Modelling, Robustness and Sensitivity Reduction in Control Systems

Ruth F. Curtain

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Modelling Robustneb And Sensitivity Reduction In Control Systems:

Model Reduction for Control System Design Goro Obinata,Brian D.O. Anderson,2012-12-06 Modern methods of filter design and controller design often yield systems of very high order posing a problem for their implementation Over the past two decades or so sophisticated methods have been developed to achieve simplification of filters and controllers Such methods often come with easy to use error bounds and in the case of controller simplification methods such error bounds will usually be related to closed loop properties This book is the first comprehensive treatment of approximation methods for filters and controllers It is fully up to date and it is authored by two leading researchers who have personally contributed to the development of some of the methods Balanced truncation Hankel norm reduction multiplicative reduction weighted methods and coprime factorization methods are all discussed The book is amply illustrated with examples and will equip practising control engineers and graduates for intelligent use of commercial software modules for model and controller reduction Control and Dynamic Systems V50: Robust Control System Techniques and Applications C.T. Leonides,2012-12-02 Control and Dynamic Systems Advances in Theory and Applications Volume 50 Robust Control System Techniques and Applications Part 1 of 2 is a two volume sequence devoted to the issues and application of robust control systems techniques This volume is composed of 10 chapters and begins with a presentation of the important techniques for dealing with conflicting design objectives in control systems The subsequent chapters describe the robustness techniques of systems using differential difference equations the design of a wide class of robust nonlinear systems the techniques for dealing with the problems resulting from the use of observers in robust systems design and the effective techniques for the robust control on non linear time varying of tracking control systems with uncertainties These topics are followed by discussions of the effective techniques for the robust control on non linear time varying of tracking control systems with uncertainties and for incorporating adaptive control techniques into a non adaptive robust control design Other chapters present techniques for achieving exponential and robust stability for a rather general class of nonlinear systems techniques in modeling uncertain dynamics for robust control systems design and techniques for the optimal synthesis of these systems The last chapters provide a generalized eigenproblem solution for both singular and nonsingular system cases These chapters also look into the stability robustness design for discrete time systems This book will be of value to process and systems engineers designers and researchers *Signal Processing and Systems Theory* Charles K. Chui,Guanrong Chen,2012-12-06 Signal Processing and Systems Theory is concerned with the study of H optimization for digital signal processing and discrete time control systems The first three chapters present the basic theory and standard methods in digital filtering and systems from the frequency domain approach followed by a discussion of the general theory of approximation in Hardy spaces AAK theory is introduced first for finite rank operators and then more generally before being extended to the multi input multi output setting This mathematically rigorous book is self contained and suitable for self

study The advanced mathematical results derived here are applicable to digital control systems and digital filtering

Modelling, Robustness and Sensitivity Reduction in Control Systems Ruth F. Curtain,2012-11-05 Historically one of the basic issues in control systems design has been robustness the ability of a controlled plant to withstand variations in or lack of knowledge of its dynamics Even if the dynamics of a system are accurately known for purposes of implementation it is often desirable to design a control system based on a simplified model Consequently it is essential to be able to guarantee a reasonable performance not only for the nominal plant but also for its neighbouring perturbations this is the issue of robustness Since the beginning of this decade major advances have been made in this area notably using the H approach this term is meant to cover the solution of sensitivity reduction approximation and model reduction robustness and related control design problems using the mathematics of Hardy spaces and related areas in Harmonic Analysis This book contains the proceedings of the NATO Advanced Research Workshop on Modelling Robustness and Sensitivity Reduction in Control Systems which was held at the University of Groningen December 1986 Its aim was to explore the development of H design techniques and its ramifications in Systems Theory in a unified and systematic way with the emphasis on recent advances and future directions in this fast developing area In particular the following inter related aspects were addressed H mathematical foundations model approximation and robustness in control design optimal sensitivity reduction modelling and system identification and signal processing Uncertain Models and Robust Control Alexander Weinmann,2012-12-06 Control systems particularly designed to manage uncertainties are called robust control system Choosing appropriate design methods the influence of uncertainties on the closed loop behaviour can be reduced to a large extent Most of the important areas of robust control are covered The aim of the book is to provide an introduction to the theory and methods of robust control system design to present a coherent body of knowledge to clarify and unify presentation of significant derivations and proofs The book contains a thorough treatment of important material of uncertainties and robust control which is scattered throughout the literature *Control and Dynamic Systems V51: Robust Control System Techniques and Applications* C.T. Leonides,2012-12-02 Control and Dynamic Systems Advances in Theory and Application Volume 51 Robust Control System Techniques and Applications Part 2 of 2 discusses system robustness techniques This volume presents a comprehensive treatment of robust system techniques in nonlinear linear and multilinear interval systems It also covers techniques for dealing with system disturbances system modeling approximations and parameter uncertainties This volume ends by reviewing robustness techniques for systems with structured state space uncertainty This volume will be of great use as a reference source for mechanical and electrical engineers Discrete H∞ Optimization Charles K. Chui,Guanrong Chen,2012-12-06 Discrete H Optimization is concerned with the study of H optimization for digital signal processing and discrete time control systems The first three chapters present the basic theory and standard methods in digital filtering and systems from the frequency domain approach followed by a discussion of the general theory of approximation in Hardy

spaces AAK theory is introduced first for finite rank operators and then more generally before being extended to the multi input multi output setting This mathematically rigorous book is self contained and suitable for self study The advanced mathematical results derived here are applicable to digital control systems and digital filtering **Robust Industrial Control Systems** Michael J. Grimble,2006-05-01 Robust Industrial Control Systems Optimal Design Approach for Polynomial Systems presents a comprehensive introduction to the use of frequency domain and polynomial system design techniques for a range of industrial control and signal processing applications The solution of stochastic and robust optimal control problems is considered building up from single input problems and gradually developing the results for multivariable design of the later chapters In addition to cataloguing many of the results in polynomial systems needed to calculate industrial controllers and filters basic design procedures are also introduced which enable cost functions and system descriptions to be specified in order to satisfy industrial requirements Providing a range of solutions to control and signal processing problems this book Presents a comprehensive introduction to the polynomial systems approach for the solution of H_2 and H_infinity optimal control problems Develops robust control design procedures using frequency domain methods Demonstrates design examples for gas turbines marine systems metal processing flight control wind turbines process control and manufacturing systems Includes the analysis of multi degrees of freedom controllers and the computation of restricted structure controllers that are simple to implement Considers time varying control and signal processing problems Addresses the control of non linear processes using both multiple model concepts and new optimal control solutions Robust Industrial Control Systems Optimal Design Approach for Polynomial Systems is essential reading for professional engineers requiring an introduction to optimal control theory and insights into its use in the design of real industrial processes Students and researchers in the field will also find it an excellent reference tool *Robotic Systems for Handling and Assembly* Daniel Schütz,Friedrich M. Wahl,2010-11-20 Although parallel robots are known to offer many advantages with respect to accuracy dynamics and stiffness major breakthroughs in industrial applications have not yet taken place This is due to a knowledge gap preventing fast and precise execution of industrial handling and assembly tasks This book focuses on the design modeling and control of innovative parallel structures as well as the integration of novel machine elements Special attention is paid to the integration of active components into lightweight links and passive joints In addition new control concepts are introduced to minimize structural vibrations Although the optimization of robot systems itself allows a reduction of cycle times these can be further decreased by improved path planning robot programming and automated assembly planning concepts described by 25 contributions within this book The content of this volume is subdivided into four main parts dealing with Modeling and Design System Implementation Control and Programming as well as Adaptronics and Components This book is aimed at researchers and postgraduates working in the field of parallel robots as well as practicing engineers dealing with industrial robot development and robotic applications Modelling, Robustness and Sensitivity Reduction in Control Systems Ruth F

Curtain,2014-01-15 **Minimax Approaches to Robust Model Predictive Control** Johan Löfberg,2003-04-11 Controlling a system with control and state constraints is one of the most important problems in control theory but also one of the most challenging Another important but just as demanding topic is robustness against uncertainties in a controlled system One of the most successful approaches both in theory and practice to control constrained systems is model predictive control MPC The basic idea in MPC is to repeatedly solve optimization problems on line to find an optimal input to the controlled system In recent years much effort has been spent to incorporate the robustness problem into this framework The main part of the thesis revolves around minimax formulations of MPC for uncertain constrained linear discrete time systems A minimax strategy in MPC means that worst case performance with respect to uncertainties is optimized Unfortunately many minimax MPC formulations yield intractable optimization problems with exponential complexity Minimax algorithms for a number of uncertainty models are derived in the thesis These include systems with bounded external additive disturbances systems with uncertain gain and systems described with linear fractional transformations The central theme in the different algorithms is semidefinite relaxations This means that the minimax problems are written as uncertain semidefinite programs and then conservatively approximated using robust optimization theory The result is an optimization problem with polynomial complexity The use of semidefinite relaxations enables a framework that allows extensions of the basic algorithms such as joint minimax control and estimation and approx imation of closed loop minimax MPC using a convex programming framework Additional topics include development of an efficient optimization algorithm to solve the resulting semidefinite programs and connections between deterministic minimax MPC and stochastic risk sensitive control The remaining part of the thesis is devoted to stability issues in MPC for continuous time nonlinear unconstrained systems While stability of MPC for un constrained linear systems essentially is solved with the linear quadratic controller no such simple solution exists in the nonlinear case It is shown how tools from modern nonlinear control theory can be used to synthesize finite horizon MPC controllers with guaranteed stability and more importantly how some of the tech nical assumptions in the literature can be dispensed with by using a slightly more complex controller Dynamics and Feedback: A Unified Framework for Control System Design, Modeling, and Implementation William E Clark,2025-08-18 Dynamics and Feedback A Unified Framework for Control System Design Modeling and Implementation presents a coherent and rigorous introduction to the principles that govern dynamic systems and their regulation Beginning with system classification modeling paradigms and the fundamentals of feedback the book leads readers through differential and difference equation representations block diagram algebra and state space formulations that unify continuous and discrete time perspectives Emphasis on clear mathematical foundations ensures a solid grasp of stability performance and sensitivity before moving to practical design tools Building on these foundations the text systematically develops both classical and modern design methods time and frequency domain analyses root locus and Nyquist techniques PID tuning and compensator synthesis as well as state space concepts of controllability

observability optimal control and state estimation Throughout the narrative bridges theory and practice showing how to linearize nonlinear dynamics identify models from data and manage multivariable interactions and robustness concerns in high order systems Worked examples and problem solving strategies make advanced topics accessible while preparing readers for real world implementation challenges Reflecting contemporary advances the final sections treat digital and discrete time control nonlinear and adaptive architectures model predictive and distributed control and the integration of AI and machine learning into cyber physical and autonomous systems Special attention is given to fault tolerance robustness and the practicalities of implementation from sensor actuator constraints to software hardware co design Designed for students researchers and practicing engineers this unified framework equips readers to design analyze and implement control systems across a wide range of emerging applications Nonlinear Numerical Methods and Rational Approximation II A. Cuyt,2012-12-06 These are the proceedings of the international conference on Nonlinear numerical methods and Rational approximation II organised by Annie Cuyt at the University of Antwerp Belgium 05 11 September 1993 It was held for the third time in Antwerp at the conference center of UIA after successful meetings in 1979 and 1987 and an almost yearly tradition since the early 70 s The following figures illustrate the growing number of participants and their geographical dissemination In 1993 the Belgian scientific committee consisted of A Bultheel Leuven A Cuyt Antwerp J Meinguet Louvain Ia Neuve and J P Thiran Namur The conference focused on the use of rational functions in different fields of Numer ical Analysis The invited speakers discussed Orthogonal polynomials D S Lu binsky Rational interpolation M Gutknecht Rational approximation E B Saff Pade approximation A Gonchar and Continued fractions W B Jones In contributed talks multivariate and multidimensional problems applications and implementations of each main topic were considered To each of the five main topics a separate conference day was devoted and a separate proceedings chapter compiled accordingly In this way the proceedings reflect the organisation of the talks at the conference Nonlinear numerical methods and rational approximation may be a nar row field for the outside world but it provides a vast playground for the chosen ones It can fascinate specialists from Moscow to South Africa from Boulder in Colorado and from sunny Florida to Zurich in Switzerland

Automatic Control 1990 Ü Jaaksoo,2014-05-23 This volume provides a general overview on the state of the art and future developments in automation and control The application of systems and control in all areas is covered from the social and cultural effects of control to control in mineral and metal processing This volume will be an invaluable source of information to all those interested in the areas of automation and control **Contributions to Operator Theory and its Applications** I. Gohberg,J.W. Helton,Leiba Rodman,2012-12-06 Adaptive and Robust Active Vibration Control Ioan Doré Landau,Tudor-Bogdan Airimițoaie,Abraham Castellanos-Silva,Aurelian Constantinescu,2016-09-15 This book approaches the design of active vibration control systems from the perspective of today s ideas of computer control It formulates the various design problems encountered in the active management of vibration as control problems and searches for the most

appropriate tools to solve them The experimental validation of the solutions proposed on relevant tests benches is also addressed To promote the widespread acceptance of these techniques the presentation eliminates unnecessary theoretical developments which can be found elsewhere and focuses on algorithms and their use The solutions proposed cannot be fully understood and creatively exploited without a clear understanding of the basic concepts and methods so these are considered in depth The focus is on enhancing motivations algorithm presentation and experimental evaluation MATLAB routines Simulink diagrams and bench test data are available for download and encourage easy assimilation of the experimental and exemplary material Three major problems are addressed in the book active damping to improve the performance of passive absorbers adaptive feedback attenuation of single and multiple tonal vibrations and feedforward and feedback attenuation of broad band vibrations Adaptive and Robust Active Vibration Control will interest practising engineers and help them to acquire new concepts and techniques with good practical validation It can be used as the basis for a course for graduate students in mechanical mechatronics industrial electronics aerospace and naval engineering Readers working in active noise control will also discover techniques with a high degree of cross over potential for use in their field **SVD and Signal Processing** Ed. F. Deprettere,1988 Compiled in this book is a selection of articles written by internationally recognized experts in the fields of matrix computation and signal processing In almost all digital signal processing DSR problems the available data is corrupted by measurement noise or is incomplete Classical techniques are unable to separate signal spaces and noise spaces However the information hidden in the data can be made explicit through singular value decomposition SVD SVD based signal processing is making headway and will become feasible soon thanks to the progress in parallel computations and VLSI implementation The book is divided into six parts Part one is a tutorial beginning with an introduction including VLSI parallel algorithms and some intriguing problems It describes several applications of SVD in system identification and signal detection It also deals with the fundamental harmonic retrieval problem and principal component analysis Part two discusses details of model reduction system identification and detection of multiple sinusoids in white noise while part three is devoted to the total least squares and generalized singular value decomposition problems The fourth section deals with real time and adaptive algorithms the fifth examines fast algorithms and architectures such as block algorithms computational arrays systolic arrays hypercubes and connection machines and the final part addresses some open problems Robust Control of Uncertain Dynamic Systems Rama K. Yedavalli,2013-12-05 This textbook aims to provide a clear understanding of the various tools of analysis and design for robust stability and performance of uncertain dynamic systems In model based control design and analysis mathematical models can never completely represent the real world system that is being modeled and thus it is imperative to incorporate and accommodate a level of uncertainty into the models This book directly addresses these issues from a deterministic uncertainty viewpoint and focuses on the interval parameter characterization of uncertain systems Various tools of analysis

and design are presented in a consolidated manner This volume fills a current gap in published works by explicitly addressing the subject of control of dynamic systems from linear state space framework namely using a time domain matrix theory based approach This book also Presents and formulates the robustness problem in a linear state space model framework Illustrates various systems level methodologies with examples and applications drawn from aerospace electrical and mechanical engineering Provides connections between lyapunov based matrix approach and the transfer function based polynomial approaches Robust Control of Uncertain Dynamic Systems A Linear State Space Approach is an ideal book for first year graduate students taking a course in robust control in aerospace mechanical or electrical engineering

Performance and Implementation Aspects of Nonlinear Filtering Gustaf Hendeby,2008-02-15 Nonlinear filtering is an important standard tool for information and sensor fusion applications e g localization navigation and tracking It is an essential component in surveillance systems and of increasing importance for standard consumer products such as cellular phones with localization car navigation systems and augmented reality This thesis addresses several issues related to nonlinear filtering including performance analysis of filtering and detection algorithm analysis and various implementation details The most commonly used measure of filtering performance is the root mean square error RMSE which is bounded from below by the Cram r Rao lower bound CRLB This thesis presents a methodology to determine the effect different noise distributions have on the CRLB This leads up to an analysis of the intrinsic accuracy IA the informativeness of a noise distribution For linear systems the resulting expressions are direct and can be used to determine whether a problem is feasible or not and to indicate the efficacy of nonlinear methods such as the particle filter PF A similar analysis is used for change detection performance analysis which once again shows the importance of IA A problem with the RMSE evaluation is that it captures only one aspect of the resulting estimate and the distribution of the estimates can differ substantially To solve this problem the Kullback divergence has been evaluated demonstrating the shortcomings of pure RMSE evaluation Two estimation algorithms have been analyzed in more detail the Rao Blackwellized particle filter RBPF by some authors referred to as the marginalized particle filter MPF and the unscented Kalman filter UKF The RBPF analysis leads to a new way of presenting the algorithm thereby making it easier to implement In addition the presentation can possibly give new intuition for the RBPF as being a stochastic Kalman filter bank In the analysis of the UKF the focus is on the unscented transform UT The results include several simulation studies and a comparison with the Gauss approximation of the first and second order in the limit case This thesis presents an implementation of a parallelized PF and outlines an object oriented framework for filtering The PF has been implemented on a graphics processing unit GPU i e a graphics card The GPU is a inexpensive parallel computational resource available with most modern computers and is rarely used to its full potential Being able to implement the PF in parallel makes new applications where speed and good performance are important possible The object oriented filtering framework provides the flexibility and performance needed for large scale Monte Carlo

simulations using modern software design methodology It can also be used to help to efficiently turn a prototype into a finished product *Applied Mechanics Reviews* ,1987

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Modelling Robustneb And Sensitivity Reduction In Control Systems Introduction

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