

Nonlinear Predictive Control

theory and practice

**Edited by Basil Kouvaritakis
and Mark Cannon**

Non Linear Predictive Control Theory Practice

AW Chickering



Non Linear Predictive Control Theory Practice:

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

Nonlinear Predictive Control Using Wiener Models Maciej Ławryńczuk, 2021-09-21 This book presents computationally efficient MPC solutions The classical model predictive control MPC approach to control dynamical systems described by the Wiener model uses an inverse static block to cancel the influence of process nonlinearity Unfortunately the model's structure is limited and it gives poor control quality in the case of an imperfect model and disturbances An alternative is to use the computationally demanding MPC scheme with on line nonlinear optimisation repeated at each sampling instant A linear approximation of the Wiener model or the predicted trajectory is found on line As a result quadratic optimisation tasks are obtained Furthermore parameterisation using Laguerre functions is possible to reduce the number of decision variables Simulation results for ten benchmark processes show that the discussed MPC algorithms lead to excellent control quality For a neutralisation reactor and a fuel cell essential advantages of neural Wiener models are demonstrated

Nonlinear Model Predictive Control Frank Allgöwer, Alex Zheng, 2012-12-06 During the past decade model predictive control MPC also referred to as receding horizon control or moving horizon control has become the preferred control strategy for quite a number of industrial processes There have been many significant advances in this area over the past years one of the most important ones being its extension to nonlinear systems This book gives an up to date assessment of the current state of the art in the new field of nonlinear model predictive control NMPC The main topic areas that appear to be of central importance for NMPC are covered namely receding horizon control theory modeling for NMPC computational aspects of on line optimization and application issues The book consists of selected papers presented at the International Symposium on Nonlinear Model Predictive Control Assessment and Future Directions which took place from June 3 to 5 1998 in Ascona Switzerland The book is geared towards researchers and practitioners in the area of control engineering and control theory It is also suited for postgraduate students as the book contains several overview articles that give a tutorial introduction into the various aspects of nonlinear model predictive control including systems theory computations modeling and applications

Advanced Model Predictive Control Tao Zheng, 2011-07-05 Model Predictive Control MPC refers to a class of control algorithms in which a dynamic process model is used to predict and optimize process performance From lower request of modeling accuracy and robustness to complicated

process plants MPC has been widely accepted in many practical fields As the guide for researchers and engineers all over the world concerned with the latest developments of MPC the purpose of Advanced Model Predictive Control is to show the readers the recent achievements in this area The first part of this exciting book will help you comprehend the frontiers in theoretical research of MPC such as Fast MPC Nonlinear MPC Distributed MPC Multi Dimensional MPC and Fuzzy Neural MPC In the second part several excellent applications of MPC in modern industry are proposed and efficient commercial software for MPC is introduced Because of its special industrial origin we believe that MPC will remain energetic in the future

Precision agriculture '07 J.V. Stafford,2023-08-28 With ever increasing pressures on world agriculture in both economic and environmental terms application of the concept of precision agriculture is one way of enabling farmers and producers to cope Doing arable agriculture and horticulture more precisely means that the use of inputs is optimised crop yield and quality are maximised and leakage of agro chemicals and fertilisers to the environment is minimised This publication contains papers presented at the 6th European Conference on Precision Agriculture The papers reflect the wide range of disciplines encompassed by precision agriculture including soil physics crop physiology agronomy IT agricultural technology sensor technology remote sensing geostatistics and environmental science The wide range of research topics reported will be a valuable resource for researchers advisors teachers and professionals in agriculture long after the conference has finished Peer reviewed papers from the 3rd European Conference on Precision Livestock Farming are presented in a companion proceedings Precision livestock farming 07

Neural Approximations for Optimal Control and Decision Riccardo Zoppoli,Marcello Sanguineti,Giorgio Gnecco,Thomas Parisini,2019-12-17 Neural Approximations for Optimal Control and Decision provides a comprehensive methodology for the approximate solution of functional optimization problems using neural networks and other nonlinear approximators where the use of traditional optimal control tools is prohibited by complicating factors like non Gaussian noise strong nonlinearities large dimension of state and control vectors etc Features of the text include a general functional optimization framework thorough illustration of recent theoretical insights into the approximate solutions of complex functional optimization problems comparison of classical and neural network based methods of approximate solution bounds to the errors of approximate solutions solution algorithms for optimal control and decision in deterministic or stochastic environments with perfect or imperfect state measurements over a finite or infinite time horizon and with one decision maker or several applications of current interest routing in communications networks traffic control water resource management etc and numerous numerically detailed examples The authors diverse backgrounds in systems and control theory approximation theory machine learning and operations research lend the book a range of expertise and subject matter appealing to academics and graduate students in any of those disciplines together with computer science and other areas of engineering

Fault-Tolerant Process Control Prashant Mhaskar,Jinfeng Liu,Panagiotis D. Christofides,2012-11-27 Fault Tolerant Process Control focuses on the development of general yet practical

methods for the design of advanced fault tolerant control systems these ensure an efficient fault detection and a timely response to enhance fault recovery prevent faults from propagating or developing into total failures and reduce the risk of safety hazards To this end methods are presented for the design of advanced fault tolerant control systems for chemical processes which explicitly deal with actuator controller failures and sensor faults and data losses Specifically the book puts forward A framework for detection isolation and diagnosis of actuator and sensor faults for nonlinear systems Controller reconfiguration and safe parking based fault handling methodologies Integrated data and model based fault detection and isolation and fault tolerant control methods Methods for handling sensor faults and data losses and Methods for monitoring the performance of low level PID loops The methodologies proposed employ nonlinear systems analysis Lyapunov techniques optimization statistical methods and hybrid systems theory and are predicated upon the idea of integrating fault detection local feedback control and supervisory control The applicability and performance of the methods are demonstrated through a number of chemical process examples Fault Tolerant Process Control is a valuable resource for academic researchers industrial practitioners as well as graduate students pursuing research in this area

Energy Management and Conservation Handbook Frank Kreith,D. Yogi Goswami,2016-10-03 Energy is the mainstay of industrial societies and without an adequate supply of energy the social political and economic stability of nations is put into jeopardy With supplies of inexpensive fossil fuels decreasing and climate change factors becoming more threatening the need to conserve energy and move steadily to more sustainable energy sources is more urgent than ever before The updated Second Edition of this successful handbook includes chapters from leading experts on the economics and fiscal management of energy with a focus on the tools available to advance efficiency and conservation measures Updated coverage of renewable energy sources energy storage technologies energy audits for buildings and building systems and demand side management is provided The appendix of the handbook provides extensive data resources for analysis and calculation

Energy Efficiency and Renewable Energy Handbook D. Yogi Goswami, Frank Kreith, 2015-09-09 For the Movers Shakers and Policy Makers in Energy Engineering and Related Industries The latest version of a bestselling reference Energy Efficiency and Renewable Energy Handbook Second Edition covers the foremost trends and technologies in energy engineering today This new edition contains the latest material on energy planning and policy wi

Advanced Control of Chemical Processes 1994 D. Bonvin, 2014-05-23 This publication brings together the latest research findings in the key area of chemical process control including dynamic modelling and simulation modelling and model validation for application in linear and nonlinear model based control nonlinear model based predictive control and optimization to facilitate constrained real time optimization of chemical processes statistical control techniques major developments in the statistical interpretation of measured data to guide future research knowledge based v model based control the integration of theoretical aspects of control and optimization theory with more recent developments in artificial intelligence and computer science

Essential C# fast Ian

Chivers,2003-04-08 A quick and practical introduction to the C programming language The text includes complete programming examples that highlight the core features of this language In this book you will learn about Using C with a traditional compile run cycle using C within the Developer Studio environment different data types supported in C control structures and input and output i o in C key features of C and their relationship to C C Java and other programming languages

Recent Advances in Artificial Neural Networks L. C. Jain,2018-05-04 Neural networks represent a new generation of information processing paradigms designed to mimic in a very limited sense the human brain They can learn recall and generalize from training data and with their potential applications limited only by the imaginations of scientists and engineers they are commanding tremendous popularity and research interest Over the last four decades researchers have reported a number of neural network paradigms however the newest of these have not appeared in book form until now Recent Advances in Artificial Neural Networks collects the latest neural network paradigms and reports on their promising new applications World renowned experts discuss the use of neural networks in pattern recognition color induction classification cluster detection and more Application engineers scientists and research students from all disciplines with an interest in considering neural networks for solving real world problems will find this collection useful

Neural Nets Bruno Apolloni,2006-04-06 This book constitutes the thoroughly refereed postproceedings of the 16th Italian Workshop on Neural Nets WIRN 2005 as well as the satellite International Workshop on Natural and Artificial Immune Systems NAIS 2005 held in Vietri sul Mare Italy in June 2005 The 41 revised papers presented together with a lecture by the winner of the Premio Caianiello award were carefully reviewed and improved during two rounds of selection and refereeing

Computationally Efficient Model Predictive Control Algorithms Maciej Ławryńczuk,2014-01-24 This book thoroughly discusses computationally efficient suboptimal Model Predictive Control MPC techniques based on neural models The subjects treated include A few types of suboptimal MPC algorithms in which a linear approximation of the model or of the predicted trajectory is successively calculated on line and used for prediction Implementation details of the MPC algorithms for feed forward perceptron neural models neural Hammerstein models neural Wiener models and state space neural models The MPC algorithms based on neural multi models inspired by the idea of predictive control The MPC algorithms with neural approximation with no on line linearization The MPC algorithms with guaranteed stability and robustness Cooperation between the MPC algorithms and set point optimization Thanks to linearization or neural approximation the presented suboptimal algorithms do not require demanding on line nonlinear optimization The presented simulation results demonstrate high accuracy and computational efficiency of the algorithms For a few representative nonlinear benchmark processes such as chemical reactors and a distillation column for which the classical MPC algorithms based on linear models do not work properly the trajectories obtained in the suboptimal MPC algorithms are very similar to those given by the ideal MPC algorithm with on line nonlinear optimization repeated at each sampling instant At the same time the suboptimal MPC

algorithms are significantly less computationally demanding

Control of Nonlinear and Hybrid Process Systems Panagiotis D. Christofides, Nael El-Farra, 2005-10-04 This monograph provides insight and fundamental understanding into the feedback control of nonlinear and hybrid process systems It presents state of the art methods for the synthesis of nonlinear feedback controllers for nonlinear and hybrid systems with uncertainty constraints and time delays with numerous applications especially to chemical processes It covers both state feedback and output feedback including state estimator design controller designs *Control of Nonlinear and Hybrid Process Systems* includes numerous comments and remarks providing insight and fundamental understanding into the feedback control of nonlinear and hybrid systems as well as applications that demonstrate the implementation and effectiveness of the presented control methods The book includes many detailed examples which can be easily modified by a control engineer to be tailored to a specific application This book is useful for researchers in control systems theory graduate students pursuing their degree in control systems and control engineers

Switching and Learning in Feedback Systems Roderick Murray-Smith, Robert Shorten, 2005-01-27 A central theme in the study of dynamic systems is the modelling and control of uncertain systems While uncertainty has long been a strong motivating factor behind many techniques developed in the modelling control statistics and mathematics communities the past decade in particular has witnessed remarkable progress in this area with the emergence of a number of powerful new methods for both modelling and controlling uncertain dynamic systems The specific objective of this book is to describe and review some of these exciting new approaches within a single volume Our approach was to invite some of the leading researchers in this area to contribute to this book by submitting both tutorial papers on their specific area of research and to submit more focussed research papers to document some of the latest results in the area We feel that collecting some of the main results together in this manner is particularly important as many of the important ideas that emerged in the past decade were derived in a variety of academic disciplines By providing both tutorial and research papers we hope to be able to provide the interested reader with sufficient background to appreciate some of the main concepts from a variety of related but nevertheless distinct fields and to provide a flavor of how these results are currently being used to cope with uncertainty It is our sincere hope that the availability of these results within a single volume will lead to further cross fertilization of ideas and act as a spark for further research in this important area of applied mathematics

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

High Performance Algorithms and Software for Nonlinear Optimization Gianni Pillo, Almerico Murli, 2013-12-01 This volume contains the edited texts of the lectures presented at the Workshop on High Performance Algorithms and Software for Nonlinear Optimization held in Erice Sicily at the G Stampacchia School of Mathematics of the E Majorana Centre for Scientific Culture June 30 July 8 2001 In the first year of the new century the aim of the Workshop was to assess the past and to discuss the future of Nonlinear Optimization and to highlight recent achievements and promising research trends in this field An emphasis was requested on algorithmic and high performance software developments and on new computational experiences as well as on theoretical advances We believe that such goal was basically achieved The Workshop was attended by 71 people from 22 countries Although not all topics were covered the presentations gave indeed a wide overview of the field from different and complementary stand points Besides the lectures several formal and informal discussions took place We wish to express our appreciation for the active contribution of all the participants in the meeting The 18 papers included in this volume represent a significant selection of the most recent developments in nonlinear programming theory and practice They show that there is plenty of exciting ideas implementation issues and new applications which produce a very fast evolution in the field

Benchmark Models of Control System Design for Remotely Operated Vehicles Cheng Siong Chin, Michael Wai Shing Lau, 2020-08-07 This book is intended to meet the needs of those who seek to develop control systems for ROVs when there is no model available during the initial design stage The modeling simulation and application of marine vehicles like underwater robotic vehicles URVs are multidisciplinary and combine mathematical aspects from various engineering disciplines URVs such as remotely operated vehicle ROVs are used for a wide range of applications such as exploring the extreme depths of our ocean where a hard wired link is still required Most ROVs operate in extreme environments with uncertainties in the model prior to control system design However the method involved extensive testing before the system model could be used for any control actions It has been found that the range of error can be extensive and uncertain in actual continuously varying conditions Hence it is important to address the problem of reliance on model testing using different modeling approaches In this book approaches

such as WAMIT ANSYS CFX STAR CCM MATLAB and Simulink are used to model parameters for ROVs A few benchmark models are provided allowing researchers and students to explore and test different control schemes Given its scope the book offers a valuable reference guide for postgraduate and undergraduate students engaged in modeling and simulation for ROV control

Monitoring and Control of Information-Poor Systems Arthur L. Dexter, 2012-04-09 The monitoring and control of a system whose behaviour is highly uncertain is an important and challenging practical problem Methods of solution based on fuzzy techniques have generated considerable interest but very little of the existing literature considers explicit ways of taking uncertainties into account This book describes an approach to the monitoring and control of information poor systems that is based on fuzzy relational models which generate fuzzy outputs The first part of *Monitoring and Control of Information Poor Systems* aims to clarify why design decisions must take account of the uncertainty associated with optimal choices and to explain how a fuzzy relational model can be used to generate a fuzzy output which reflects the uncertainties associated with its predictions Part two gives a brief introduction to fuzzy decision making and shows how it can be used to design a predictive control scheme that is suitable for controlling information poor systems using inaccurate measurements Part three describes different ways in which fuzzy relational models can be generated online and explains the practical issues associated with their identification and application The final part of the book provides examples of the use of the previously described techniques in real applications

Key features Describes techniques applicable to a wide range of engineering environmental medical financial and economic applications Uses simple examples to help explain the basic techniques for dealing with uncertainty Describes a novel design approach based on the use of fuzzy relational models Considers practical issues associated with applying the techniques to real systems *Monitoring and Control of Information Poor Systems* forms an invaluable resource for a wide range of graduate students and is also a comprehensive reference for researchers and practitioners working on problems involving mathematical modelling and control

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