Roberto Tempo
Giuseppe Calafiore
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Randomized Algorithms for Analysis and Control of Uncertain Systems

With Applications

Second Edition

Randomized Algorithms For Analysis And Control Of Uncertain Systems

Giuseppe Conte,Claude H. Moog,Anna Maria Perdon

Randomized Algorithms For Analysis And Control Of Uncertain Systems:

Randomized Algorithms for Analysis and Control of Uncertain Systems Roberto Tempo,Giuseppe Calafiore,Fabrizio Dabbene,2012-10-21 The presence of uncertainty in a system description has always been a critical issue in control The main objective of Randomized Algorithms for Analysis and Control of Uncertain Systems with Applications Second Edition is to introduce the reader to the fundamentals of probabilistic methods in the analysis and design of systems subject to deterministic and stochastic uncertainty The approach propounded by this text guarantees a reduction in the computational complexity of classical control algorithms and in the conservativeness of standard robust control techniques The second edition has been thoroughly updated to reflect recent research and new applications with chapters on statistical learning theory sequential methods for control and the scenario approach being completely rewritten Features self contained treatment explaining Monte Carlo and Las Vegas randomized algorithms from their genesis in the principles of probability theory to their use for system analysis development of a novel paradigm for convex and nonconvex controller synthesis in the presence of uncertainty and in the context of randomized algorithms comprehensive treatment of multivariate sample generation techniques including consideration of the difficulties involved in obtaining identically and independently distributed samples applications of randomized algorithms in various endeavours such as PageRank computation for the Google Web search engine unmanned aerial vehicle design both new in the second edition congestion control of high speed communications networks and stability of quantized sampled data systems Randomized Algorithms for Analysis and Control of Uncertain Systems second edition is certain to interest academic researchers and graduate control students working in probabilistic robust or optimal control methods and control engineers dealing with system uncertainties The present book is a very timely contribution to the literature I have no hesitation in asserting that it will remain a widely cited reference work for many years M Vidyasagar   **Randomized Algorithms for Analysis and Control of Uncertain Systems** Roberto Tempo,Giuseppe Calafiore,Fabrizio Dabbene,2005-09-05 Moving on from earlier stochastic and robust control paradigms this book introduces the fundamentals of probabilistic methods in the analysis and design of uncertain systems The use of randomized algorithms guarantees a reduction in the computational complexity of classical robust control algorithms and in the conservativeness of methods like H infinity control Features self contained treatment explaining randomized algorithms from their genesis in the principles of probability theory to their use for robust analysis and controller synthesis comprehensive treatment of sample generation including consideration of the difficulties involved in obtaining independent and identically distributed samples applications in congestion control of high speed communications networks and the stability of quantized sampled data systems This monograph will be of interest to theorists concerned with robust and optimal control techniques and to all control engineers dealing with system uncertainties   An Overview on Randomized Algorithms for Analysis and Control of Uncertain Systems ,2003   Control of Uncertain Systems: Modelling, Approximation,

and Design Bruce A. Francis,2006-03-07 This Festschrift contains a collection of articles by friends co authors colleagues and former Ph D students of Keith Glover Professor of Engineering at the University of Cambridge on the occasion of his sixtieth birthday Professor Glover s scientific work spans a wide variety of topics the main themes being system identification model reduction and approximation robust controller synthesis and control of aircraft and engines The articles in this volume are a tribute to Professor Glover s seminal work in these areas **Dynamic Surface Control of Uncertain Nonlinear Systems** Bongsob Song,J. Karl Hedrick,2011-05-16 Although the problem of nonlinear controller design is as old as that of linear controller design the systematic design methods framed in response are more sparse Given the range and complexity of nonlinear systems effective new methods of control design are therefore of significant importance Dynamic Surface Control of Uncertain Nonlinear Systems provides a theoretically rigorous and practical introduction to nonlinear control design The convex optimization approach applied to good effect in linear systems is extended to the nonlinear case using the new dynamic surface control DSC algorithm developed by the authors A variety of problems DSC design output feedback input saturation and fault tolerant control among them are considered The inclusion of applications material demonstrates the real significance of the DSC algorithm which is robust and easy to use for nonlinear systems with uncertainty in automotive and robotics Written for the researcher and graduate student of nonlinear control theory this book will provide the applied mathematician and engineer alike with a set of powerful tools for nonlinear control design It will also be of interest to practitioners working with a mechatronic systems in aerospace manufacturing and automotive and robotics milieux

Randomized Algorithms in Automatic Control and Data Mining Oleg Granichin,Zeev (Vladimir) Volkovich,Dvora Toledano-Kitai,2014-07-14 In the fields of data mining and control the huge amount of unstructured data and the presence of uncertainty in system descriptions have always been critical issues The book Randomized Algorithms in Automatic Control and Data Mining introduces the readers to the fundamentals of randomized algorithm applications in data mining especially clustering and in automatic control synthesis The methods proposed in this book guarantee that the computational complexity of classical algorithms and the conservativeness of standard robust control techniques will be reduced It is shown that when a problem requires brute force in selecting among options algorithms based on random selection of alternatives offer good results with certain probability for a restricted time and significantly reduce the volume of operations Control of Nonlinear Dynamical Systems Felix L. Chernous'ko,I. M. Ananievski,S. A. Reshmin,2008-09-26 This book is devoted to new methods of control for complex dynamical systems and deals with nonlinear control systems having several degrees of freedom subjected to unknown disturbances and containing uncertain parameters Various constraints are imposed on control inputs and state variables or their combinations The book contains an introduction to the theory of optimal control and the theory of stability of motion and also a description of some known methods based on these theories Major attention is given to new methods of control developed by the authors over the last 15 years Mechanical and electromechanical systems

described by nonlinear Lagrange s equations are considered General methods are proposed for an effective construction of the required control often in an explicit form The book contains various techniques including the decomposition of nonlinear control systems with many degrees of freedom piecewise linear feedback control based on Lyapunov s functions methods which elaborate and extend the approaches of the conventional control theory optimal control differential games and the theory of stability The distinctive feature of the methods developed in the book is that the c trols obtained satisfy the imposed constraints and steer the dynamical system to a prescribed terminal state in nite time Explicit upper estimates for the time of the process are given In all cases the control algorithms and the estimates obtained are strictly proven **Nonlinear Model Predictive Control** Lars Grüne,Jürgen Pannek,2011-04-11 Nonlinear Model Predictive Control is a thorough and rigorous introduction to nonlinear model predictive control NMPC for discrete time and sampled data systems 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 NMPC schemes with and without stabilizing terminal constraints are detailed and intuitive examples illustrate the performance of different NMPC variants An introduction to nonlinear optimal control algorithms gives insight into how the nonlinear optimisation routine the core of any NMPC controller works An appendix covering NMPC software and accompanying software in MATLAB and C downloadable from www springer com ISBN enables readers to perform computer experiments exploring the possibilities and limitations of NMPC *Passivity-based Control of Euler-Lagrange Systems* Romeo Ortega,Julio Antonio Loría Perez,Per Johan Nicklasson,Hebertt Sira-Ramirez,1998-09-16 The essence of this work is the control of electromechanical systems such as manipulators electric machines and power converters The common thread that links together the results presented here is the passivity property which is at present in numerous electrical and mechanical systems and which has great relevance in control engineering at this time Amongst other topics the authors cover Euler Lagrange Systems Mechanical Systems Generalised AC Motors Induction Motor Control Robots with AC Drives and Perspectives and Open Problems The authors have extensive experience of research and application in the field of control of electromechanical systems which they have summarised here in this self contained volume While written in a strictly mathematical way it is also elementary and will be accessible to a wide ranging audience including graduate students as well as practitioners and researchers in this field Cooperative Control Design He Bai,Murat Arcak,John Wen,2011-06-03 Cooperative Control Design A Systematic Passivity Based Approach discusses multi agent coordination problems including formation control attitude coordination and synchronization The goal of the book is to introduce passivity as a design tool for multi agent systems to provide exemplary work using this tool and to illustrate its advantages in designing robust cooperative control algorithms The discussion begins with an introduction to passivity and demonstrates how passivity can be used as a design tool for motion coordination Followed by the case of adaptive redesigns for reference

velocity recovery while describing a basic design a modified design and the parameter convergence problem Formation control is presented as it relates to relative distance control and relative position control The coverage is concluded with a comprehensive discussion of agreement and the synchronization problem with an example using attitude coordination

    Periodic Systems Sergio Bittanti,Patrizio Colaneri,2009 This book offers a comprehensive treatment of the theory of periodic systems including the problems of filtering and control It covers an array of topics presenting an overview of the field and focusing on discrete time signals and systems   <u>Stability Theory of Switched Dynamical Systems</u> 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   **Nonlinear and Adaptive Control with Applications** Alessandro Astolfi,Dimitrios Karagiannis,Romeo Ortega,2007-12-06 The authors here provide a detailed treatment of the design of robust adaptive controllers for nonlinear systems with uncertainties They employ a new tool based on the ideas of system immersion and manifold invariance New algorithms are delivered for the construction of robust asymptotically stabilizing and adaptive control laws for nonlinear systems The methods proposed lead to modular schemes that are easier to tune than their counterparts obtained from Lyapunov redesign   **Iterative Learning Control** Hyo-Sung Ahn,Kevin L. Moore,YangQuan Chen,2007-06-28 This monograph studies the design of robust monotonically convergent it ative learning controllers for discrete time systems Iterative learning control ILC is well recognized as an e cient method that o ers signi cant p formance improvement for systems that operate in an iterative or repetitive fashion e g robot arms in manufacturing or batch processes in an industrial setting Though the fundamentals of ILC design have been well addressed in the literature two key problems have been the subject of continuing search activity First many ILC design strategies assume nominal knowledge of the system to be controlled Only recently has a comprehensive approach to robust ILC analysis and design been established to handle the situation where the plant model is uncertain Second it is well known that many ILC algorithms do not produce monotonic convergence though in applications monotonic convergencecan be essential This monograph addresses these two keyproblems by providingauni ed analysisanddesignframeworkforrobust monotonically convergent ILC The particular approach used throughout is to consider ILC design in the iteration domain rather than in the time domain

Using a lifting technique the two dimensionalILC system whichhas dynamics in both the time and erationdomains istransformedintoaone dimensionalsystem withdynamics only in the iteration domain The so called super vector framework resulting from this transformation is used to analyze both robustness and monotonic convergence for typical uncertainty models including parametric interval certainties frequency like uncertainty in the iteration domain and iterati domain stochastic uncertainty **Nonlinear Control Systems** Alberto Isidori,2013-04-17 The purpose of this book is to present a self contained description of the fun damentals of the theory of nonlinear control systems with special emphasis on the differential geometric approach The book is intended as a graduate text as weil as a reference to scientists and engineers involved in the analysis and design of feedback systems The first version of this book was written in 1983 while I was teach ing at the Department of Systems Science and Mathematics at Washington University in St Louis This new edition integrates my subsequent teaching experience gained at the University of Illinois in Urbana Champaign in 1987 at the Carl Cranz Gesellschaft in Oberpfaffenhofen in 1987 at the University of California in Berkeley in 1988 In addition to a major rearrangement of the last two Chapters of the first version this new edition incorporates two additional Chapters at a more elementary level and an exposition of some relevant research findings which have occurred since 1985 **Adaptive Control** Ioan Doré Landau,Rogelio Lozano,Mohammed M'Saad,Alireza Karimi,2011-06-06 Adaptive Control second edition shows how a desired level of system performance can be maintained automatically and in real time even when process or disturbance parameters are unknown and variable It is a coherent exposition of the many aspects of this field setting out the problems to be addressed and moving on to solutions their practical significance and their application Discrete time aspects of adaptive control are emphasized to reflect the importance of digital computers in the application of the ideas presented The second edition is thoroughly revised to throw light on recent developments in theory and applications with new chapters on multimodel adaptive control with switching direct and indirect adaptive regulation and adaptive feedforward disturbance compensation Many algorithms are newly presented in MATLAB m file format to facilitate their employment in real systems Classroom tested slides for instructors to use in teaching this material are also now provided All of this supplementary electronic material can be downloaded from fill in URL The core material is also up dated and re edited to keep its perspective in line with modern ideas and more closely to associate algorithms with their applications giving the reader a solid grounding in synthesis and analysis of parameter adaptation algorithms recursive plant model identification in open and closed loop robust digital control for adaptive control robust parameter adaptation algorithms practical considerations and applications including flexible transmission systems active vibration control and broadband disturbance rejection and a supplementary introduction on hot dip galvanizing and a phosphate drying furnace Control researchers and applied mathematicians will find Adaptive Control of significant and enduring interest and its use of example and application will appeal to practitioners working with unknown and variable parameter plant Praise for the first edition well written

interesting and easy to follow so that it constitutes a valuable addition to the monographies in adaptive control for discrete time linear systems suitable at least in part for use in graduate courses in adaptive control **Digital Control Systems** Ioan Doré Landau,Gianluca Zito,2007-05-11 The extraordinary development of digital computers microprocessors microcontrollers and their extensive use in control systems in all fields of applications has brought about important changes in the design of control systems Their performance and their low cost make them suitable for use in control systems of various kinds which demand far better capabilities and performances than those provided by analog controllers However in order really to take advantage of the capabilities of microprocessors it is not enough to reproduce the behavior of analog PID controllers One needs to implement specific and high performance model based control techniques developed for computer controlled systems techniques that have been extensively tested in practice In this context identification of a plant dynamic model from data is a fundamental step in the design of the control system The book takes into account the fact that the association of books with software and on line material is radically changing the teaching methods of the control discipline Despite its interactive character computer aided control design software requires the understanding of a number of concepts in order to be used efficiently The use of software for illustrating the various concepts and algorithms helps understanding and rapidly gives a feeling of the various phenomena *Distributed Consensus in Multi-vehicle Cooperative Control* Wei Ren,Randal Beard,2007-10-27 Information consensus guarantees that robot vehicles sharing information over a network topology have a consistent view of information critical to the coordination task Assuming only neighbor neighbor interaction between vehicles this monograph develops distributed consensus strategies designed to ensure that the information states of all vehicles in a network converge to a common value This approach strengthens the team minimizing power consumption and the effects of range and other restrictions The monograph covers introductory theoretical and experimental material featuring an overview of the use of consensus algorithms in cooperative control consensus algorithms in single and double integrator and rigid body attitude dynamics rendezvous and axial alignment formation control deep space formation flying fire monitoring and surveillance Six appendices cover material drawn from graph matrix linear and nonlinear systems theories Algebraic Methods for Nonlinear Control Systems Giuseppe Conte,Claude H. Moog,Anna Maria Perdon,2007-01-19 A self contained introduction to algebraic control for nonlinear systems suitable for researchers and graduate students Algebraic Methods for Nonlinear Control Systems develops a linear algebraic alternative to the usual differential geometric approach to nonlinear control using vector spaces over suitable fields of nonlinear functions It describes a range of results some of which can be derived using differential geometry but many of which cannot They include classical and generalized realization in the nonlinear context accessibility and observability recast for the linear algebraic setting discussion and solution of basic feedback problems results for dynamic and static state and output feedback Dynamic feedback and realization are shown to be dealt with and solved much more easily in the algebraic framework The second

edition has been completely revised with new text examples and exercises it is divided into two parts necessary methodology and applications to control problems   Data-Driven Controller Design Alexandre Sanfelice Bazanella,Lucíola Campestrini,Diego Eckhard,2011-11-16 Data Based Controller Design presents a comprehensive analysis of data based control design It brings together the different data based design methods that have been presented in the literature since the late 1990 s To the best knowledge of the author these data based design methods have never been collected in a single text analyzed in depth or compared to each other and this severely limits their widespread application In this book these methods will be presented under a common theoretical framework which fits also a large family of adaptive control methods the MRAC Model Reference Adaptive Control methods This common theoretical framework has been developed and presented very recently The book is primarily intended for PhD students and researchers senior or junior in control systems It should serve as teaching material for data based and adaptive control courses at the graduate level as well as for reference material for PhD theses It should also be useful for advanced engineers willing to apply data based design As a matter of fact the concepts in this book are being used under the author s supervision for developing new software products in a automation company The book will present simulation examples along the text Practical applications of the concepts and methodologies will be presented in a specific chapter

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