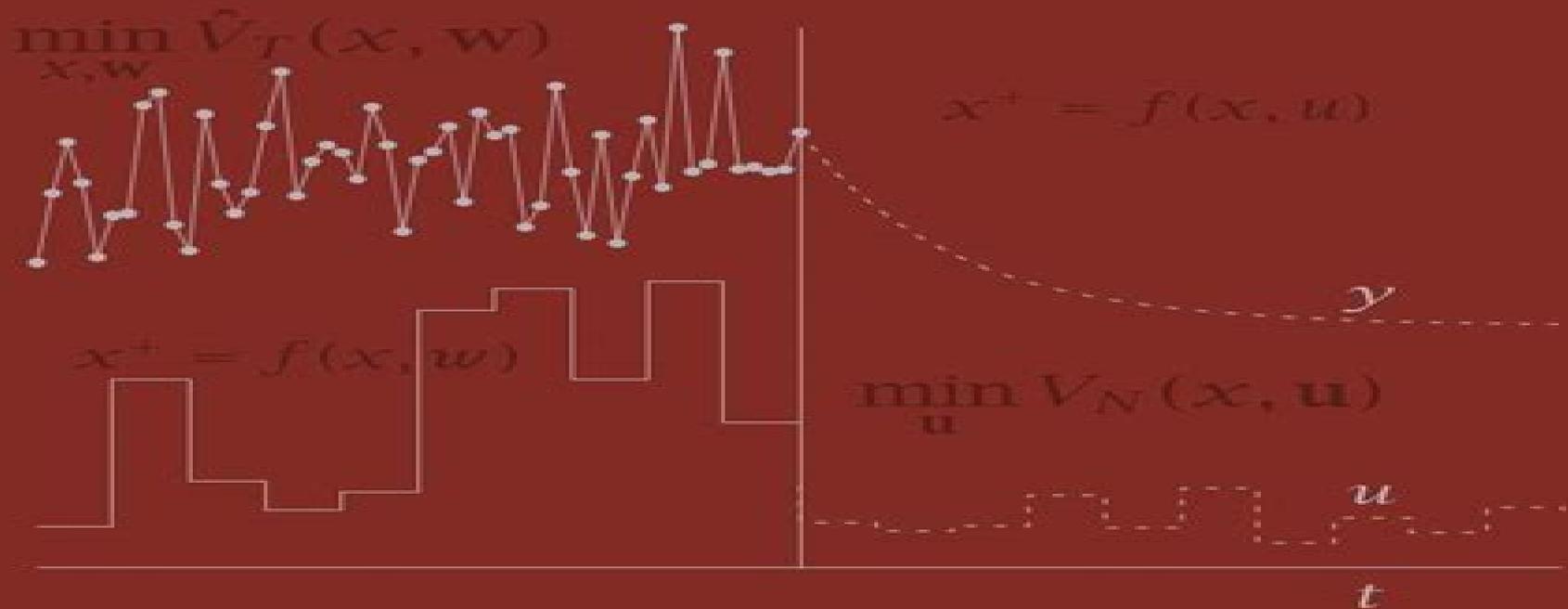# Model Predictive Control:
Theory, Computation, and Design
2nd Edition

James B. Rawlings
David Q. Mayne
Moritz M. Diehl

$$\min_{x,w} \hat{V}_T(x,w)$$

$$x^+ = f(x,u)$$

$$x^+ = f(x,w)$$

$$\min_{u} V_N(x,u)$$

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t

Model Predictive Control Theory And Design

Holger Hanselka,Peter Groche,Roland Platz

Model Predictive Control Theory And Design:

   Model Predictive Control James Blake Rawlings,David Q. Mayne,Moritz Diehl,2017   Model Predictive Control James Blake Rawlings,David Q. Mayne,2009   **Model Predictive Control** Corrine Wade,2015 Although industrial processes are inherently nonlinear many contributions for controller design for those plants are based on the assumption of a linear model of the system However in some cases it is difficult to represent a given process using a linear model Model Predictive Control MPC is an optimal control approach which can effectively deal with constraints and multivariable processes in industries Because of its advantages MPC has been widely applied in automotive and process control communities This book discusses the theory practices and future challenges of model predictive control   **Model Predictive Control - Theory and Applications** Constantin Voloşencu,2023-07-12 The book presents some recent specialized theoretical and practical works in the field of process control based on the model predictive control MPC method It includes seven chapters that present studies on the application of MPC in various technical processes such as the atmospheric plasma spray process permanent magnet synchronous motors monitoring of the pose of a walking person monitoring of the heat treatment process of raw materials discrete event processes control of passenger vehicles and natural gas sweetening processes Chapters include examples and case studies from researchers in the field This volume provides readers with new solutions and answers to questions related to the emerging applications of MPC and their implementation   **Model Predictive Control** Aris Daniilidis,Lars Grüne,Josef Haunschmied,Gernot Tragler,2025-06-07 The book explores the field of model predictive control MPC It reports on the latest developments in MPC current applications and presents various subfields of MPC The book features topics such as uncertain and stochastic MPC variants learning and neural network approaches easy to use numerical implementations as well as multi agent systems and scheduling and coordination tasks While MPC is rooted in engineering science this book illustrates the potential of using MPC theory and methods in non engineering sciences and applications such as economics finance and environmental sciences   Handbook of Model Predictive Control Saša V. Raković,William S. Levine,2018-09-01 Recent developments in model predictive control promise remarkable opportunities for designing multi input multi output control systems and improving the control of single input single output systems This volume provides a definitive survey of the latest model predictive control methods available to engineers and scientists today The initial set of chapters present various methods for managing uncertainty in systems including stochastic model predictive control With the advent of affordable and fast computation control engineers now need to think about using computationally intensive controls so the second part of this book addresses the solution of optimization problems in real time for model predictive control The theory and applications of control theory often influence each other so the last section of Handbook of Model Predictive Control rounds out the book with representative applications to automobiles healthcare robotics and finance The chapters in this volume will be useful to working engineers scientists and mathematicians as well as students and faculty interested in

the progression of control theory Future developments in MPC will no doubt build from concepts demonstrated in this book and anyone with an interest in MPC will find fruitful information and suggestions for additional reading **Explicit Nonlinear Model Predictive Control** Alexandra Grancharova,Tor Arne Johansen,2012-03-22 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 *Economic Model Predictive Control* Matthew Ellis,Jinfeng Liu,Panagiotis D. Christofides,2016-07-27 This book presents general methods for the design of economic model predictive control EMPC systems for broad classes of nonlinear systems that address key theoretical and practical considerations including recursive feasibility closed loop stability closed loop performance and computational efficiency Specifically the book proposes Lyapunov based EMPC methods for nonlinear systems two tier EMPC architectures that are highly computationally efficient and EMPC schemes handling explicitly uncertainty time varying cost functions time delays and multiple time scale dynamics The proposed methods employ a variety of tools ranging from nonlinear systems analysis through Lyapunov based control techniques to nonlinear dynamic optimization The applicability and performance of the proposed methods are demonstrated through a number of chemical process examples The book presents state of the art methods for the design of economic model predictive control systems for chemical processes In addition to being mathematically rigorous these methods accommodate key practical issues for example direct optimization of process economics time varying economic cost functions and computational efficiency Numerous comments and remarks providing fundamental understanding of the merging of process economics and feedback control into a single framework are included A control engineer can easily tailor the many detailed examples of industrial relevance given within the text to a specific application The authors present a rich collection of new

research topics and references to significant recent work making Economic Model Predictive Control an important source of information and inspiration for academics and graduate students researching the area and for process engineers interested in applying its ideas **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 **Uncertainty in Mechanical Engineering** Holger Hanselka,Peter Groche,Roland Platz,2011-09-27 Selected peer reviewed papers from the 1st International Conference on Uncertainty in Mechanical Engineering ICUME 2011 November 14 15 2011 Darmstadt Germany **Robust Model Predictive Control** Yiyang Wang,2002 Developments in Model-Based Optimization and Control Sorin Olaru,Alexandra Grancharova,Fernando Lobo Pereira,2015-12-23 This book deals with optimization methods as tools for decision making and control in the presence of model uncertainty It is oriented to the use of these tools in engineering specifically in automatic control design with all its components analysis of dynamical systems identification problems and feedback control design Developments in Model Based Optimization and Control takes advantage of optimization based formulations for such classical feedback design objectives as stability performance and feasibility afforded by the established body of results and methodologies constituting optimal control theory It makes particular use of the popular formulation known as predictive control or receding horizon optimization The individual contributions in this volume are wide ranging in subject matter but coordinated within a five part structure covering material on complexity and structure in model predictive control MPC collaborative MPC distributed MPC optimization based analysis and design and applications to bioprocesses multivehicle systems or energy management The various contributions cover a subject spectrum including inverse optimality and more modern decentralized and cooperative formulations of receding horizon optimal control Readers will find fourteen chapters dedicated to optimization based tools for robustness analysis and decision making in relation to feedback mechanisms fault detection for example and three chapters putting forward applications where the model based

optimization brings a novel perspective Developments in Model Based Optimization and Control is a selection of contributions expanded and updated from the Optimisation based Control and Estimation workshops held in November 2013 and November 2014 It forms a useful resource for academic researchers and graduate students interested in the state of the art in predictive control Control engineers working in model based optimization and control particularly in its bioprocess applications will also find this collection instructive   *Model Predictive Control* Eduardo F. Camacho,Carlos Bordons,José M. Maestre,2026-01-01 Model Predictive Control MPC the classic textbook for students and practitioners seeking deep understanding of advanced control systems is now revised updated and reorganized in a streamlined third edition The authors renowned researchers in the field cover an extensive range of topics that embraces the basic and the advanced the theoretical and the applied The book offers advanced undergraduate and graduate students an accessible step by step approach that enables them progressively to grasp and apply the concepts they are studying For instructors this is an invaluable curriculum resource packed with examples and case studies The text features material on commercial MPC convolution models transfer functions state space models and constraints advanced topics robust and stochastic MPC and MPC for nonlinear hybrid large scale and distributed systems and applications a series of case studies in solar energy generation hospital stock control a pilot microgrid and copper processing along with exercises to help readers assess their progress many with full or partial solutions in a solutions manual downloadable by adopting instructors MATLAB programs to assist with the design aspects of the book and with reproducing some of the examples are available for readers to download Model Predictive Control third edition s distinctive strength is its real world relevance It is an essential tool for future engineers its focus on practical implementation bridging the gap between academic theory and industrial practice and supplemented by exploration of optimization and algorithm related aspects of MPC ensures a holistic treatment of the subject   **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 **Advances in Mechatronics, Automation and Applied Information Technologies** Q. Lu,C.G. Zhang,2013-11-21 Selected peer reviewed papers from the 2013 International Conference on Mechatronics and Semiconductor Materials ICMSCM 2013 September 28 29 2013 Xi an China **AIChE Symposium Series** American Institute of Chemical Engineers,1997 Robust Nonlinear Control of Vectored Thrust Aircraft John Comstock Doyle,1993 **Dissertation Abstracts International** ,2004 *Predictive Control* Yugeng Xi,Dewei Li,2019-11-12 This book is a comprehensive introduction to model predictive control MPC including its basic principles and algorithms system analysis and design methods strategy developments and practical applications The main contents of the book include an overview of the development trajectory and basic principles of MPC typical MPC algorithms quantitative analysis of classical MPC systems design and tuning methods for MPC parameters constrained multivariable MPC algorithms and online optimization decomposition methods Readers will then progress to more advanced topics such as nonlinear MPC and its related algorithms the diversification development of MPC with respect to control structures and optimization strategies and robust MPC Finally applications of MPC and its generalization to optimization based dynamic problems other than control will be discussed Systematically introduces fundamental concepts basic algorithms and applications of MPC Includes a comprehensive overview of MPC development emphasizing recent advances and modern approaches Features numerous MPC models and structures based on rigorous research Based on the best selling Chinese edition which is a key text in China Predictive Control Fundamentals and Developments is written for advanced undergraduate and graduate students and researchers specializing in control technologies It is also a useful reference for industry professionals engineers and technicians specializing in advanced optimization control technology Chemical Engineering Progress ,1996

Reviewing **Model Predictive Control Theory And Design**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is really astonishing. Within the pages of "**Model Predictive Control Theory And Design**," an enthralling opus penned by a very acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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