

Communications and Control Engineering



Lars Grüne
Jürgen Pannek

Nonlinear Model Predictive Control

Theory and Algorithms

 Springer

Nonlinear Model Predictive Control Progreb In Systems And Control Theory Vol 26

E. Ali,E. Zafiriou



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Nonlinear Model Predictive Control Frank Allgöwer, Alex Zheng, 2000 Nonlinear Model Predictive Control Lars Grüne, Jürgen Pannek, 2011-04-11 Nonlinear Model Predictive Control is a thorough and rigorous introduction to nonlinear model predictive control NMPC for discrete time and sampled data systems NMPC is interpreted as an approximation of infinite horizon optimal control so that important properties like closed loop stability inverse optimality and suboptimality can be derived in a uniform manner These results are complemented by discussions of feasibility and robustness NMPC schemes with and without stabilizing terminal constraints are detailed and intuitive examples illustrate the performance of different NMPC variants An introduction to nonlinear optimal control algorithms gives insight into how the nonlinear optimisation routine the core of any NMPC controller works An appendix covering NMPC software and accompanying software in MATLAB and C downloadable from www.springer.com ISBN enables readers to perform computer experiments exploring the possibilities and limitations of NMPC **Assessment and Future Directions of Nonlinear Model Predictive Control** Rolf Findeisen, Frank Allgöwer, Lorenz Biegler, 2007-09-08 The past three decades have seen rapid development in the area of model predictive control with respect to both theoretical and application aspects Over these 30 years model predictive control for linear systems has been widely applied especially in the area of process control However today's applications often require driving the process over a wide region and close to the boundaries of operability while satisfying constraints and achieving near optimal performance Consequently the application of linear control methods does not always lead to satisfactory performance and here nonlinear methods must be employed This is one of the reasons why nonlinear model predictive control NMPC has enjoyed significant attention over the past years with a number of recent advances on both the theoretical and application frontier Additionally the widespread availability and steadily increasing power of today's computers as well as the development of specially tailored numerical solution methods for NMPC bring the practical applicability of NMPC within reach even for very fast systems This has led to a series of new exciting developments along with new challenges in the area of NMPC *Explicit Nonlinear Model Predictive Control* Alexandra Grancharova, Tor Arne Johansen, 2012-03-23 Nonlinear Model Predictive Control NMPC has become the accepted methodology to solve complex control problems related to process industries The main motivation behind explicit NMPC is that an explicit state feedback law avoids the need for executing a numerical optimization algorithm in real time The benefits of an explicit solution in addition to the efficient on line computations include also verifiability of the implementation and the possibility to design embedded control systems with low software and hardware complexity This book considers the multi parametric Nonlinear Programming mp NLP approaches to explicit approximate NMPC of constrained nonlinear systems developed by the authors as well as their applications to various NMPC problem formulations and several case studies The following types of nonlinear systems are considered resulting in different NMPC problem formulations Nonlinear systems described by first

principles models and nonlinear systems described by black box models Nonlinear systems with continuous control inputs and nonlinear systems with quantized control inputs Nonlinear systems without uncertainty and nonlinear systems with uncertainties polyhedral description of uncertainty and stochastic description of uncertainty Nonlinear systems consisting of interconnected nonlinear sub systems The proposed mp NLP approaches are illustrated with applications to several case studies which are taken from diverse areas such as automotive mechatronics compressor control combustion plant control reactor control pH maintaining system control cart and spring system control and diving computers

Recent Advances in Model Predictive Control Timm Faulwasser, Matthias A. Müller, Karl Worthmann, 2021-04-17 This book focuses on distributed and economic Model Predictive Control MPC with applications in different fields MPC is one of the most successful advanced control methodologies due to the simplicity of the basic idea measure the current state predict and optimize the future behavior of the plant to determine an input signal and repeat this procedure ad infinitum and its capability to deal with constrained nonlinear multi input multi output systems While the basic idea is simple the rigorous analysis of the MPC closed loop can be quite involved Here distributed means that either the computation is distributed to meet real time requirements for very large scale systems or that distributed agents act autonomously while being coupled via the constraints and or the control objective In the latter case communication is necessary to maintain feasibility or to recover system wide optimal performance The term economic refers to general control tasks and thus goes beyond the typically predominant control objective of set point stabilization Here recently developed concepts like strict dissipativity of optimal control problems or turnpike properties play a crucial role The book collects research and survey articles on recent ideas and it provides perspectives on current trends in nonlinear model predictive control Indeed the book is the outcome of a series of six workshops funded by the German Research Foundation DFG involving early stage career scientists from different countries and from leading European industry stakeholders

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

Non-linear Predictive Control Basil Kouvaritakis, Mark Cannon, 2001-10-26 The advantage of model predictive control is that it can take systematic account of constraints thereby allowing processes to operate at the limits of achievable performance Engineers in academia industry and government from the US and Europe explain how the linear version can be adapted and applied to the nonlinear conditions that characterize the dynamics of most

real manufacturing plants They survey theoretical and practical trends describe some specific theories and demonstrate their practical application derive strategies that provide appropriate assurance of closed loop stability and discuss practical implementation Annotation copyrighted by Book News Inc Portland OR

Predictive Control for Linear and Hybrid Systems Francesco Borrelli,Alberto Bemporad,Manfred Morari,2017-06-22 Model Predictive Control MPC the dominant advanced control approach in industry over the past twenty five years is presented comprehensively in this unique book With a simple unified approach and with attention to real time implementation it covers predictive control theory including the stability feasibility and robustness of MPC controllers The theory of explicit MPC where the nonlinear optimal feedback controller can be calculated efficiently is presented in the context of linear systems with linear constraints switched linear systems and more generally linear hybrid systems Drawing upon years of practical experience and using numerous examples and illustrative applications the authors discuss the techniques required to design predictive control laws including algorithms for polyhedral manipulations mathematical and multiparametric programming and how to validate the theoretical properties and to implement predictive control policies The most important algorithms feature in an accompanying free online MATLAB toolbox which allows easy access to sample solutions Predictive Control for Linear and Hybrid Systems is an ideal reference for graduate postgraduate and advanced control practitioners interested in theory and or implementation aspects of predictive control

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Robust Adaptive Model Predictive Control of Nonlinear Systems Darryl DeHaan,2010 Robust Adaptive Model Predictive Control of Nonlinear Systems

Economic Nonlinear Model Predictive Control Timm Faulwasser,Lars Gröne,Matthias A. Möller,2018 In recent years Economic Model Predictive Control EMPC has received considerable attention of many research groups The present tutorial survey summarizes state of the art approaches in EMPC In this context EMPC is to be understood as receding horizon optimal control with a stage cost that does not simply penalize the distance to a desired equilibrium but encodes more sophisticated economic objectives This survey provides a comprehensive overview of EMPC stability results with and without terminal constraints with and without dissipativity assumptions with averaged constraints formulations with multiple objectives and generalized terminal constraints as well as Lyapunov based approaches

Receding Horizon Control Wook Hyun Kwon,Soo Hee Han,2005-06-29 Easy to follow learning structure

makes absorption of advanced material as pain free as possible Introduces complete theories for stability and cost monotonicity for constrained and non linear systems as well as for linear systems In co ordination with MATLAB files available from springeronline com exercises and examples give the student more practice in the predictive control and filtering techniques presented

Optimization-based Tuning of Nonlinear Model Predictive Control with State Estimation E. Ali,E. Zafiriou,1993 **On the Tuning of Nonlinear Model Predictive Control Algorithms** E. Ali,E. Zafiriou,1993 **Model Predictive Control** ,2010 **Gradient-based Nonlinear Model Predictive Control with Constraint Transformation for Fast Dynamical Systems** Bartosz Maciej Käpernick,2016 Model Predictive Control Ridong Zhang,Anke Xue,Furong Gao,2018-08-14 This monograph introduces the authors work on model predictive control system design using extended state space and extended non minimal state space approaches It systematically describes model predictive control design for chemical processes including the basic control algorithms the extension to predictive functional control constrained control closed loop system analysis model predictive control optimization based PID control genetic algorithm optimization based model predictive control and industrial applications Providing important insights useful methods and practical algorithms that can be used in chemical process control and optimization it offers a valuable resource for researchers scientists and engineers in the field of process system engineering and control engineering Robust Multi-stage Nonlinear Model Predictive Control Sergio Lucia,Shaker Verlag GmbH,2014 Model Predictive Control for Nonlinear Networked Control Systems Paolo Varutti,2014 *Robust and Adaptive Model Predictive Control of Nonlinear Systems* Martin Guay,Veronica Adetola,Darryl DeHaan,2015-11-13 This book offers a novel approach to adaptive control and provides a sound theoretical background to designing robust adaptive control systems with guaranteed transient performance It focuses on the more typical role of adaptation as a means of coping with uncertainties in the system model

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