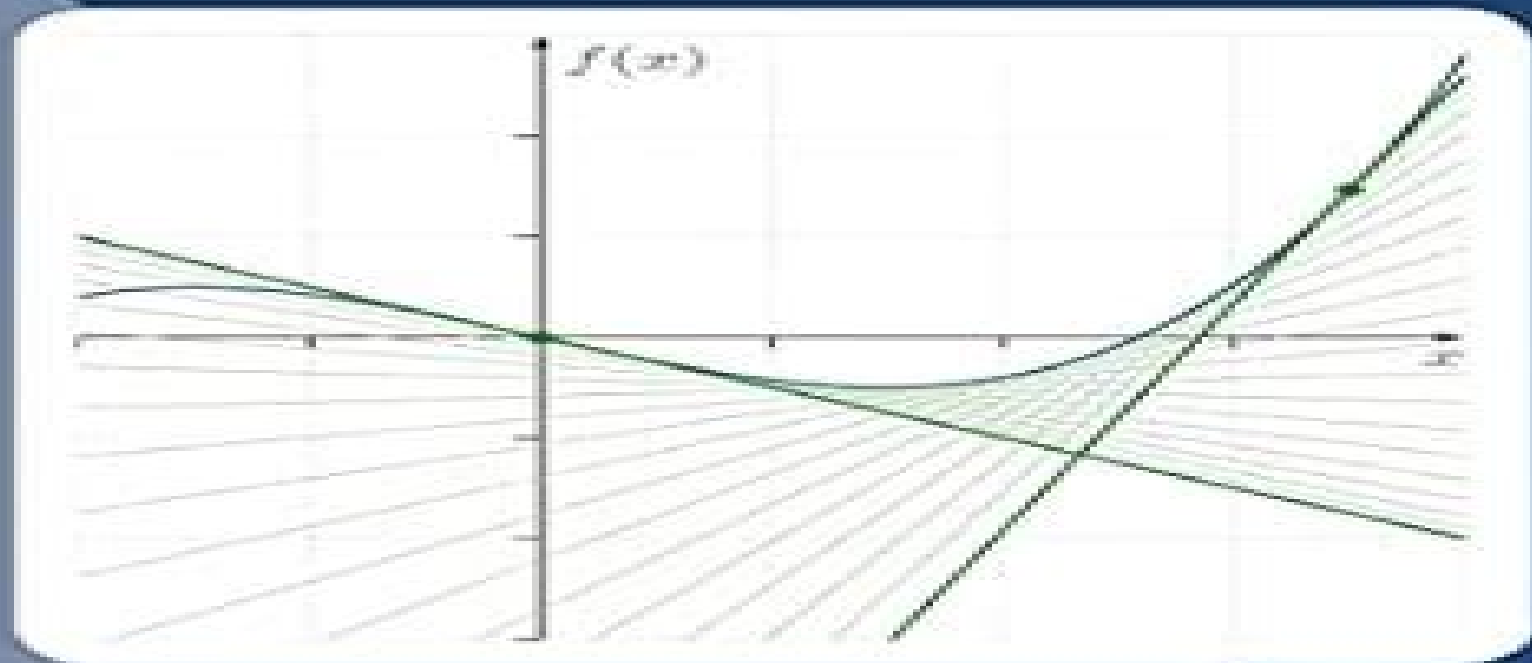


Constrained Optimal Control: Piecewise Affine and Linear Parameter-Varying Systems

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THOMAS J. BESSELMANN

Constrained Optimal Control Piecewise Affine And Linear Parameter Varying Systems

Rajeev Alur, George Pappas



Constrained Optimal Control Piecewise Affine And Linear Parameter Varying Systems:

Constrained Optimal Control Thomas Besselmann, 2010 The scope of this thesis lies in the field of constrained optimal control More precisely it is concerned with the constrained finite time optimal control of two system classes piecewise affine systems and linear parameter varying systems Firstly constrained finite time optimal control CFTOC of piecewise affine PWA systems is revisited Since the actual computation of hybrid controllers as the explicit solution to parametric CFTOC problems for piecewise affine systems is already rather mature this part deals with a post processing algorithm If the cost function of the CFTOC problem is quadratic the optimization problem at hand is a parametric mixed integer quadratic program which can be solved by decomposing it into a number of quadratic programs Thereby redundant regions are computed which increase the storage demand and the online evaluation time of the resulting controller We propose a post processing algorithm for the removal of redundant regions Furthermore we examine the application of hybrid control methods to two systems a mechanical system with backlash and autonomous vehicle steering The second part of this thesis is devoted to constrained optimal control of linear parameter varying LPV systems A sequence of dynamic programming procedures is proposed in order to solve constrained finite time optimal control problems explicitly for LPV A systems and for general LPV systems Both cases of an arbitrarily varying scheduling parameter and a bounded rate of parameter variation are considered Likewise a procedure to solve the constrained time optimal control problems is proposed enabling a low complexity alternative to explicit LPV MPC with guaranteed stability With these developments explicit MPC schemes and explicit minimum time MPC schemes are enriched by the class of LPV systems increasing the possibilities of their application Finally we demonstrate an application of explicit LPV MPC to autonomous vehicle steering

Optimal Control of Constrained Piecewise Affine Systems Frank Christophersen, 2007-09-11 One of the most important and challenging problems in control is the derivation of systematic tools for the computation of controllers for constrained nonlinear systems that can guarantee closed loop stability feasibility and optimality with respect to some performance index This book focuses on the efficient and systematic computation of closed form optimal controllers for the powerful class of fast sampled constrained piecewise affine systems These systems may exhibit rather complex behavior and are equivalent to many other hybrid system formalisms combining continuous valued dynamics with logic rules reported in the literature Furthermore piecewise affine systems are a useful modeling tool that can capture general nonlinearities e g by local approximation constraints saturations switches and other hybrid modeling phenomena The first part of the book presents an introduction to the mathematical and control theoretical background material needed for the full understanding of the book The second part provides an in depth look at the computational and control theoretic properties of the controllers and part three presents different analysis and post processing techniques

Piecewise Affine Control: Continuous-Time, Sampled-Data, and Networked Systems Luis Rodrigues, Behzad Samadi, Miad Moarref, 2019-11-06 Engineering systems operate through actuators most of which will

exhibit phenomena such as saturation or zones of no operation commonly known as dead zones These are examples of piecewise affine characteristics and they can have a considerable impact on the stability and performance of engineering systems This book targets controller design for piecewise affine systems fulfilling both stability and performance requirements The authors present a unified computational methodology for the analysis and synthesis of piecewise affine controllers taking an approach that is capable of handling sliding modes sampled data and networked systems They introduce algorithms that will be applicable to nonlinear systems approximated by piecewise affine systems and they feature several examples from areas such as switching electronic circuits autonomous vehicles neural networks and aerospace applications Piecewise Affine Control Continuous Time Sampled Data and Networked Systems is intended for graduate students advanced senior undergraduate students and researchers in academia and industry It is also appropriate for engineers working on applications where switched linear and affine models are important

Constrained Optimal Control of Linear and Hybrid Systems Francesco Borrelli, 2003-09-04 Many practical control problems are dominated by characteristics such as state input and operational constraints alternations between different operating regimes and the interaction of continuous time and discrete event systems At present no methodology is available to design controllers in a systematic manner for such systems This book introduces a new design theory for controllers for such constrained and switching dynamical systems and leads to algorithms that systematically solve control synthesis problems The first part is a self contained introduction to multiparametric programming which is the main technique used to study and compute state feedback optimal control laws The book's main objective is to derive properties of the state feedback solution as well as to obtain algorithms to compute it efficiently The focus is on constrained linear systems and constrained linear hybrid systems The applicability of the theory is demonstrated through two experimental case studies a mechanical laboratory process and a traction control system developed jointly with the Ford Motor Company in Michigan

Nonlinear Control Systems 2004 Frank Allgower, Michael Zeitz, 2005-02-02 *Constrained Control of Uncertain, Time-Varying, Discrete-Time Systems* Hoai-Nam Nguyen, 2013-12-11 A comprehensive development of interpolating control this monograph demonstrates the reduced computational complexity of a ground breaking technique compared with the established model predictive control The text deals with the regulation problem for linear time invariant discrete time uncertain dynamical systems having polyhedral state and control constraints with and without disturbances and under state or output feedback For output feedback a non minimal state space representation is used with old inputs and outputs as state variables Constrained Control of Uncertain Time Varying Discrete time Systems details interpolating control in both its implicit and explicit forms In the former at most two linear programming or one quadratic programming problem are solved on line at each sampling instant to yield the value of the control variable In the latter the control law is shown to be piecewise affine in the state and so the state space is partitioned into polyhedral cells so that at each sampling interval the cell to which the measured state belongs

must be determined Interpolation is performed between vertex control and a user chosen control law in its maximal admissible set surrounding the origin Novel proofs of recursive feasibility and asymptotic stability of the vertex control law and of the interpolating control law are given Algorithms for implicit and explicit interpolating control are presented in such a way that the reader may easily realize them Each chapter includes illustrative examples and comparisons with model predictive control in which the disparity in computational complexity is shown to be particularly in favour of interpolating control for high order systems and systems with uncertainty Furthermore the performance of the two methods proves similar except in those cases when a solution cannot be found with model predictive control at all The book concludes with two high dimensional examples and a benchmark robust model predictive control problem the non isothermal continuously stirred tank reactor For academic control researchers and students or for control engineers interested in implementing constrained control systems Constrained Control of Uncertain Time Varying Discrete time Systems will provide an attractive low complexity control alternative for cases in which model predictive control is currently attempted

Control and Observer Design for Nonlinear Finite and Infinite Dimensional Systems Thomas Meurer, Knut Graichen, Ernst-Dieter Gilles, 2005-09-19 This volume presents a well balanced combination of state of the art theoretical results in the field of nonlinear controller and observer design combined with industrial applications stemming from mechatronics electrical bio chemical engineering and fluid dynamics The unique combination of results of finite as well as infinite dimensional systems makes this book a remarkable contribution addressing postgraduates researchers and engineers both at universities and in industry The contributions to this book were presented at the Symposium on Nonlinear Control and Observer Design From Theory to Applications SYNCOD held September 15 16 2005 at the University of Stuttgart Germany The conference and this book are dedicated to the 65th birthday of Prof Dr Ing Dr h c Michael Zeitz to honor his life long research and contributions on the fields of nonlinear control and observer design

Hybrid Systems: Computation and Control Rajeev Alur, George Pappas, 2004-02-24 This volume contains the proceedings of the 7th Workshop on Hybrid Systems Computation and Control HSCC 2004 held in Philadelphia USA from March 25 to 27 2004 The annual workshop on hybrid systems attracts researchers from academia and industry interested in modeling analysis and implementation of dynamic and reactive systems involving both discrete and continuous behaviors The previous workshops in the HSCC series were held in Berkeley USA 1998 Nijmegen The Netherlands 1999 Pittsburgh USA 2000 Rome Italy 2001 Palo Alto USA 2002 and Prague Czech Republic 2003 This year's HSCC was organized in cooperation with ACM SIGBED Special Interest Group on Embedded Systems and was technically co sponsored by the IEEE Control Systems Society The program consisted of 4 invited talks and 43 regular papers selected from 117 regular submissions The program covered topics such as tools for analysis and verification control and optimization modeling and engineering applications as in past years and emerging directions in programming language support and implementation The program also contained one special session focusing on the interplay between biomolecular

networks systems biology formal methods and the control of hybrid systems *Nonlinear Model Predictive Control* Lalo Magni, Davide Martino Raimondo, Frank Allgöwer, 2009-05-25 Over the past few years significant progress has been achieved in the field of nonlinear model predictive control NMPC also referred to as receding horizon control or moving horizon control More than 250 papers have been published in 2006 in ISI Journals With this book we want to bring together the contributions of a diverse group of internationally well recognized researchers and industrial practitioners to critically assess the current status of the NMPC field and to discuss future directions and needs The book consists of selected papers presented at the International Workshop on Assessment and Future Directions of Nonlinear Model Predictive Control that took place from September 5 to 9 2008 in Pavia Italy *Active and Semi-active Suspension Systems* Yukun Lu, Chen Sun, Amir Khajepour, 2024-12-03 This book comprehensively explores fundamental aspects of adaptive vehicle suspension systems offering numerous examples for suspension modeling control estimation and fault diagnosis and prognosis methodologies It is intended for senior undergraduate and graduate students vehicle R D departments and anyone with an interest in the design and control of adaptive or active suspension systems In order to simplify the understanding of more difficult concepts the book uses a step by step approach along with pictures graphs and practical examples The book begins with an introduction of vehicle adaptive suspensions highlighting some common mass produced products in recent decades Furthermore three widely used mathematical models of adaptive suspension systems are derived Subsequently four suspension control algorithms and gain adaptive approaches are introduced accompanied by MATLAB Simulink programming examples for enhanced understanding and practical implementation Lastly the fault diagnosis and prognosis of adaptive suspension systems are introduced *Stability Theory of Switched Dynamical Systems* Zhendong Sun, Shuzhi Sam Ge, 2011-01-06 There are plenty of challenging and interesting problems open for investigation in the field of switched systems Stability issues help to generate many complex nonlinear dynamic behaviors within switched systems The authors present a thorough investigation of stability effects on three broad classes of switching mechanism arbitrary switching where stability represents robustness to unpredictable and undesirable perturbation constrained switching including random within a known stochastic distribution dwell time with a known minimum duration for each subsystem and autonomously generated with a pre assigned mechanism switching and designed switching in which a measurable and freely assigned switching mechanism contributes to stability by acting as a control input For each of these classes this book propounds detailed stability analysis and or design related robustness and performance issues connections to other control problems and many motivating and illustrative examples **Microfabricated Power Generation Devices** Alexander Mitsos, Paul I. Barton, 2008-12-23 Focusing on a description of the technologies and methodologies for computer aided conceptual design this book covers the design modeling and simulation of micropower generation devices The articles are authored by internationally recognized experts in the field who take the reader from fundamentals and design aspects to numerous power

generation strategies and system engineering The comprehensive coverage also extends to fuel processing energy conversion material and heat management device operation economics and quality control For materials scientists chemists physicists process engineers and those in power technology Handbook of Hybrid Systems Control Jan Lunze,Françoise Lamnabhi-Lagarigue,2009-10-15 Sets out core theory and reviews new methods and applications to show how hybrid systems can be modelled and understood Modeling and Control of Magnetic Fluid Deformable Mirrors for Adaptive Optics Systems Zhizheng Wu,Azhar Iqbal,Foued Ben Amara,2012-10-21 Modeling and Control of Magnetic Fluid Deformable Mirrors for Adaptive Optics Systems presents a novel design of wavefront correctors based on magnetic fluid deformable mirrors MFDM as well as corresponding control algorithms The presented wavefront correctors are characterized by their linear dynamic response Various mirror surface shape control algorithms are presented along with experimental evaluations of the performance of the resulting adaptive optics systems Adaptive optics AO systems are used in various fields of application to enhance the performance of optical systems such as imaging laser free space optical communication systems etc This book is intended for undergraduate and graduate students professors engineers scientists and researchers working on the design of adaptive optics systems and their various emerging fields of application Zhizheng Wu is an associate professor at Shanghai University China Azhar Iqbal is a research associate at the University of Toronto Canada Foued Ben Amara is an assistant professor at the University of Toronto Canada **Predictive Control for Linear and Hybrid Systems** Francesco Borrelli,Alberto Bemporad,Manfred Morari,2017-06-22 With a simple approach that includes real time applications and algorithms this book covers the theory of model predictive control MPC **Reconfigurable Control of Nonlinear Dynamical Systems** Jan H. Richter,2011-01-16 This research monograph summarizes solutions to reconfigurable fault tolerant control problems for nonlinear dynamical systems that are based on the fault hiding principle It emphasizes but is not limited to complete actuator and sensor failures In the first part the monograph starts with a broad introduction of the control reconfiguration problems and objectives as well as summaries and explanations of solutions for linear dynamical systems The solution is always a reconfiguration block which consists of linear virtual actuators in the case of actuator faults and linear virtual sensors in the case of sensor faults The main advantage of the fault hiding concept is the reusability of the nominal controller which remains in the loop as an active system while the virtual actuator and sensor adapt the control input and the measured output to the fault scenario The second and third parts extend virtual actuators and virtual sensors towards the classes of Hammerstein Wiener systems and piecewise affine systems The main analyses concern stability recovery setpoint tracking recovery and performance recovery as reconfiguration objectives The fourth part concludes the monograph with descriptions of practical implementations and case studies The book is primarily intended for active researchers and practicing engineers in the field of fault tolerant control Due to many running examples it is also suitable for interested graduate students International Aerospace Abstracts ,1999 **Nonlinear Industrial Control Systems**

Michael J. Grimble, Paweł Majecki, 2020-05-19 Nonlinear Industrial Control Systems presents a range of mostly optimisation based methods for severely nonlinear systems it discusses feedforward and feedback control and tracking control systems design The plant models and design algorithms are provided in a MATLAB toolbox that enable both academic examples and industrial application studies to be repeated and evaluated taking into account practical application and implementation problems The text makes nonlinear control theory accessible to readers having only a background in linear systems and concentrates on real applications of nonlinear control It covers different ways of modelling nonlinear systems including state space polynomial based linear parameter varying state dependent and hybrid design techniques for nonlinear optimal control including generalised minimum variance model predictive control quadratic Gaussian factorised and H design methods design philosophies that are suitable for aerospace automotive marine process control energy systems robotics servo systems and manufacturing steps in design procedures that are illustrated in design studies to define cost functions and cope with problems such as disturbance rejection uncertainties and integral wind up and baseline non optimal control techniques such as nonlinear Smith predictors feedback linearization sliding mode control and nonlinear PID Nonlinear Industrial Control Systems is valuable to engineers in industry dealing with actual nonlinear systems It provides students with a comprehensive range of techniques and examples for solving real nonlinear control design problems

On the Numerical Solution of Nonlinear and Hybrid Optimal Control Problems Matthias Rungger, 2012

Optimal Trajectory Planning and Train Scheduling for Urban Rail Transit Systems Yihui Wang, Bin Ning, Ton van den Boom, Bart De Schutter, 2016-04-21 This book contributes to making urban rail transport fast punctual and energy efficient significant factors in the importance of public transportation systems to economic environmental and social requirements at both municipal and national levels It proposes new methods for shortening passenger travel times and for reducing energy consumption addressing two major topics 1 train trajectory planning the authors derive a nonlinear model for the operation of trains and present several approaches for calculating optimal and energy efficient trajectories within a given schedule and 2 train scheduling the authors develop a train scheduling model for urban rail systems and optimization approaches with which to balance total passenger travel time with energy efficiency and other costs to the operator Mixed integer linear programming and pseudospectral methods are among the new methods proposed for single and multi train systems for the solution of the nonlinear trajectory planning problem which involves constraints such as varying speed restrictions and maximum traction braking force Signaling systems and their effects are also accounted for in the trajectory planning model Origin destination passenger demand is included in the model formulation for train scheduling Iterative convex programming and efficient bi level approaches are utilized in the solution of the train scheduling problem In addition the splitting rates and route choices of passengers are also optimized from the system point of view The problems and solutions described in Optimal Trajectory Planning and Train Scheduling for Urban Rail Transit Systems will interest researchers studying public transport systems

and logistics whether from an academic or practitioner background as well as providing a real application for anybody studying optimization theory and predictive control

Constrained Optimal Control Piecewise Affine And Linear Parameter Varying Systems: Bestsellers in 2023 The year 2023 has witnessed a noteworthy surge in literary brilliance, with numerous engrossing novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the engaging narratives that have charmed audiences this year. Constrained Optimal Control Piecewise Affine And Linear Parameter Varying Systems : Colleen Hoover's "It Ends with Us" This poignant tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover masterfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can triumph. Uncover the Best : Taylor Jenkins Reid's "The Seven Husbands of Evelyn Hugo" This intriguing historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reid's compelling storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Constrained Optimal Control Piecewise Affine And Linear Parameter Varying Systems : Delia Owens "Where the Crawdads Sing" This evocative coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens crafts a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These top-selling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of captivating stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is an exceptional and gripping novel that will keep you speculating until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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