FREE DOWNLOAD TOPICS IN TIME DELAY SYSTEMS ANALYSIS ALGORITHMS AND CONTROL LECTURE NOTES IN CONTROL AND INFORMATION SCIENCES

Topics in Time Delay Systems

Time delays are present in many physical processes due to the period of time it takes for the events to occur. Delays are particularly more pronounced in networks of interconnected systems, such as supply chains and systems controlled over c- munication networks. In these control problems, taking the delays into account is particularly important for performance evaluation and control system’s design. It has been shown, indeed, that delays in a controlled system (for instance, a c- munication delay for data acquisition) may have an “ambiguous” nature: they may stabilize the system, or, in the contrary,they may lead to deteriorationof the clos- loop performance or even instability, depending on the delay value and the system parameters. It is a fact that delays have stabilizing effects, but this is clearly con i- ing for human intuition. Therefore,speci c analysis techniquesand design methods are to be developed to satisfactorily take into account the presence of delays at the design stage of the control system. The research on time delay systems stretches back to 1960s and it has been very active during the last twenty years. During this period, the results have been presented at the main control conferences(CDC, ACC, IFAC), in specialized wo- shops (IFAC TDS series), and published in the leading journals of control engine- ing, systems and control theory, applied and numerical mathematics.

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Stability, Control, and Computation for Time-Delay Systems

Time delays are important components of many systems in, for instance, engineering, physics, economics, and the life sciences, because the transfer of material, energy, and information is usually not instantaneous. Time delays may appear as computation and communication lags, they model transport phenomena and heredity, and they arise as feedback delays in control loops. This monograph addresses the problem of stability analysis, stabilization, and robust fixed-order control of dynamical systems subject to delays, including both retarded- and neutral-type systems. Within the eigenvalue-based framework, an overall solution is given to the stability analysis, stabilization, and robust control design problem, using both analytical methods and numerical algorithms and applicable to a broad class of linear time-delay systems. In this revised edition, the authors make the leap from stabilization to the design of robust and optimal controllers and from retarded-type to neutral-type delay systems, thus enlarging the scope of the book within control; include new, state-of-the-art material on numerical methods and algorithms to broaden the book?s focus and to reach additional research communities, in particular numerical linear algebra and numerical optimization; and increase the number and range of applications to better illustrate the effectiveness and generality of their approach.

Controlling Delayed Dynamics

This book gathers contributions on analytical, numerical, and application aspects of time-delay systems, under the paradigm of control theory, and discusses recent advances in these different contexts, also highlighting the interdisciplinary connections. The book will serve as a useful tool for graduate students and researchers in the fields of dynamical systems, automatic control, numerical methods, and functional analysis.

Low-Complexity Controllers for Time-Delay Systems

This volume in the newly established series Advances in Delays and Dynamics (ADD@S) provides a collection of recent results on the design and analysis of Low Complexity Controllers for Time Delay Systems. A widely used indirect method to obtain low order controllers for time delay systems is to design a controller for the reduced order model of the plant. In the dual indirect approach, an infinite dimensional controller is designed first for the original plant model; then, the controller is approximated by keeping track of the degradation in performance and stability robustness measures. The present volume includes new techniques used at different stages of the indirect approach. It also includes new direct design methods for fixed structure and low order controllers. On the other hand, what is meant by low complexity controller is not necessarily low order controller. For example, Smith predictor or similar type of controllers include a copy of the plant internally in the controller, so they are technically infinite dimensional. However, they have very nice numerical properties from the point of reliable implementation. Therefore, such predictor-based controllers are considered as low complexity. This book includes new predictor-based design techniques, with several application examples.

Delays and Interconnections: Methodology, Algorithms and Applications

This book contains advances on the theory and applications of time-delay systems with particular focus on interconnected systems. The methods for stability analysis and control design are based on time-domain and frequency-domain approaches, for continuous-time and sampled-data systems, linear and nonlinear systems. This volume is a valuable source of reference for control practitioners, graduate students, and scientists researching practical as well as theoretical solutions to a variety of control problems inevitably influenced by the presence of time delays. The contents are organized in three parts: Interconnected Systems analysis, Modeling and and Analysis for Delay systems, and Stabilization and Control Strategies for Delay Systems. This volume presents a selection of 19 contributions presented in the 4th DelSys Workshop which took place in Gif-sur-Yvette, France November 25-27, 2015.

Analysis and Synthesis of Singular Systems with Time-Delays

Singular time-delay systems are very suitable to describe a lot of practical systems such as manufacturing systems, networked control systems, power systems and electrical circuits. Thus, the past two decades have witnessed a significant progress on the theory of singular time-delay systems, and many fundamental and important topics have been successfully investigated including stability analysis, stabilization, guaranteed cost control, filtering, observer design, sliding mode control and so on. The main objective of this book is to present the latest developments and references in the analysis and synthesis of singular time-delay systems with or without Markov jumping parameters in a unified framework. The materials adopted in this book are mainly based on research results of the authors. This book will be of interest to academic researchers working in singular systems, time-delay systems and Markov jump systems and to graduate students interested in systems and control theory.

Feedback Control

This book develops the understanding and skills needed to be able to tackle original control problems. The general approach to a given control problem is to try the simplest tentative solution first and, when this is insufficient, to explain why and use a more sophisticated alternative to remedy the deficiency and achieve satisfactory performance. This pattern of working gives readers a full understanding of different controllers and teaches them to make an informed choice between traditional controllers and more advanced modern alternatives in meeting the needs of a particular plant. Attention is focused on the time domain, covering model-based linear and nonlinear forms of control together with robust control based on sliding modes and the use of state observers such as disturbance estimation. Feedback Control is self-contained, paying much attention to explanations of underlying concepts, with detailed mathematical derivations being employed where necessary. Ample use is made of diagrams to aid these conceptual explanations and the subject matter is enlivened by continual use of examples and problems derived from real control applications. Readers' learning is further enhanced by experimenting with the fully-commented MATLAB®/Simulink® simulation environment made accessible at insert URL here to produce simulations relevant to all of the topics covered in the text. A solutions manual for use by instructors adopting the book can also be downloaded from insert URL here. Feedback Control is suitable as a main textbook for graduate and final-year undergraduate courses containing control modules; knowledge of ordinary linear differential equations, Laplace transforms, transfer functions, poles and zeros, root locus and elementary frequency response analysis, and elementary feedback control is required. It is also a useful reference source on control design methods for engineers practicing in industry and for academic control researchers.

Introduction to Time-Delay Systems

The beginning of the 21st century can be characterized as the" time-delay boom" leading to numerous important results. The purpose of this book is two-fold, to familiarize the non-expert reader with time-delay systems and to provide a systematic treatment of modern ideas and techniques for experts. This book is based on the course "Introduction to time-delay systems" for graduate students in Engineering and Applied Mathematics that the author taught in Tel Aviv University in 2011-2012 and 2012-2013 academic years. The sufficient background to follow most of the material are the undergraduate courses in mathematics and an introduction to control. The book leads the reader from some basic classical results on time-delay systems to recent developments on Lyapunov-based analysis and design with applications to the hot topics of sampled-data and network-based control. The objective is to provide useful tools that will allow the reader not only to apply the existing methods, but also to develop new ones. It should be of interest for researchers working in the field, for graduate students in engineering and applied mathematics, and for practicing engineers. It may also be used as a textbook for a graduate course on time-delay systems.

Analysis and Synthesis of Dynamical Systems with Time-Delays

Time-delay occurs in many dynamical systems such as biological systems, chemical systems, metallurgical processing systems, nuclear reactor, long transmission lines in pneumatic, hydraulic systems and electrical networks. Especially, in recent years, time-delay which exists in networked control s-temshasbroughtmorecomplexprobleminto anewresearcharea.Frequently, itisasourceofthegenerationofoscillation,instabilityandpoorperformance. Considerable e?ort has been applied to di?erent aspects of linear time-delay systems during recent years. Because the introduction of the delay factor renders the system analysis more complicated, in addition to the di?culties caused by the perturbation or uncertainties, in the control of time-delay s- tems, the problems of robust stability and robust stabilization are of great importance. This book presents some basic theories of stability and stabilization of systems with time-delay, which are related to the main results in this book. More attention will be paid on synthesis of systems with time-delay. That is, sliding mode control of systems with time-delay; networked control systems with time-delay; networked data fusion with random delay.

Time Delay Systems: Methods, Applications and New Trends

This volume is concerned with the control and dynamics of time delay systems; a research field with at least six-decade long history that has been very active especially in the past two decades. In parallel to the new challenges emerging from engineering, physics, mathematics, and economics, the volume covers several new directions including topology induced stability, large-scale interconnected systems, roles of networks in stability, and new trends in predictor-based control and consensus dynamics. The associated applications/problems are described by highly complex models, and require solving inverse problems as well as the development of new theories, mathematical tools, numerically-tractable algorithms for real-time control. The volume, which is targeted to present these developments in this rapidly evolving field, captures a careful selection of the most recent papers contributed by experts and collected under five parts: (i) Methodology: From Retarded to Neutral Continuous Delay Models, (ii) Systems, Signals and Applications, (iii): Numerical Methods, (iv) Predictor-based Control and Compensation, and (v) Networked Control Systems and Multi-agent Systems.

Applications of Time Delay Systems

This book provides an update of the latest research in control of time delay systems and applications by world leading experts. It will appeal to engineers, researchers and students in Control.

Computer Aided Control System Design: Methods, Tools And Related Topics

This book is about Computer Aided Control System Design (CACSD) of the direct process controller. Various methods and tools, representing an up-to-date level of development, are presented by leading experts. Several articles describe main principles and problems associated with modern direct control and with CACSD. Existing tools are presented, including packages for stability analysis of nonlinear systems, adaptive control design and integrated analysis, and simulation and tuning of controllers. The reader can observe that it is possible to develop CACSD tools by using open general packages such as Matlab or Simulab, or by providing specialised software. He can then compare both approaches and get an improved understanding of their respective advantages and disadvantages. The leading article by the editors presents CACSD Methods and tools in a broader context. There is also detailed material on upper control layers, hierarchical control, and real-time systems.

Control and Estimation of Systems with Input/Output Delays

Time delays exist in many engineering systems such as transportation, communication, process engineering and networked control systems. In recent years, time delay systems have attracted recurring interests from research community. Much of the effort has been focused on stability analysis and stabilization of time delay systems using the so-called Lyapunov-Krasovskii functional together with a linear matrix inequality approach, which provides an efficient numerical tool for handling systems with delays in state and/or inputs. Recently, some more interesting and fundamental development for systems with input/output (i/o) delays has been made using time domain or frequency domain approaches. These approaches lead to analytical solutions to time delay problems in terms of Riccati equations or spectral factorizations. This monograph presents simple analytical solutions to control and estimation problems for systems with multiple i/o delays via elementary tools such as projection. We propose a re-organized innovation analysis approach for delay systems and establish a duality between optimal control of systems with multiple input delays and smoothing estimation for delay free systems. These appealing new techniques are applied to solve control and estimation problems for systems with multiple i/o delays and state delays under both the H2 and H-infinity performance criteria.

Delay Effects on Stability

This monograph is devoted to the effect of delays on the stability properties of dynamical systems. Stability regions with respect to the delay parameters are considered, and some sufficient characterizations are proposed. This monograph addresses general delay problems and offers solutions in some cases. In other cases, approximations of the stability regions can be proposed. The interpretation of delays as uncertainty allows the authors to use the advances in robust control and robust convex optimization to solve or to approximate the solutions of the corresponding problems.

Time-delay Systems

This book comprehensively presents a recently developed novel methodology for analysis and control of time-delay systems. Time-delays frequently occurs in engineering and science. Such time-delays can cause problems (e.g. instability) and limit the achievable performance of control systems. The concise and self-contained volume uses the Lambert W function to obtain solutions to time-delay systems represented by delay differential equations. Subsequently, the solutions are used to analyze essential system properties and to design controllers precisely and effectively.

Robust Filtering and Fault Detection of Switched Delay Systems

Switched delay systems appear in a wide field of applications including networked control systems, power systems, memristive systems. Though the large amount of ideas with respect to such systems have generated, until now, it still lacks a framework to focus on filter design and fault detection issues which are relevant to life safety and property loss. Beginning with the comprehensive coverage of the new developments in the analysis and control synthesis for switched delay systems, the monograph not only provides a systematic approach to designing the filter and detecting the fault of switched delay systems, but it also covers the model reduction issues. Specific topics covered include: (1) Arbitrary switching signal where delay-independent and delay-dependent conditions are presented by proposing a linearization technique. (2) Average dwell time where a weighted Lyapunov function is come up with dealing with filter design and fault detection issues beside taking model reduction problems. The monograph is intended for academic researchers and engineers in systems and control community who will discover of particular value in dealing with filter design and fault detection of switched system and time delay systems. In addition, it will be helpful and complementary reading for graduate students in such field.

Applied Mechanics Reviews

A discussion of robust control and filtering for time-delay systems. It provides information on approaches to stability, stabilization, control design, and filtering aspects of electronic and computer systems - explicating the developments in time-delay systems and uncertain time-delay systems. There are appendices detailing important facets of matrix theory, standard lemmas and mathematical results, and applications of industry-tested software.

Robust Control and Filtering for Time-Delay Systems

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 mo- vation 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 swit- ing 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 inves- gated 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 fundam- tal concepts and powerful tools have been developed. It has been pointed out that switched systems have been studied from various viewpoints.

Time-Delay Systems

\"Robust Control for Uncertain Networked Control Systems with Random Delays\" addresses the problem of analysis and design of networked control systems when the communication delays are varying in a random fashion. The random nature of the time delays is typical for commercially used networks, such as a DeviceNet (which is a controller area network) and Ethernet network. The main technique used in this book is based on the Lyapunov-Razumikhin method, which results in delay-dependent controllers. The existence of such controllers and fault estimators are given in terms of the solvability of bilinear matrix inequalities. Iterative algorithms are proposed to change this non-convex problem into quasi-convex optimization problems, which can be solved effectively by available mathematical tools. Finally, to demonstrate the effectiveness and advantages of the proposed design method in the book, numerical examples are given in each designed control system.

Switched Time-Delay Systems

\u200bHybrid System Identification helps readers to build mathematical models of dynamical systems switching between different operating modes, from their experimental observations. It provides an overview of the interaction between system identification, machine learning and pattern recognition fields in explaining and analysing hybrid system identification. It emphasises the optimization and computational complexity issues that lie at the core of the problems considered and sets them aside from standard system identification problems. The book presents practical methods that leverage this complexity, as well as a broad view of state-of-the-art machine learning methods. The authors illustrate the key technical points using examples and figures to help the reader understand the material. The book includes an in-depth discussion and computational analysis of hybrid system identification problems, moving from the basic questions of the definition of hybrid systems and system identification to methods of hybrid system identification and the estimation of switched linear/affine and piecewise affine models. The authors also give an overview of the various applications of hybrid systems, discuss the connections to other fields, and describe more advanced material on recursive, state-space and nonlinear hybrid system identification. Hybrid System Identification includes a detailed exposition of major methods, which allows researchers and practitioners to acquaint themselves rapidly with state-of-the-art tools. The book is also a sound basis for graduate and undergraduate students studying this area of control, as the presentation and form of the book provides the background and coverage necessary for a full understanding of hybrid system identification, whether the reader is initially familiar with system identification related to hybrid systems or not.

Robust Control for Uncertain Networked Control Systems with Random Delays

The Industrial Electronics Handbook, Second Edition combines traditional and newer, more specialized knowledge that will help industrial electronics engineers develop practical solutions for the design and implementation of high-power applications. Embracing the broad technological scope of the field, this collection explores fundamental areas, including analog and digital circuits, electronics, electromagnetic machines, signal processing, and industrial control and communications systems. It also facilitates the use of intelligent systems—such as neural networks, fuzzy systems, and evolutionary methods—in terms of a hierarchical structure that makes factory control and supervision more efficient by addressing the needs of all production components. Enhancing its value, this fully updated collection presents research and global trends as published in the IEEE Transactions on Industrial Electronics Journal, one of the largest and most respected publications in the field. Control and Mechatronics presents concepts of control theory in a way that makes them easily understandable and practically useful for engineers or students working with control system applications. Focusing more on practical applications than on mathematics, this book avoids typical theorems and proofs and instead uses plain language and useful examples to: Concentrate on control system analysis and design, comparing various techniques Cover estimation, observation, and identification of the objects to be controlled—to ensure accurate system models before production Explore the various aspects of robotics and mechatronics Other volumes in the set: Fundamentals of Industrial Electronics Power Electronics and Motor Drives Industrial Communication Systems Intelligent Systems

Hybrid System Identification

This book is about time-domain modelling, stability, stabilization, control design and filtering for JTDS. It gives readers a thorough understanding of the basic mathematical analysis and fundamentals, offers a straightforward treatment of the different topics and provides broad coverage of the recent methodologies.

Control and Mechatronics

This book mostly results from a selection of papers presented during the 11th IFAC (International Federation of Automatic Control) Workshop on Time-Delay Systems, which took place in Grenoble, France, February 4 - 6, 2013. During this event, 37 papers were presented. Taking into account the reviewers' evaluation and the papers' presentation the best papers have been selected and collected into the present volume. The authors of 13 selected papers were invited to participate to this book and provided a more detailed and improved version of the conference paper. To enrich the book, three more chapters have been included from specialists on time-delay systems who presented their work during the 52nd IEEE Conference on Decision and Control, which held in December 10 - 13, 2013, at Florence, Italy. The content of the book is divided into four main parts as follows: Modeling, Stability analysis, Stabilization and control, and Input-delay systems. Focusing on various topics of time-delay systems, this book will be interesting for researchers and graduate students working on control and system theory.

Methodologies for Control of Jump Time-Delay Systems

Industrial electronics systems govern so many different functions that vary in complexity-from the operation of relatively simple applications, such as electric motors, to that of more complicated machines and systems, including robots and entire fabrication processes. The Industrial Electronics Handbook, Second Edition combines traditional and new

Recent Results on Time-Delay Systems

This book presents up-to-date research developments and novel methodologies to solve various stability and control problems of dynamic systems with time delays. First, it provides the new introduction of integral and summation inequalities for stability analysis of nominal time-delay systems in continuous and discrete time domain, and presents corresponding stability conditions for the nominal system and an applicable nonlinear system. Next, it investigates several control problems for dynamic systems with delays including H(infinity) control problem Event-triggered control problems; Dynamic output feedback control problems; Reliable sampled-data control problems. Finally, some application topics covering filtering, state estimation, and synchronization are considered. The book will be a valuable resource and guide for graduate students, scientists, and engineers in the system sciences and control communities.

The Industrial Electronics Handbook - Five Volume Set

The book focuses on delay systems and their applications. Well-known experts in the field were brought together to present a wide panorama of interdisciplinary methods in handling stability, control and related numerical issues. By reading the book, the readers will get an up-to-date picture of this active area of research as well as representative methods used in this field. This book can be used as a reference for both experts and novices interested in the research of time-delay, numerical issues, as well as applications of time-delay systems.

Dynamic Systems with Time Delays: Stability and Control

Time-delay systems arise when information or material transmission delay occurs, for example in transportation, communications, chemical processing, metallurgical processing, environmental systems or power systems. Time delays in the systems are either due to inherent component delays or due to deliberate delays introduced for control purposes. Considerable research has been done on various aspects of these systems in the last twenty-five years. However, unlike linear nondelay systems on which a host of books have been published, very few books exist on time-delay systems, and those that do are often very theoretical. This book fulfils a need by covering the techniques of analysis and design of time-delay systems without dwelling on mathematical rigor - though to make the book self-sufficient, the required mathematical background is provided in the appendices. The book covers classical as well as modern control approaches, and discrete-time as well as continuous-time TD systems. It is concerned mainly with linear time delay systems, though nonlinear time delay systems are also included whenever applicable. Large-scale time-delay systems are also presented. All areas of concern are dealt with: modeling, analysis, structural properties, design, optimization and applications. Useful for graduates in engineering, science and mathematics, the volume will also appeal to researchers in the area since up-to-date surveys on most topics are provided.

Advances in Time-Delay Systems

This book incorporates data rate issues that arise in control design for systems involving communication networks. The general setup is that, given a plant, a communication channel with limited data rate and control objectives, one must find a controller that uses the channel in the feedback loop to achieve the control objectives. The theoretical question of interest is to find the minimum data rate necessary for the channel. This book is motivated by the recent developments in communication technology and aims at engineers and scientists in this field. The use of networks has become common practice in many control applications connecting sensors/actuators to controllers. The book therefore provides the fundamentals of the networks used in control systems, based on hybrid systems theory. The book focuses on the use of networks in distributed systems and on quantization in messages sent over networks.

Time-delay Systems

Semidefinite and conic optimization is a major and thriving research area within the optimization community. Although semidefinite optimization has been studied (under different names) since at least the 1940s, its importance grew immensely during the 1990s after polynomial-time interior-point methods for linear optimization were extended to solve semidefinite optimization problems. Since the beginning of the 21st century, not only has research into semidefinite and conic optimization continued unabated, but also a fruitful interaction has developed with algebraic geometry through the close connections between semidefinite matrices and polynomial optimization. This has brought about important new results and led to an even higher level of research activity. This Handbook on Semidefinite, Conic and Polynomial Optimization provides the reader with a snapshot of the state-of-the-art in the growing and mutually enriching areas of semidefinite optimization, conic optimization, and polynomial optimization. It contains a compendium of the recent research activity that has taken place in these thrilling areas, and will appeal to doctoral students, young graduates, and experienced researchers alike. The Handbook's thirty-one chapters are organized into four parts: Theory, covering significant theoretical developments as well as the interactions between conic optimization and polynomial optimization; Algorithms, documenting the directions of current algorithmic development; Software, providing an overview of the state-of-the-art; Applications, dealing with the application areas where semidefinite and conic optimization has made a significant impact in recent years.

Limited Data Rate in Control Systems with Networks

V VII X Table of Contents Table of Contents XI XII Table of Contents A. Taware and G. Tao: Control of Sandwich Nonlinear Systems, LNCIS 288, pp. 1-8, 2003. Springer-Verlag Berlin Heidelberg 2003 A. Taware and G. Tao: Control of Sandwich Nonlinear Systems, LNCIS 288, pp. 9-16, 2003. Springer-Verlag Berlin Heidelberg 2003 x(t), pilot valve piston position Return Pressure Source Return Load M, b y(t) A. Taware and G. Tao: Control of Sandwich Nonlinear Systems, LNCIS 288, pp. 17-28, 2003. Springer-Verlag Berlin Heidelberg 2003 load displacement, y(t) 3 2 1 0 ?1 ?2 ?3 0 10 20 30 40 50 60 70 80 90 100 solid?without DZ, dotted? with DZ Load displacement, y(t) 0.4 0.2 0 ?0.2 ?0.4 ?0.6 ?0.8 10 20 30 40 50 60 70 80 90 100 solid?without DZ, dotted?with DZ, dashdot?compensated Load displacement, y(t) 3 2 1 0 ?1 ?2 ?3 0 10 20 30 40 50 60 70 80 90 100 Control input, x(t) 0.8 0.6 0.4 0.2 0 ?0.2 ?0.4 ?0.6 0 10 20 30 40 50 60 70 80 90 100 solid?without DZ, dotted?with DZ, dashdot?compensated Load displacement, y(t) 0.6 0.4 0.2 0 ?0.2 ?0.4 ?0.6 ?0.8 0 10 20 30 40 50 60 70 80 90 100 solid?without DZ, dotted?with DZ, dashdot?compensated A. Taware and G. Tao: Control of Sandwich Nonlinear Systems, LNCIS 288, pp. 29-54, 2003. Springer-Verlag Berlin Heidelberg 2003

Handbook on Semidefinite, Conic and Polynomial Optimization

This book offers readers a thorough and rigorous introduction to nonlinear model predictive control (NMPC) for discrete-time and sampled-data systems. NMPC schemes with and without stabilizing terminal constraints are detailed, and intuitive examples illustrate the performance of different NMPC variants. NMPC is interpreted as an approximation of infinite-horizon optimal control so that important properties like closed-loop stability, inverse optimality and suboptimality can be derived in a uniform manner. These results are complemented by discussions of feasibility and robustness. An introduction to nonlinear optimal control algorithms yields essential insights into how the nonlinear optimization routine—the core of any nonlinear model predictive controller—works. Accompanying software in MATLAB® and C++ (downloadable from extras.springer.com/), together with an explanatory appendix in the book itself, enables readers to perform computer experiments exploring the possibilities and limitations of NMPC. The second edition has been substantially rewritten, edited and updated to reflect the significant advances that have been made since the publication of its predecessor, including: • a new chapter on economic NMPC relaxing the assumption that the running cost penalizes the distance to a pre-defined equilibrium; • a new chapter on distributed NMPC discussing methods which facilitate the control of large-scale systems by splitting up the optimization into smaller subproblems; • an extended discussion of stability and performance using approximate updates rather than full optimization; • replacement of the pivotal sufficient condition for stability without stabilizing terminal conditions with a weaker alternative and inclusion of an alternative and much simpler proof in the analysis; and • further variations and extensions in response to suggestions from readers of the first edition. Though primarily aimed at academic researchers and practitioners working in control and optimization, the text is self-contained, featuring background material on infinite-horizon optimal control and Lyapunov stability theory that also makes it accessible for graduate students in control engineering and applied mathematics.

Control of Sandwich Nonlinear Systems

Discrete Event Systems: Analysis and Control is the proceedings of WODES2000 (the 5th Workshop on Discrete Event Systems, held in Ghent, Belgium, on August 21-23, 2000). This book provides a survey of the current state of the art in the field of modeling, analysis and control synthesis of discrete event systems, lecture notes for a mini course on sensitivity analysis for performance evaluation of timed discrete event systems, and 48 carefully selected papers covering all areas of discrete event theory and the most important applications domains. Topics include automata theory and supervisory control (12); Petri net based models for discrete event systems, and their control synthesis (11); (max,+) and timed automata models (9); applications papers related to scheduling, failure detection, and implementation of supervisory controllers (7); formal description of PLCs (6); and finally, stochastic models of discrete event systems (3).

Nonlinear Model Predictive Control

Control Strategy for Time-Delay Systems Part I: Concepts and Theories covers all the important features of real-world practical applications which will be valuable to practicing engineers and specialists, especially given that delays are present in 99% of industrial processes. The book presents the views of the editors on promising research directions and future industrial applications in this area. Although the fundamentals of time-delay systems are discussed, the book focuses on the advanced modeling and control of such systems and will provide the analysis and test (or simulation) results of nearly every technique described. For this purpose, highly complex models are introduced to ?describe the mentioned new applications, which are characterized by ?time-varying delays with intermittent and stochastic nature, several types of nonlinearities, and the presence ?of different time-scales. Researchers, practitioners, and PhD students will gain insights into the prevailing trends in design and operation of real-time control systems, reviewing the shortcomings and future developments concerning practical system issues, such as standardization, protection, and design. Presents an overview of the most recent trends for time-delay systems Covers the important features of the real-world practical applications that can be valuable to practicing engineers and specialists Provides analysis and simulations results of the techniques described in the book

Discrete Event Systems

This volume is the first of the new series Advances in Dynamics and Delays. It offers the latest advances in the research of analyzing and controlling dynamical systems with delays, which arise in many real-world problems. The contributions in this series are a collection across various disciplines, encompassing engineering, physics, biology, and economics, and some are extensions of those presented at the IFAC (International Federation of Automatic Control) conferences since 2011. The series is categorized in five parts covering the main themes of the contributions: · Stability Analysis and Control Design · Networks and Graphs · Time Delay and Sampled-Data Systems · Computational and Software Tools · Applications This volume will become a good reference point for researchers and PhD students in the field of delay systems, and for those willing to learn more about the field, and it will also be a resource for control engineers, who will find innovative control methodologies for relevant applications, from both theory and numerical analysis perspectives.

Control Strategy for Time-Delay Systems

This monograph provides a comprehensive analysis of the control of singularly perturbed time delay systems. Expanding on the author’s previous work on controllability of linear systems with delays in the state and control variables, this volume’s comprehensive coverage makes it a valuable addition to the field. Each chapter is self-contained, allowing readers to study them independently or in succession. After a brief introduction, the book systematically examines properties of different classes of singularly perturbed time delay systems, including linear time-dependent systems with multiple point-wise and distributed state delays. The author then considers more general singularly perturbed systems with state and control delays. Euclidean space controllability for all of these systems is also discussed, using numerous examples from real-life models throughout the text to illustrate the results presented. More technically complicated proofs are presented in separate subsections. The final chapter includes a section dedicated to non-linear time delay systems. This book is ideal for researchers, engineers, and graduate students in systems science and control theory. Other applied mathematicians and researchers working in biology and medicine will also find this volume to be a valuable resource.

Delay Systems

The Markov chain approximation methods are widely used for the numerical solution of nonlinear stochastic control problems in continuous time. This book extends the methods to stochastic systems with delays. The book is the first on the subject and will be of great interest to all those who work with stochastic delay equations and whose main interest is either in the use of the algorithms or in the mathematics. An excellent resource for graduate students, researchers, and practitioners, the work may be used as a graduate-level textbook for a special topics course or seminar on numerical methods in stochastic control.

Controllability of Singularly Perturbed Linear Time Delay Systems

Recently, there have been significant developments in robust control of time-delay systems. This volume presents a systematic treatment of robust control for such systems in the frequency domain. The emphasis is on systems with a single input or output delay, although the delay-free part of the plant can be multi-input-multi-output, in which case the delays in different channels should be the same. The author covers the whole range of H-infinity control of time-delay systems: from controller parameterization implementation; from the Nehari problem to the four-block problem; from theoretical developments to practical issues. The major tools used are similarity transformation, the chain-scattering approach and J-spectral factorization. Self-contained, \"Robust Control of Time-delay Systems\" will interest control theorists and mathematicians working with time-delay systems. Its methodical approach will be of value to graduates studying general robust control theory or its applications in time-delay systems.

Numerical Methods for Controlled Stochastic Delay Systems

Robust Control of Time-delay Systems