Linear Parameter Varying Control For Engineering Applications Springerbriefs In Electrical And Computer Engineering

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Advances in Missile Guidance, Control, and Estimation

Through the past 20 years, the framework of Linear Parameter-Varying (LPV) systems has become a promising system theoretical approach to h- dle the controlof mildly nonlinear and especially position dependent systems which are common in mechatronic applications and in the process ind- try. The birth of this system class was initiated by the need of engineers to achieve better performance for nonlinear and time-varying dynamics, c- mon in many industrial applications, than what the classical framework of Linear Time-Invariant (LTI) control can provide. However, it was also a p- mary goal to preserve simplicity and “re-use” the powerful LTI results by extending them to the LPV case. The progress continued according to this philosophy and LPV control has become a well established ?eld with many promising applications. Unfortunately, modeling of LPV systems, especially based on measured data (which is called system identi?cation) has seen a limited development sincethebirthoftheframework. Currentlythisbottleneck oftheLPVfra- work is halting the transfer of the LPV theory into industrial use. Without good models that ful?ll the expectations of the users and without the und- standing how these models correspond to the dynamics of the application, it is di?cult to design high performance LPV control solutions. This book aims to bridge the gap between modeling and control by investigating the fundamental questions of LPV modeling and identi?cation. It explores the missing details of the LPV system theory that have hindered the formu- tion of a well established identi?cation framework.

Chaos in Automatic Control

For applying linear parameter varying (LPV) control synthesis and analysis to a nonlinear system, it is required that a nonlinear system be represented in the form of an LPV model. In this paper, a new representation method is developed to construct an LPV model from a nonlinear mathematical model without the restriction that an operating point must be in the neighborhood of equilibrium points. An LPV model constructed by the new method preserves local stabilities of the original nonlinear system at "frozen" scheduling parameters and also represents the original nonlinear dynamics of a system over a non-trim region. An LPV model of the motion of FASER (Free-flying Aircraft for Subscale Experimental Research) is constructed by the new method. Shin, Jong-Yeob Langley Research Center NASA/CR-2007-213926, NIA Report No. 2005-08 NCC1-02043; WBS 23-079-30-12 LINEAR PARAMETER-VARYING CONTROL; STABILITY; NONLINEAR SYSTEMS; AIRCRAFT MODELS; SCHEDULING; MATHEMATICAL MODELS

Set-Theoretic Methods in Control

Quasi-Linear Parameter Varying Representation of General Aircraft Dynamics Over Non-Trim Region

This review volume reports the state-of-the-art in Linear Parameter Varying (LPV) system identification. Written by world renowned researchers, the book contains twelve chapters, focusing on the most recent LPV identification methods for both discrete-time and continuous-time models, using different approaches such as optimization methods for input/output LPV models Identification, set membership methods, optimization methods and subspace methods for state-space LPV models identification and orthonormal basis functions methods. Since there is a strong connection between LPV systems, hybrid switching systems and piecewise affine models, identification of hybrid switching systems and piecewise affine systems will be considered as well.

2016 IEEE International Conference on Advanced Intelligent Mechatronics (AIM)

Vehicles are complex systems (non-linear, multi-variable) where the abundance of embedded controllers should ensure better security. This book aims at emphasizing the interest and potential of Linear Parameter Varying methods within the framework of vehicle dynamics, e.g. proposed control-oriented model, complex enough to handle some system non linearities but still simple for control or observer design, take into account the adaptability of the vehicle's response to driving situations, to the driver request and/or to the road sollicitations, manage interactions between various actuators to optimize the dynamic behavior of vehicles. This book results from the 32th International Summer School in Automatic that held in Grenoble, France, in September 2011, where recent methods (based on robust control and LPV technics), then applied to the control of vehicle dynamics, have been presented. After some theoretical background and a view on some recent works on LPV approaches (for modelling, analysis, control, observation and diagnosis), the main emphasis is put on road vehicles but some illustrations are concerned with railway, aerospace and underwater vehicles. The main objective of the book is to demonstrate the value of this approach for controlling the dynamic behavior of vehicles. It presents, in a rm way, background and new results on LPV methods and their application to vehicle dynamics.

Identification for Automotive Systems

During the 90s robust control theory has seen major advances and achieved a new maturity, centered around the notion of convexity. The goal of this book is to give a graduate-level course on this theory that emphasizes these new developments, but at the same time conveys the main principles and ubiquitous tools at the heart of the subject. Its pedagogical objectives are to introduce a coherent and unified framework for studying the theory, to provide students with the control-theoretic background required to read and contribute to the research literature, and to present the main ideas and demonstrations of the major results. The book will be of value to mathematical researchers and computer scientists, graduate students planning to do research in the area, and engineering practitioners requiring advanced control techniques.

Switching Linear Parameter-varying Electronic Throttle Control for Automotive Engines

This paper presents the design of a linear parameter varying (LPV) controller for the F-16 longitudinal axes over the entire flight envelope using a blending methodology which lets an LPV controller preserve performance level over each parameter subspace and reduces computational costs for synthesizing an LPV controller. Three blending LPV controller synthesis methodologies are applied to control F-16 longitudinal axes. Using a function substitution method, a quasi-LPV model of the F-16 longitudinal axes is constructed from the nonlinear equations of motion over the entire flight envelope, including non-trim regions, to facilitate synthesis of LPV controllers for the F-16 aircraft. The nonlinear simulations of the blending LPV controller show that the desired performance and robustness objectives are achieved across all altitude variations.

Linear Parameter-Varying and Time-Delay Systems

Annotation The CDC is recognized as the premier scientific and engineering conference dedicated to the advancement of the theory and practice of systems and control The CDC annually brings together an international community of researchers and practitioners in the field of automatic control to discuss new research results, perspectives on future developments, and innovative applications relevant to decision making, automatic control, and related areas.

Model-Based Predictive Control

This monograph focuses on control methods that influence vehicle dynamics to assist the driver in enhancing passenger comfort, road holding, efficiency and safety of transport, etc., while maintaining the driver’s ability to override that assistance. On individual-vehicle-component level the control problem is formulated and solved by a unified modelling and design method provided by the linear parameter varying (LPV) framework. The global behaviour desired is achieved by a judicious interplay between the individual components, guaranteed by an integrated control mechanism. The integrated control problem is also formalized and solved in the LPV framework. Most important among the ideas expounded in the book are: application of the LPV paradigm in the modelling and control design methodology; application of the robust LPV design as a unified framework for setting control tasks related to active driver assistance; formulation and solution proposals for the integrated vehicle control problem; proposal for a reconfigurable and fault-tolerant control architecture; formulation and solution proposals for the plug-and-play concept; detailed case studies. Robust Control Design for Active Vehicle Assistance Systems will be of interest to academic researchers and graduate students interested in automotive control and to control and mechanical engineers working in the automotive industry. Advances in Industrial Control aims to report and encourage the transfer of technology in control engineering. The rapid development of control technology has an impact on all areas of the control discipline. The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control.

Blending Methodology of Linear Parameter Varying Control Synthesis of F-16 Aircraft System

Saturation nonlinearities are ubiquitous in engineering systems. In control systems, every physical actuator or sensor is subject to saturation owing to its maximum and minimum limits. A digital filter is subject to saturation if it is implemented in a finite word length format. Saturation nonlinearities are also purposely introduced into engineering systems such as control sys tems and neural network systems. Regardless of how saturation arises, the analysis and design of a system that contains saturation nonlinearities is an important problem. Not only is this problem theoretically challenging, but it is also practically imperative. This book intends to study control systems with actuator saturation in a systematic way. It will also present some related results on systems with state saturation or sensor saturation. Roughly speaking, there are two strategies for dealing with actuator sat uration. The first strategy is to neglect the saturation in the first stage of the control design process, and then to add some problem-specific schemes to deal with the adverse effects caused by saturation. These schemes, known as anti-windup schemes, are typically introduced using ad hoc modifications and extensive simulations. The basic idea behind these schemes is to intro duce additional feedbacks in such a way that the actuator stays properly within its limits. Most of these schemes lead to improved performance but poorly understood stability properties.

Linear, Time-varying Approximations to Nonlinear Dynamical Systems

This book gives an introduction to H-infinity and H2 control for linear time-varying systems. Chapter 2 is concerned with continuous-time systems while Chapter 3 is devoted to discrete-time systems. The main aim of this book is to develop the H-infinity and H2 theory for jump systems and to apply it to sampled-data systems. The jump system gives a natural state space representation of sampled-data systems, and original signals and parameters are maintained in the new system. Two earlier chapters serve as preliminaries. Chapter 4 introduces jump systems and develops the H-infinity and H2 theory for them. It is then applied to sampled-data systems in Chapter 5. The new features of this book are as follows: The H-infinity control theory is developed for time-varying systems with initial uncertainty. Recent results on the relation of three Riccati equations are included. The H2 theory usually given for time-invariant systems is extended to time-varying systems. The H-infinity and H2 theory for sampled-data systems is established from the jump system point of view. Extension of the theory to infinite dimensional systems and nonlinear systems is discussed. This covers the sampled-data system with first-order hold. In this book 16 examples and 40 figures of computer simulations are included. The reader can find the H-infinity and H2 theory for linear time-varying systems and sampled-data systems developed in a unified manner. Some arguments inherent to time varying systems or the jump system point of view to sampled-data systems may give new insights into the system theory of time-invariant systems and sampled-data systems.

Robust Control Design for Active Driver Assistance Systems

This book provides an introduction to the analysis and control of Linear Parameter-Varying Systems and Time-Delay Systems and their interactions. The purpose is to give the readers some fundamental theoretical background on these topics and to give more insights on the possible applications of these theories. This self-contained monograph is written in an accessible way for readers ranging from undergraduate/PhD students to engineers and researchers willing to know more about the fields of time-delay systems, parameter-varying systems, robust analysis, robust control, gain-scheduling techniques in the LPV fashion and LMI based approaches. The only prerequisites are basic knowledge in linear algebra, ordinary differential equations and (linear) dynamical systems. Most of the results are proved unless the proof is too complex or not necessary for a good understanding of the results. In the latter cases, suitable references are systematically provided. The first part pertains on the representation, analysis and control of LPV systems along with a reminder on robust analysis and control techniques. The second part is concerned with the representation and analysis of time-delay systems using various time-domain techniques. The third and last part is devoted to the representation, analysis, observation, filtering and control of LPV time-delay systems. The book also presents many important basic and advanced results on the manipulation of LMIs.

Robust Control

Increasing complexity and performance and reliability expectations make modeling of automotive system both more difficult and more urgent. Automotive control has slowly evolved from an add-on to classical engine and vehicle design to a key technology to enforce consumption, pollution and safety limits. Modeling, however, is still mainly based on classical methods, even though much progress has been done in the identification community to speed it up and improve it. This book, the product of a workshop of representatives of different communities, offers an insight on how to close the gap and exploit this progress for the next generations of vehicles.

Model Validation and Uncertainty Quantification, Volume 3

This monograph details basic concepts and tools fundamental for the analysis and synthesis of linear systems subject to actuator saturation and developments in recent research. The authors use a state-space approach and focus on stability analysis and the synthesis of stabilizing control laws in both local and global contexts. Different methods of modeling the saturation and behavior of the nonlinear closed-loop system are given special attention. Various kinds of Lyapunov functions are considered to present different stability conditions. Results arising from uncertain systems and treating performance in the presence of saturation are given. The text proposes methods and algorithms, based on the use of linear programming and linear matrix inequalities, for computing estimates of the basin of attraction and for designing control systems accounting for the control bounds and the possibility of saturation. They can be easily implemented with mathematical software packages.

Advances in Linear Matrix Inequality Methods in Control

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

Linear Time Varying Systems and Sampled-data Systems

This dissertation proposes low-order model development and controller design for various automotive and manufacturing applications. The first task models a single wafer rapid thermal process (RTP) using first-principles modeling. Then, making use of the linear parameter-varying (LPV) state-space representation, we convert the nonlinear RTP model into an affine LPV model. For controller design purposes, we reduce the number of scheduling variables and the order of the model. Using this reduced-order model, we design a gain-scheduled H_infinity controller for reference tracking. In the second task, we reconfigure the model of a cooperative adaptive cruise control platoon in order to account for the uncertain and time-varying parameters of the system dynamics and communication delay. Using this model, we design a robust controller and reduce its order. The reduced-order controller remains robust to the model. We validate the controller design by performing experiments on the test bed to show the need for robust control. The third task uses model order reduction techniques to design a low-order robust controller in a parabolic convection-diffusion equation application.

Linear Parameter-varying Control of Systems of High Complexity

Comprehensive and up to date coverage of robust control theory and its application • Presented in a well-planned and logical way • Written by a respected leading author, with extensive experience in robust control • Accompanying website provides solutions manual and other supplementary material

Robust Control and Linear Parameter Varying Approaches

The last thirty years have witnessed an enormous effort in the field of robust control of dynamical systems. The main objective of this book is that of presenting, in a unified framework, the main results appeared in the literature on this topic, with particular reference to the robust stability problem for linear systems subject to time-varying uncertainties. The book mainly focuses on those problems for which a definitive solution has been found; indeed most of the results we shall present are given in the form of necessary and sufficient conditions involving the feasibility of Linear Matrix Inequalities based problems. For self-containedness purposes, most of the results provided in the book are proven. We have tried to maintain the development of the proofs as simple as possible, without sacrificing the mathematical rigor. Some parts of the book (especially those contained in Chaps. 2, 3 and 5) can be teached in advanced control courses; however this work is mainly devoted to both researchers in the field of systems and control theory and engineers working in industries which want to apply the methodologies presented in the book to practical control problems. To this regard, as the various results are derived, they are immediately reinforced with real world examples.

Control of Linear Parameter Varying Systems with Applications

The aim of this book is to propose a new approach to analysis and control of linear time-varying systems. These systems are defined in an intrinsic way, i.e., not by a particular representation (e.g., a transfer matrix or a state-space form) but as they are actually. The system equations, derived, e.g., from the laws of physics, are gathered to form an intrinsic mathematical object, namely a finitely presented module over a ring of operators. This is strongly connected with the engineering point of view, according to which a system is not a specific set of equations but an object of the material world which can be described by equivalent sets of equations. This viewpoint makes it possible to formulate and solve efficiently several key problems of the theory of control in the case of linear time-varying systems. The solutions are based on algebraic analysis. This book, written for engineers, is also useful for mathematicians since it shows how algebraic analysis can be applied to solve engineering problems. Henri Bourlès is a Professor and holds the industrial automation chair at the Conservatoire national des arts et métiers in France. He has been teaching automation for over 20 years in engineering and graduate schools. Bogdan Marinescu is currently research engineer at the French Transmission System Operator (RTE) and Associate Professor at SATIE-Ecole Normale Supérieure de Cachan.

Stability and Stabilization of Linear Systems with Saturating Actuators

Tensor Product Model Transformation in Polytopic Model-Based Control offers a new perspective of control system design. Instead of relying solely on the formulation of more effective LMIs, which is the widely adopted approach in existing LMI-related studies, this cutting-edge book calls for a systematic modification and reshaping of the polytopic convex hull to achieve enhanced performance. Varying the convexity of the resulting TP canonical form is a key new feature of the approach. The book concentrates on reducing analytical derivations in the design process, echoing the recent paradigm shift on the acceptance of numerical solution as a valid form of output to control system problems. The salient features of the book include: Presents a new HOSVD-based canonical representation for (qLPV) models that enables trade-offs between approximation accuracy and computation complexity Supports a conceptually new control design methodology by proposing TP model transformation that offers a straightforward way of manipulating different types of convexity to appear in polytopic representation Introduces a numerical transformation that has the advantage of readily accommodating models described by non-conventional modeling and identification approaches, such as neural networks and fuzzy rules Presents a number of practical examples to demonstrate the application of the approach to generate control system design for complex (qLPV) systems and multiple control objectives. The authors’ approach is based on an extended version of singular value decomposition applicable to hyperdimensional tensors. Under the approach, trade-offs between approximation accuracy and computation complexity can be performed through the singular values to be retained in the process. The use of LMIs enables the incorporation of multiple performance objectives into the control design problem and assurance of a solution via convex optimization if feasible. Tensor Product Model Transformation in Polytopic Model-Based Control includes examples and incorporates MATLAB® Toolbox TPtool. It provides a reference guide for graduate students, researchers, engineers, and practitioners who are dealing with nonlinear systems control applications.

Quantitative Robust Linear Parameter Varying H∞ Vibration Control of Flexible Structures for Saving the Control Energy

Linear, Time-varying Approximations to Nonlinear Dynamical Systems introduces a new technique for analysing and controlling nonlinear systems. This method is general and requires only very mild conditions on the system nonlinearities, setting it apart from other techniques such as those – well-known – based on differential geometry. The authors cover many aspects of nonlinear systems including stability theory, control design and extensions to distributed parameter systems. Many of the classical and modern control design methods which can be applied to linear, time-varying systems can be extended to nonlinear systems by this technique. The implementation of the control is therefore simple and can be done with well-established classical methods. Many aspects of nonlinear systems, such as spectral theory which is important for the generalisation of frequency domain methods, can be approached by this method.

Linear Parameter Varying Control Design for Industrial Manipulators

The ROPEC is a forum where practitioners as well as researchers and students will meet to exchange points of view, present new ideas as well as advances to push further the areas of Power Systems, Electronics and Computing The location, Ixtapa Mexico, provides the ideal environment to engage in discussions which surely will continue up after the conference

Low-order Linear Parameter-varying Model Development and Robust Control Design for Automotive and Manufacturing Applications

Stringent demands on modern guided weapon systems require new approaches to guidance, control, and estimation. There are requirements for pinpoint accuracy, low cost per round, easy upgrade paths, enhanced performance in counter-measure environments, and the ability to track low-observable targets. Advances in Missile Guidance, Control, and Estimat

Linear Parameter-Varying System Identification

Control technology permeates every aspect of our lives. We rely on them to perform a wide variety of tasks without giving much thought to the origins of the technology or how it became such an important part of our lives. Control System

Applications covers the uses of control systems, both in the common and in the uncommon areas of our lives. From the everyday to the unusual, it's all here. From process control to human-in-the-loop control, this book provides illustrations and examples of how these systems are applied. Each chapter contains an introduction to the application, a section defining terms and references, and a section on further readings that help you understand and use the techniques in your work environment. Highly readable and comprehensive, Control System Applications explores the uses of control systems. It illustrates the diversity of control systems and provides examples of how the theory can be applied to specific practical problems. It contains information about aspec ts of control that are not fully captured by the theory, such as techniques for protecting against controller failure and the role of cost and complexity in specifying controller designs.

Linear Parameter-Varying Control for Engineering Applications

Tensor Product Model Transformation in Polytopic Model-Based Control

Linear matrix inequalities (LMIs) have recently emerged as useful tools for solving a number of control problems. This book provides an up-to-date account of the LMI method and covers topics such as recent LMI algorithms, analysis and synthesis issues, nonconvex problems, and applications. It also emphasizes applications of the method to areas other than control.

Linear Time-Varying Systems

We live in a highly connected world with multiple self-interested agents interacting and myriad opportunities for conflict and cooperation. The goal of game theory is to understand these opportunities. This book presents a rigorous introduction to the mathematics of game theory without losing sight of the joy of the subject. This is done by focusing on theoretical highlights (e.g., at least six Nobel Prize winning results are developed from scratch) and by presenting exciting connections of game theory to other fields such as computer science (algorithmic game theory), economics (auctions and matching markets), social choice (voting theory), biology (signaling and evolutionary stability), and learning theory. Both classical topics, such as zero-sum games, and modern topics, such as sponsored search auctions, are covered. Along the way, beautiful mathematical tools used in game theory are introduced, including convexity, fixed-point theorems, and probabilistic arguments. The book is appropriate for a first course in game theory at either the undergraduate or graduate level, whether in mathematics, economics, computer science, or statistics. The importance of game-theoretic thinking transcends the academic setting—for every action we take, we must consider not only its direct effects, but also how it influences the incentives of others.

Control System Applications

Chaotic behavior arises in a variety of control settings. In some cases, it is beneficial to remove this behavior; in others, introducing or taking advantage of the existing chaotic components can be useful for example in cryptography. Chaos in Automatic Control surveys the latest methods for inserting, taking advantage of, or removing chaos in a variety of applications. This book supplies the theoretical and pedagogical basis of chaos in control systems along with new concepts and recent developments in the field. Presented in three parts, the book examines open-loop analysis, closed-loop control, and applications of chaos in control systems. The first section builds a background in the mathematics of ordinary differential and difference equations on which the remainder of the book is based. It includes an introductory chapter by Christian Mira, a pioneer in chaos research. The next section explores solutions to problems arising in observation and control of closed-loop chaotic control systems. These include model-independent control methods, strategies such as H-infinity and sliding modes, polytopic observers, normal forms using homogeneous transformations, and observability normal forms. The final section explores applications in wireless transmission, optics, power electronics, and cryptography. Chaos in Automatic Control distills the latest thinking in chaos while relating it to the most recent developments and applications in control. It serves as a platform for developing more robust, autonomous, intelligent, and adaptive systems.

Control of Dead-time Processes

Control of Linear Parameter Varying Systems compiles state-of-the-art contributions on novel analytical and computational methods for addressing system identification, model reduction, performance analysis and feedback control design and addresses address theoretical developments, novel computational approaches and illustrative applications to various fields. Part I discusses modeling and system identification of linear parameter varying systems, Part II covers the importance of analysis and control design when working with linear parameter varying systems (LPVS) , Finally, Part III presents an applications based approach to linear parameter varying systems, including modeling of a turbocharged diesel engines, Multivariable control of wind turbines, modeling and control of aircraft engines, control of an autonomous underwater vehicles and analysis and synthesis of re-entry vehicles.

Modeling and Identification of Linear Parameter-Varying Systems

Model Predictive Control (MPC) has become a widely used methodology across all engineering disciplines, yet there are few books which study this approach. Until now, no book has addressed in detail all key issues in the field including apriori stability and robust stability results. Engineers and MPC researchers now have a volume that provides a complete overview of the theory and practice of MPC as it relates to process and control engineering. Model-Based Predictive Control, A Practical Approach, analyzes predictive control from its base mathematical foundation, but delivers the subject matter in a readable, intuitive style. The author writes in layman's terms, avoiding jargon and using a style that relies upon personal insight into practical applications. This detailed introduction to predictive control introduces basic MPC concepts and demonstrates how they are applied in the design and control of systems, experiments, and industrial processes. The text outlines how to model, provide robustness, handle constraints, ensure feasibility, and guarantee stability. It also details options in regard to algorithms, models, and complexity vs. performance issues.

A Course in Robust Control Theory

This text introduces the fundamental techniques for controlling dead-time processes from simple monovariable to complex multivariable cases. Dead-time-process-control problems are studied using classical proportional-integral-differential (PID) control for the simpler examples and dead-time-compensator (DTC) and model predictive control (MPC) methods for progressively more complex ones. Downloadable MATLAB® code makes the examples and ideas more convenient and simpler.

Robust Control of Linear Systems Subject to Uncertain Time-Varying Parameters

Model Validation and Uncertainty Quantification, Volume 3: Proceedings of the 35th IMAC, A Conference and Exposition on Structural Dynamics, 2017, the third volume of ten from the Conference brings together contributions to this important area of research and engineering. The collection presents early findings and case studies on fundamental and applied aspects of Model Validation and Uncertainty Quantification, including papers on: Uncertainty Quantification in Material Models Uncertainty Propagation in Structural Dynamics Practical Applications of MVUQ Advances in Model Validation & Uncertainty Quantification: Model Updating Model Validation & Uncertainty Quantification: Industrial Applications Controlling Uncertainty Uncertainty in Early Stage Design Modeling of Musical Instruments Overview of Model Validation and Uncertainty

Advances in Gain-Scheduling and Fault Tolerant Control Techniques

Game Theory, Alive

In this article, a general and systematical quantitative robust linear parameter varying control method is proposed for active vibration control of linear parameter varying flexible structures such that a complete set of control objectives can be considered, especially the reduction of necessarily required control energy and the control input. To achieve this goal, the phase and gain control policies are employed in linear parameter varying H∞ control designs for suitable selection of weighting functions. The designed parameter-dependent H∞ controller allows us to explicitly consider the time-varying parameters of the dynamical models for saving the control energy and achieving other control objectives such as the specification of vibration reduction and qualitative robustness properties to both parametric and dynamic uncertainties. Then, various reliable robustness analyses are conducted to quantitatively verify the robustness properties in both deterministic and probabilistic senses. The design processes and the effectiveness of the proposed control method are illustrated by active vibration control of a non-collocated piezoelectric cantilever beam excited by an external position-varying force which is the disturbance to be rejected. This plant has typical parameter (force position)-dependent dynamics and is modeled as a linear parameter varying system whose time-varying parameter is the actual position of the disturbance. The numerical simulations demonstrate that, compared to the classical H∞ control and the acceleration feedback control, the proposed control method allows us to compute a quantitatively robust force-position-dependent H∞ controller whose benefit is requiring less control energy and smaller control input, while satisfying the same control objectives in the frequency and time domains.

2016 IEEE 55th Conference on Decision and Control (CDC)

The subject of this brief is the application of linear parameter-varying (LPV) control to a class of dynamic systems to provide a systematic synthesis of gain-scheduling controllers with guaranteed stability and performance. An important step in LPV control design, which is not well covered in the present literature, is the selection of weighting functions. The proper selection of weighting functions tunes the controller to obtain the desired closed-loop response. The selection of appropriate weighting functions is difficult and sometimes appears arbitrary. In this brief, gain-scheduling control with engineering applications is covered in detail, including the LPV modeling, the control problem formulation, and the weighting function optimization. In addition, an iterative algorithm for obtaining optimal output weighting functions with respect to the H2 norm bound is presented in this brief. Using this algorithm, the selection of appropriate weighting functions becomes an automatic process. The LPV design and control synthesis procedures in this brief are illustrated using: • air-to-fuel ratio control for port-fuel-injection engines; • variable valve timing control; and • application to a vibration control problem. After reading this brief, the reader will be able to apply its concepts to design gain-scheduling controllers for their own engineering applications. This brief provides detailed step-by-step LPV modeling and control design strategies along with an automatic weight-selection algorithm so that engineers can apply state-of-the-art LPV control synthesis to solve their own engineering problems. In addition, this brief should serve as a bridge between the H-infinity and H2 control theory and the real-world application of gain-scheduling control.

Linear Parameter Varying Control for Actuator Failure

The second edition of this monograph describes the set-theoretic approach for the control and analysis of dynamic systems, both from a theoretical and practical standpoint. This approach is linked to fundamental control problems, such as Lyapunov stability analysis and stabilization, optimal control, control under constraints, persistent disturbance rejection, and uncertain systems analysis and synthesis. Completely self-contained, this book provides a solid foundation of mathematical techniques and applications, extensive references to the relevant literature, and numerous avenues for further theoretical study. All the material from the first edition has been updated to reflect the most recent developments in the field, and a new chapter on switching systems has been added. Each chapter contains examples, case studies, and exercises to allow for a better understanding of theoretical concepts by practical application. The mathematical language is kept to the minimum level necessary for the adequate formulation and statement of the main concepts, yet allowing for a detailed exposition of the numerical algorithms for the solution of the proposed problems. Set-Theoretic Methods in Control will appeal to both researchers and practitioners in control engineering and applied mathematics. It is also well-suited as a textbook for graduate students in these areas. Praise for the First Edition "This is an excellent book, full of new ideas and collecting a lot of diverse material related to set-theoretic methods. It can be recommended to a wide control community audience." - B. T. Polyak, Mathematical Reviews "This book is an outstanding monograph of a recent research trend in control. It reflects the vast experience of the authors as well as their noticeable contributions to the development of this field[It] is highly recommended to PhD students and researchers working in control engineering or applied mathematics. The material can also be used for graduate courses in these areas." - Octavian Pastravanu, Zentralblatt MATH

Fault Tolerant Control Schemes Using Integral Sliding Modes

The key attribute of a Fault Tolerant Control (FTC) system is its ability to maintain overall system stability and acceptable performance in the face of faults and failures within the feedback system. In this book Integral Sliding Mode (ISM) Control Allocation (CA) schemes for FTC are described, which have the potential to maintain close to nominal fault-free performance (for the entire system response), in the face of actuator faults and even complete failures of certain actuators. Broadly an ISM controller based around a model of the plant with the aim of creating a nonlinear fault tolerant feedback controller whose closed-loop performance is established during the design process. The second approach involves retro-fitting an ISM scheme to an existing feedback controller to introduce fault tolerance. This may be advantageous from an industrial perspective, because fault tolerance can be introduced without changing the existing control loops. A high fidelity benchmark model of a large transport aircraft is used to demonstrate the efficacy of the FTC schemes. In particular a scheme based on an LPV representation has been implemented and tested on a motion flight simulator.

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Control and Mechatronics

This thesis reports on novel methods for gain-scheduling and fault tolerant control (FTC). It begins by analyzing the connection between the linear parameter varying (LPV) and Takagi-Sugeno (TS) paradigms. This is then followed by a detailed description of the design of robust and shifting state-feedback controllers for these systems. Furthermore, it presents two approaches to fault-tolerant control: the first is based on a robust polytopic controller design, while the second involves a reconfiguration of the reference model and the addition of virtual actuators into the loop. Inaddition the thesis offers a thorough review of the state-of-the art in gain scheduling and fault-tolerant control, with a special emphasis on LPV and TS systems.

Control Systems with Actuator Saturation

A robust linear parameter varying (LPV) control synthesis is carried out for an HiMAT vehicle subject to loss of control effectiveness. The scheduling parameter is selected to be a function of the estimates of the control effectiveness factors. The estimates are provided on-line by a two-stage Kalman estimator. The inherent conservatism of the LPV design is reducing through the use of a scaling factor on the uncertainty block that represents the estimation errors of the effectiveness factors. Simulations of the controlled system with the on-line estimator show that a superior fault-tolerance can be achieved.