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Numerical Control: Part A Springer
New approaches are needed that could move us towards developing effective systems for problem solving and decision making, systems that can deal with complex and ill-structured situations, systems that can function in information rich environments, systems that can cope with imprecise information, systems that can rely on their knowledge and learn from experience - i.e. intelligent systems. One of the main efforts in intelligent systems development is focused on knowledge and information management which is regarded as the crucial issue in smart decision making support. The 13 Chapters of this book represent a sample of such effort. The overall aim of this book is to provide guidelines to develop tools for smart processing of knowledge and information. Still, the guide does not presume to give ultimate answers. Rather, it poses ideas and case studies to explore and the complexities and challenges of modern knowledge management issues. It also encourages its reader to become aware of the multifaceted interdisciplinary character of such issues. The premise of this book is that its reader will leave it with a heightened ability to think - in different ways - about developing, evaluating, and supporting intelligent knowledge and information management systems in real life based environment.
Theory and Algorithms CRC Press
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.

Privacy in Dynamical Systems Springer Science & Business Media

This book addresses privacy in dynamical systems, with applications to smart metering, traffic estimation, and building management. In the first part, the book explores statistical methods for privacy preservation from the areas of differential privacy and information-theoretic privacy (e.g., using privacy metrics motivated by mutual information, relative entropy, and Fisher information) with provable guarantees. In the second part, it investigates the use of homomorphic encryption for the implementation of control laws over encrypted numbers to support the development of fully secure remote estimation and control. Chiefly intended for graduate students and researchers, the book provides an essential overview of the latest developments in privacy-aware design for dynamical systems.

Networked Control Systems Springer

The chemical industry is a vital sector of the US economy. Maintaining optimal chemical process operation is critical to the future success of the US chemical industry on a global market. Traditionally, economic optimization of chemical processes has been addressed in a two-layer hierarchical architecture. In the upper layer, real-time optimization carries out economic process optimization by computing optimal process operation set-points using detailed nonlinear steady-state process models. These set-points are used by the lower layer feedback control systems to force the process to operate on these set-points. While this paradigm has been successful, we are witnessing an increasing need for dynamic market and demand-driven operations for more efficient process operation, increasing response capability to changing customer demand, and achieving real-time energy management. To enable next-generation market-driven operation, economic model predictive control (EMPC), which is an model predictive control scheme formulated with a stage cost that represents the process economics, has been proposed to integrate dynamic economic optimization of processes with feedback control. Motivated by these considerations, novel theory and methods needed for the design of computationally tractable economic model predictive control systems for nonlinear processes are developed in this dissertation. Specifically, the following considerations are addressed: a) EMPC structures for nonlinear systems which address: infinite-time and finite-time closed-loop economic performance and time-varying economic considerations such as changing energy pricing; b) two-layer (hierarchical) dynamic economic process optimization and feedback control frameworks that incorporate EMPC with other control strategies allowing for computational efficiency; and c) EMPC schemes that account for real-time computation requirements. The EMPC schemes and methodologies are applied to chemical process applications. The application studies demonstrate the effectiveness of the EMPC schemes to maintain process stability and improve economic performance under dynamic operation as well as to increase efficiency, reliability and profitability of processes, thereby contributing to the vision of Smart Manufacturing.

Model Predictive Control Springer Nature

The second edition of "Model Predictive Control" provides a thorough introduction to theoretical and practical aspects of the most commonly used MPC strategies. It bridges the gap between the powerful but often abstract techniques of control researchers and the more empirical approach of practitioners. The book demonstrates that a powerful technique does not always require complex control algorithms. Many new exercises and examples have also been added throughout. Solutions available for download from the authors' website save the tutor time and enable the student to follow results more closely even when the tutor isn't present.

Nonlinear Model Predictive Control Springer

Model Predictive ControlTheory, Computation, and DesignNonlinear Model Predictive ControlSpringer Science & Business Media

Advances in Control Springer Science & Business Media

This brief addresses the design of model predictive control algorithms for performing space rendezvous manoeuvres. It consolidates developments within guidance and control algorithms, with the aim of improving the efficiency, safety, and autonomy of these manoeuvres. The brief presents several applications of model predictive control to rendezvous manoeuvres, including Ankersen zero-order-hold particular solution1, which provides a realistic thrust profile. It offers new approaches for rendezvous manoeuvres in elliptical orbits, formulating obstacle avoidance constraints, passive safety constraints, and robustness techniques. It also compares finite-horizon and variable-horizon formulations for model predictive control in the context of performance and computational complexity. Predictive Control for Spacecraft Rendezvous is accessible to academics and students new to the topics of orbital rendezvous and model predictive control, but also presents compelling subject matter for researchers and professionals in the aerospace industry.

Solving Urban Infrastructure Problems Using Smart City Technologies Springer Science & Business Media

For the first time, a textbook that brings together classical predictive control with treatment of up-to-date robust and stochastic techniques. Model Predictive Control describes the development of tractable algorithms for uncertain, stochastic, constrained systems. The starting point is classical predictive control and the appropriate formulation of performance objectives and constraints to provide guarantees of closed-loop stability and performance. Moving on to robust predictive control, the text explains how similar guarantees may be obtained for cases in which the model describing the system dynamics is subject to additive disturbances and parametric uncertainties. Open- and closed-loop optimization are considered and the state of the art in computationally tractable methods based on uncertainty tubes presented for systems with additive model uncertainty. Finally, the tube framework is also applied to model predictive control problems involving hard or probabilistic constraints for the cases of multiplicative and stochastic model uncertainty. The book provides: extensive use of illustrative examples; sample problems; and discussion of novel control

applications such as resource allocation for sustainable development and turbine-blade control for maximized power capture with simultaneously reduced risk of turbulence-induced damage. Graduate students pursuing courses in model predictive control or more generally in advanced or process control and senior undergraduates in need of a specialized treatment will find Model Predictive Control an invaluable guide to the state of the art in this important subject. For the instructor it provides an authoritative resource for the construction of courses.
Recent Advances in Model Predictive Control Model Predictive ControlTheory, Computation, and DesignNonlinear Model Predictive Control
This open access Brief introduces the basic principles of control theory in a concise self-study guide. It complements the classic texts by emphasizing the simple conceptual unity of the subject. A novice can quickly see how and why the different parts fit together. The concepts build slowly and naturally one after another, until the reader soon has a view of the whole. Each concept is illustrated by detailed examples and graphics. The full software code for each example is available, providing the basis for experimenting with various assumptions, learning how to write programs for control analysis, and setting the stage for future research projects. The topics focus on robustness, design trade-offs, and optimality. Most of the book develops classical linear theory. The last part of the book considers robustness with respect to nonlinearity and explicitly nonlinear extensions, as well as advanced topics such as adaptive control and model predictive control. New students, as well as scientists from other backgrounds who want a concise and easy-to-grasp coverage of control theory, will benefit from the emphasis on concepts and broad understanding of the various approaches.
Handbook of Model Predictive Control John Wiley & Sons
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
Recent Advances and Applications of Hybrid Simulation Springer Science & Business Media
Model Predictive Control is an important technique used in the process control industries. It has developed considerably in the last few years, because it is the most general way of posing the process control problem in the time domain. The Model Predictive Control formulation integrates optimal control, stochastic control, control of processes with dead time, multivariable control and future references. The finite control horizon makes it possible to handle constraints and non linear processes in general which are frequently found in industry. Focusing on implementation issues for Model Predictive Controllers in industry, it fills the gap between the empirical way practitioners use control algorithms and the sometimes abstractly formulated techniques developed by researchers. The text is firmly based on material from lectures given to senior undergraduate and graduate students and articles written by the authors.
Reinforcement Learning and Optimal Control Athena Scientific
In model predictive control (MPC) an optimization problem has to be solved at each time step, which in real-time applications makes it important to solve these efficiently and to have good upper bounds on worst-case solution time. Often for linear MPC problems, the optimization problem in question is a quadratic program (QP) that depends on parameters such as system states and reference signals. A popular class of methods for solving such QPs is active-set methods, where a sequence of linear systems of equations is solved. The primary contribution of this thesis is a method which determines which sequence of subproblems a popular class of such active-set algorithms need to solve, for every possible QP instance that might arise from a given linear MPC problem (i.e, for every possible state and reference signal). By knowing these sequences, worst-case bounds on how many iterations, floating-point operations and, ultimately, the maximum solution time, these active-set algorithms require to compute a solution can be determined, which is of importance when, e.g, linear MPC is used in safety-critical applications. After establishing this complexity certification method, its applicability is extended by showing how it can be used indirectly to certify the complexity of another, efficient, type of active-set QP algorithm which reformulates the QP as a nonnegative least-squares method. Finally, the proposed complexity certification method is extended further to situations when enhancements to the active-set algorithms are used, namely, when they are terminated early (to save computations) and when outer proximal-point iterations are performed (to improve numerical stability).
Assessment and Future Directions of Nonlinear Model Predictive Control MDPI
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.
Handbook on Planning, Design, Development, and Regulation Linköping University Electronic Press
This unique and up-to-date work surveys the use of mechatronics in rail vehicles, notably traction, braking, communications, data sharing, and control. The results include improved safety, comfort, and fuel efficiency. Mechatronic systems are a key element in modern rail vehicle design and operation. Starting with an overview of mechatronic theory, the book goes on to cover topics including modeling of mechanical and electrical systems for rail vehicles, open and closed loop control systems, sensors, actuators and microprocessors. Modern simulation techniques and examples are included throughout, and numerical experiments and developed models for railway application are presented and explained. Case studies are used, alongside practical examples, to ensure that the reader can apply mechatronic theory to real world conditions. These case studies include modeling of a hybrid locomotive and simplified models of

railway vehicle lateral dynamics for suspension control studies. Rail Vehicle Mechatronics provides current and in-depth content for design engineers, operations managers, systems engineers and technical consultants world-wide, working with freight, passenger, and urban transit railway systems.

Classical, Robust and Stochastic Springer Science & Business Media

Calculus of Thought: Neuromorphic Logistic Regression in Cognitive Machines is a must-read for all scientists about a very simple computation method designed to simulate big-data neural processing. This book is inspired by the Calculus Ratiocinator idea of Gottfried Leibniz, which is that machine computation should be developed to simulate human cognitive processes, thus avoiding problematic subjective bias in analytic solutions to practical and scientific problems. The reduced error logistic regression (RELR) method is proposed as such a "Calculus of Thought." This book reviews how RELR's completely automated processing may parallel important aspects of explicit and implicit learning in neural processes. It emphasizes the fact that RELR is really just a simple adjustment to already widely used logistic regression, along with RELR's new applications that go well beyond standard logistic regression in prediction and explanation. Readers will learn how RELR solves some of the most basic problems in today’s big and small data related to high dimensionality, multi-colinearity, and cognitive bias in capricious outcomes commonly involving human behavior. Provides a high-level introduction and detailed reviews of the neural, statistical and machine learning knowledge base as a foundation for a new era of smarter machines Argues that smarter machine learning to handle both explanation and prediction without cognitive bias must have a foundation in cognitive neuroscience and must embody similar explicit and implicit learning principles that occur in the brain

Model Predictive Control in the Process Industry Elsevier

This volume presents some recent and principal developments related to computational intelligence and optimization methods in control. Theoretical aspects and practical applications of control engineering are covered by 14 self-contained contributions. Additional gems include the discussion of future directions and research perspectives designed to add to the reader’s understanding of both the challenges faced in control engineering and the insights into the developing of new techniques. With the knowledge obtained, readers are encouraged to determine the appropriate control method for specific applications.

Economic Model Predictive Control Theory: Computational Efficiency and Application to Smart Manufacturing Springer Science & Business Media

This book contains 112 papers selected from about 250 submissions to the 6th World Congress on Global Optimization (WCGO 2019) which takes place on July 8–10, 2019 at University of Lorraine, Metz, France. The book covers both theoretical and algorithmic aspects of Nonconvex Optimization, as well as its applications to modeling and solving decision problems in various domains. It is composed of 10 parts, each of them deals with either the theory and/or methods in a branch of optimization such as Continuous optimization, DC Programming and DCA, Discrete optimization & Network optimization, Multiobjective programming, Optimization under uncertainty, or models and optimization methods in a specific application area including Data science, Economics & Finance, Energy & Water management, Engineering systems, Transportation, Logistics, Resource allocation & Production management. The researchers and practitioners working in Nonconvex Optimization and several application areas can find here many inspiring ideas and useful tools & techniques for their works.

Economic Model Predictive Control Academic Press

Solving Urban Infrastructure Problems Using Smart City Technologies is the most complete guide for integrating next generation smart city technologies into the very foundation of urban areas worldwide, showing how to make urban areas more efficient, more sustainable, and safer. Smart cities are complex systems of systems that encompass all aspects of modern urban life. A key component of their success is creating an ecosystem of smart infrastructures that can work together to enable dynamic, real-time interactions between urban subsystems such as transportation, energy, healthcare, housing, food, entertainment, work, social interactions, and governance. Solving Urban Infrastructure Problems Using Smart City Technologies is a complete reference for building a holistic, system-level perspective on smart and sustainable cities, leveraging big data analytics and strategies for planning, zoning, and public policy. It offers in-depth coverage and practical solutions for how smart cities can utilize resident’s intellectual and social capital, press environmental sustainability, increase personalization, mobility, and higher quality of life. Brings together experts from academia, government and industry to offer state-of- the-art solutions for urban system problems, showing how smart technologies can be used to improve the lives of the billions of people living in cities across the globe Demonstrates practical implementation solutions through real-life case studies Enhances reader comprehension with learning aid such as hands-on exercises, questions and answers, checklists, chapter summaries, chapter review questions, exercise problems, and more

Synthesis of Feedback Systems Athena Scientific

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.

Model Predictive Control System Design and Implementation Using MATLAB® Springer Nature

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.