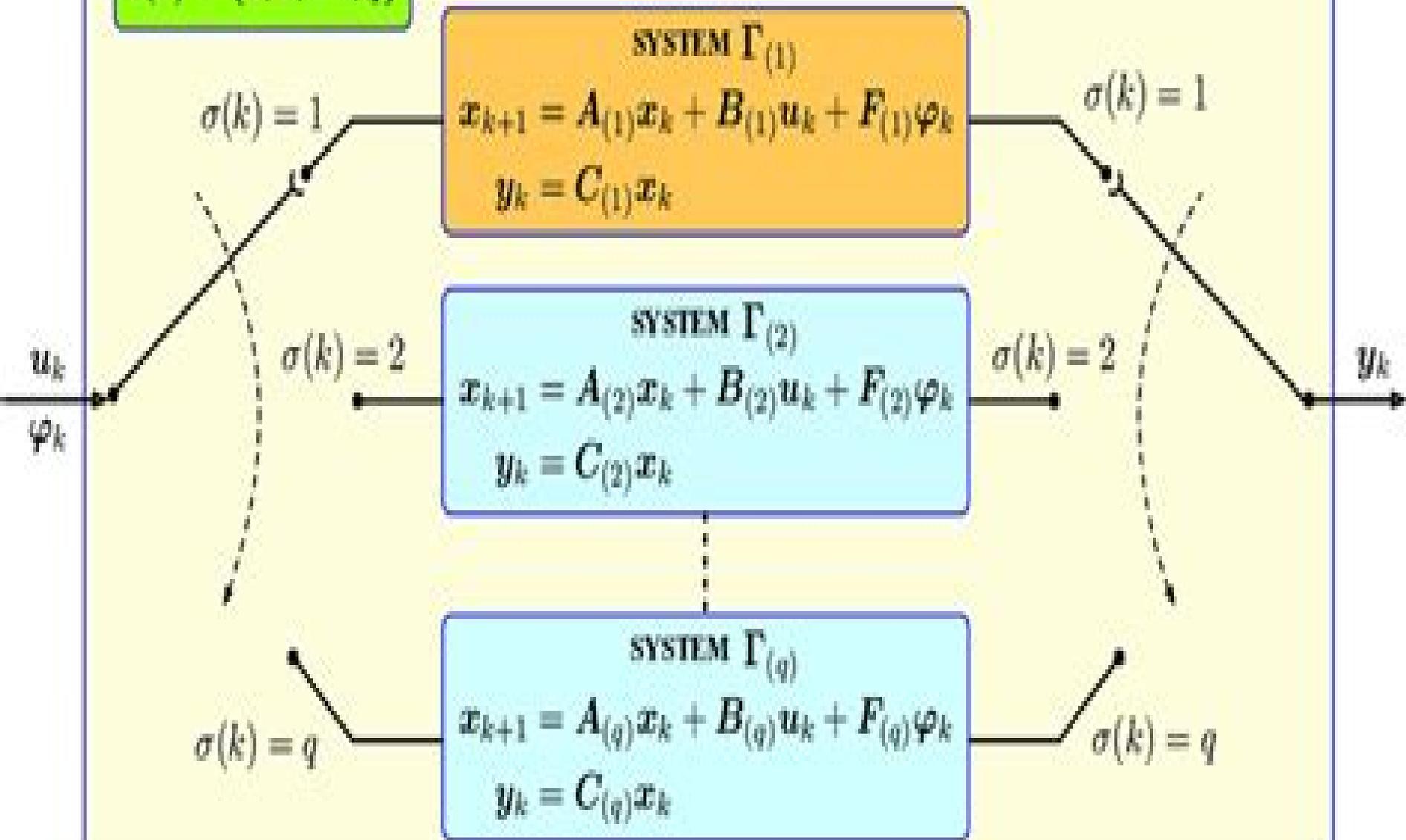


SWITCHED LINEAR SYSTEM

SUPERVISOR

$$\sigma(k) = \{1, 2, \dots, q\}$$



Switched Linear Systems

John Edward Miller



Switched Linear Systems:

Switched Linear Systems Zhendong Sun, 2006-03-30 Switched linear systems have enjoyed a particular growth in interest since the 1990s. The large amount of data and ideas thus generated have until now lacked a coordinating framework to focus them effectively on some of the fundamental issues such as the problems of robust stabilizing switching design, feedback stabilization, and optimal switching. This deficiency is resolved by this book, which features a nucleus of constructive design approaches based on canonical decomposition and forming a sound basis for the systematic treatment of secondary results, theoretical exploration, and logical association of several independent but pivotal concerns in control design as they pertain to switched linear systems: controllability and observability, feedback stabilization, optimization, and periodic switching. A reliable foundation for further theoretical research as well as design guidance for real-life engineering applications through the integration of novel ideas, fresh insights, and rigorous results. Switching in Systems and Control Daniel

Liberzon, 2012-12-06 Many systems encountered in practice involve a coupling between continuous dynamics and discrete events. Systems in which these two kinds of dynamics coexist and interact are usually called hybrid. For example, the following phenomena give rise to hybrid behavior: a valve or a power switch opening and closing, a thermostat turning the heat on and off, biological cells growing and dividing, a server switching between buffers in a queueing network, aircraft entering, crossing, and leaving an air traffic control region, dynamics of a car changing abruptly due to wheels locking and unlocking on ice. Hybrid systems constitute a relatively new and very active area of current research. They present interesting theoretical challenges and are important in many real-world problems. Due to its inherently interdisciplinary nature, the field has attracted the attention of people with diverse backgrounds, primarily computer scientists, applied mathematicians, and engineers. Researchers with a background and interest in continuous-time systems and control theory are concerned primarily with properties of the continuous dynamics, such as Lyapunov stability. A detailed investigation of the discrete behavior, on the other hand, is usually not a goal in itself. In fact, rather than dealing with specifics of the discrete dynamics, it is often useful to describe and analyze a more general category of systems which is known to contain a particular model of interest. Control Synthesis of Switched Systems Xudong Zhao, Yonggui Kao, Ben Niu, Tingting Wu, 2016-11-04 This book offers its readers a detailed overview of the synthesis of switched systems with a focus on switching stabilization and intelligent control. The problems investigated are not only previously unsolved theoretically but also of practical importance in many applications: voltage conversion, naval piloting and navigation, and robotics, for example. The book considers general switched system models and provides more efficient design methods to bring together theory and application more closely than was possible using classical methods. It also discusses several different classes of switched systems. For general switched linear systems and switched nonlinear systems comprising unstable subsystems, it introduces novel ideas such as invariant subspace theory and the time-scheduled Lyapunov function method of designing switching signals to stabilize the

underlying systems For some typical switched nonlinear systems affected by various complex dynamics the book proposes novel design approaches based on intelligent control concepts It is a useful source of up to date design methods and algorithms for researchers studying switched systems and graduate students of control theory and engineering In addition it is a valuable reference resource for practising engineers working in switched system control design Readers should have a basic knowledge of linear nonlinear and switched systems

Switched Linear Systems Zhendong Sun,2009-10-12

Switched linear systems have enjoyed a particular growth in interest since the 1990s The large amount of data and ideas thus generated have until now lacked a co ordinating framework to focus them effectively on some of the fundamental issues such as the problems of robust stabilizing switching design feedback stabilization and optimal switching This deficiency is resolved by this book which features nucleus of constructive design approaches based on canonical decomposition and forming a sound basis for the systematic treatment of secondary results theoretical exploration and logical association of several independent but pivotal concerns in control design as they pertain to switched linear systems controllability and observability feedback stabilization optimization and periodic switching a reliable foundation for further theoretical research as well as design guidance for real life engineering applications through the integration of novel ideas fresh insights and rigorous results

Event-Triggered Control of Switched Linear Systems Jun Fu,Tai-Fang Li,2021-04-12 This book

approaches its subject matter in a way that provides Lyapunov function analysis and event triggered design methods for switched dynamic systems in terms of sampled data control hysteresis switching control and fault tolerant control This book presents several novel design methods on event triggered control of switched linear systems in which the events inclusively consist of not only switching itself but events occurring as the switched systems evolve The features of our approaches lie in threefold i In the framework of sampled data control a bond between the sampling period and the average dwell time of the asynchronous switched linear neutral systems is revealed with which stabilization conditions are derived for periodic sampling and event triggered sampling mechanisms respectively ii New event triggered control strategies are proposed for switched linear systems and switched delay systems including switched neutral systems The Zeno phenomenon can be excluded easily since the constant threshold can guarantee the existence of minimum positive lower bound between two continuous sampling intervals iii Two new fault tolerant control methods are presented for switched cascade systems with structural uncertainties existing in both system matrices and input matrices of the linear subsystems by using the average dwell time techniques The proposed control design works on both the switched systems with actuator faults and its nominal systems i e without actuator faults without necessarily changing any structures and or parameters of the proposed controllers This book presents several systematical analysis and design methods for event triggered control of switched systems in terms of the Lyapunov based stability It is of great significance to theoretical research and practical applications for switched systems The book provides a unified framework of sampled data control including periodic sampled data control

and event triggered control and fault tolerant control of switched systems It serves as a useful book for researchers and graduate students who are interested in knowing the state of the art of analysis and synthesis of switched systems In addition it is also a useful source of up to date design methods for researchers who study switched dynamic systems and graduate students of control theory and control engineering

Time-Dependent Switched Discrete-Time Linear Systems: Control and Filtering Lixian Zhang, Yanzheng Zhu, Peng Shi, Qiugang Lu, 2016-01-19 This book focuses on the basic control and filtering synthesis problems for discrete time switched linear systems under time dependent switching signals Chapter 1 as an introduction of the book gives the backgrounds and motivations of switched systems the definitions of the typical time dependent switching signals the differences and links to other types of systems with hybrid characteristics and a literature review mainly on the control and filtering for the underlying systems By summarizing the multiple Lyapunov like functions MLFs approach in which different requirements on comparisons of Lyapunov function values at switching instants a series of methodologies are developed for the issues on stability and stabilization and l_2 gain performance or tube based robustness for l disturbance respectively in Chapters 2 and 3 Chapters 4 and 5 are devoted to the control and filtering problems for the time dependent switched linear systems with either polytopic uncertainties or measurable time varying parameters in different sense of disturbances The asynchronous switching problem where there is time lag between the switching of the currently activated system mode and the controller filter to be designed is investigated in Chapter 6 The systems with various time delays under typical time dependent switching signals are addressed in Chapter 7

Fault Tolerant Control for Switched Linear Systems Dongsheng Du, Bin Jiang, Peng Shi, 2015-01-29 This book presents up to date research and novel methodologies on fault diagnosis and fault tolerant control for switched linear systems It provides a unified yet neat framework of filtering fault detection fault diagnosis and fault tolerant control of switched systems It can therefore serve as a useful textbook for senior and or graduate students who are interested in knowing the state of the art of filtering fault detection fault diagnosis and fault tolerant control areas as well as recent advances in switched linear systems

Analysis and Control of Switched Linear Systems Using Different Switching Strategies Chang Duan, 2013

Switched Positive Linear Systems Franco Blanchini, Patrizio Colaneri, Maria Elena Valcher, 2015-10-19 Positive systems are an important class of systems that frequently arise in application areas such as in the chemical process industry electronic circuit design communication networks and biology The study of the stability of such systems differs from standard systems in that the analysis focuses only on the trajectories generated under positivity constraints Switched positive systems also arise in a variety of applications Examples can be found in TCP congestion control in processes described by non homogeneous Markov chains in image processing in biochemical networks and so on In comparison to general switched systems that have received a lot of attention in the past years the theory for positive switched systems is still in its infancy Switched Positive Linear Systems studies the stability performance evaluation stabilization via switching control and optimal control of continuous

time and linear positive switched systems It provides a review of the results that have already been established in the literature Other results especially those related to norm computation and optimization are new and are presented integrated with previous ones Switched Positive Linear Systems provides a comprehensive and timely introduction to the study of such systems Readers who are new to the topic will find everything required to understand such systems in a concise and accessible form Dynamics and Stability of Continuous-Time Switched Linear Systems Yacine Chitour, Paolo Mason, Mario Sigalotti, 2025-05-14 Linear switched systems are a fascinating field of research with many theoretical questions arising from applications which require sophisticated mathematical tools for their resolution This monograph presents a unified theoretical approach for the analysis of stability of continuous time linear switched systems organizing and optimizing results scattered throughout literature Emphasis is placed on the development of a rigorous and complete mathematical theory In addition to fundamental tools such as common Lyapunov functions converse Lyapunov theorems and maximal Lyapunov exponents the concept of Barabanov norm is also discussed While this is now well understood from a theoretical point of view it has not received much attention in more application focused settings likely because this fundamental object was developed in the context of arbitrary switches but has no immediate equivalent for classes of switching signals subject to various constraints dwell time persistent excitation etc One of the aims of this text is to bridge this gap as far as possible by explaining how the main features of Barabanov norms can be generalized for classes of constrained switchings Throughout the text the authors maintain a general point of view rather than treating classes of switching signals separately by developing an axiomatic approach and identifying structural properties of these classes that allow crucial aspects of the Barabanov norm to be extended This monograph will be a valuable resource for mathematicians and control engineers interested in continuous time switched linear systems as well as a definitive reference for more experienced researchers

The Recent Advances in Switched Linear Systems. Geovanny Wolff, 2021-06-30 The recent advances in switched linear systems *Switched Linear Systems* Sylvia M. Ritz, 1989 *The Control of Switched Linear Systems* Ali Benmerzouga, 1985 Switched Linear Systems Mohamed Babaali, 2004 Switched linear systems have long been subject to high interest and intense research efforts not only because many real world systems happen to exhibit switching behaviors but also because the control of many complex systems is only possible via the combination of classical continuous control laws with supervisory switching logic A particularly important problem is that of estimator and observer design since the state of a system is usually only available through partial often noise corrupted measurements Even though hybrid estimation has been around for at least thirty years a veil of mystery has surrounded the concept of observability in switched linear systems It is not until recently with the recent renewal of interest toward deterministic hybrid systems that observer design and observability analysis have fuelled sustained research efforts It is in this context that this work is grounded More precisely the objective of this research is twofold To define proper concepts of observability in discrete time switched linear

systems to characterize them and to analyze their main properties among which decidability is of special importance To propose and analyze observers deadbeat and asymptotic for such systems The main contributions of this dissertation are as follows It is shown that pathwise observability i e state observability under arbitrary mode sequences is decidable Furthermore the Kalman Bertram sampling criterion is carried over to switched linear systems Under unknown modes mode and state observability are both characterized through simple linear algebraic tests and are shown to be decidable in the autonomous case As for asymptotic observers a direct algebraic approach is proposed for the class of linear systems subjected to switching in the measurement equation

Stability Theory of Switched Dynamical Systems Zhendong Sun, Shuzhi Sam Ge, 2011-01-06 There are plenty of challenging and interesting problems open for investigation in the field of switched systems Stability issues help to generate many complex nonlinear dynamic behaviors within switched systems The authors present a thorough investigation of stability effects on three broad classes of switching mechanism arbitrary switching where stability represents robustness to unpredictable and undesirable perturbation constrained switching including random within a known stochastic distribution dwell time with a known minimum duration for each subsystem and autonomously generated with a pre assigned mechanism switching and designed switching in which a measurable and freely assigned switching mechanism contributes to stability by acting as a control input For each of these classes this book propounds detailed stability analysis and or design related robustness and performance issues connections to other control problems and many motivating and illustrative examples

Analysis and Synthesis for Discrete-Time Switched Systems Zhongyang Fei, Shuang Shi, Peng Shi, 2019-08-02 This book presents recent theoretical advances in the analysis and synthesis of discrete time switched systems under the time dependent switching scheme including stability and disturbance attenuation performance analysis control and filtering asynchronous switching finite time analysis and synthesis and reachable set estimation It discusses time scheduled technology which can achieve a better performance and reduce conservatism compared with the traditional time independent approach Serving as a reference resource for researchers and engineers in the system and control community it is also useful for graduate and undergraduate students interested in switched systems and their applications

Switched Time-Delay Systems Magdi S. Mahmoud, 2010-09-14 In many practical applications we deal with a wide class of dynamical systems that are comprised of a family of continuous time or discrete time subsystems and a rule orchestrating the switching between the subsystems This class of systems is frequently called switched system Switched linear systems provide a framework that bridges the linear systems and the complex and or uncertain systems The motivation for investigating this class of systems is twofold rst it has an inherent multi modal behavior in the sense that several dynamical subsystems are required to describe their behavior which might depend on various environmental factors Second the methods of intelligent control systems are based on the idea of switching between different controllers Looked at in this light switched systems provide an integral framework to deal with complex system behaviors

such as chaos and multiple limit cycles and gain more insights into powerful tools such as intelligent control adaptive control and robust control Switched systems have been investigated for a long time in the control and systems literature and have increasingly attracted more attention for the past three decades The number of journal articles books and conference papers have grown exponentially and a number of fundamental concepts and powerful tools have been developed It has been pointed out that switched systems have been studied from various viewpoints

Stability of Non-diagonalizable Switched Linear Systems on Time Scales John Edward Miller, 2009 This thesis investigates the stability of switched linear systems on time scales using Lyapunov stability theory First we focus on the most general case nondiagonalizable systems with arbitrary switching Subsequently a constrained switching case is investigated Several examples are given for both cases Switched linear systems are often found wherever a dynamical system is coupled with supervisory control logic that can abruptly change the system's operating mode such as in the transmission of a vehicle or on computer controlled real time networks This coupling of a dynamical system with discrete logic is difficult to model on standard time domains especially if the switching events are non uniformly spaced Time scales mathematics allows for these non uniform time domains

Fault Detection and Isolation in Switched Linear Systems and Applications ,2014 Identification of Switched Linear Systems Jiadong Wang, 2013

Unveiling the Magic of Words: A Review of "**Switched Linear Systems**"

In some sort of defined by information and interconnectivity, the enchanting power of words has acquired unparalleled significance. Their capability to kindle emotions, provoke contemplation, and ignite transformative change is actually awe-inspiring. Enter the realm of "**Switched Linear Systems**," a mesmerizing literary masterpiece penned by a distinguished author, guiding readers on a profound journey to unravel the secrets and potential hidden within every word. In this critique, we shall delve in to the book is central themes, examine its distinctive writing style, and assess its profound impact on the souls of its readers.

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