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Stable Adaptive Control and Estimation for Nonlinear Systems Adaptive Control System Identification for Self-adaptive Control Adaptive Methods for Control System Design Adaptive Control Systems Robust Adaptive Control Direct Adaptive Control Algorithms: Robust and Adaptive Control Model-Reference Adaptive Control Control Engineering Solutions Optimal, Predictive, and Adaptive Control Adaptive Control Tutorial Adaptive Dual Control Adaptive Control Nonlinear and Adaptive Control Nonlinear and Adaptive Control Design ADEX Optimized Adaptive Controllers and Systems Adaptive Control of Nonsmooth Dynamic Systems Safe Adaptive Control Adaptive Control for Robotic Manipulators Adaptive Control for Partially Known Systems Nonlinear and Adaptive Control Adaptive Inverse Control, Reissue Edition System Identification and Adaptive Control Adaptive Control and Optimization Techniques Adaptive Mechanics Theory of Self-Adaptive Control Systems Functional Adaptive Control Adaptive Control Adaptive and Learning Systems Applications Of Neural Adaptive Control Technology Adaptive Filtering Prediction and Control Adaptive Robust Control Systems Statistical Decision Theory in Adaptive Control Systems Practical Applications of Computational Intelligence for Adaptive Control Adaptive Optimal Control Advanced Methods in Adaptive Control for Industrial Applications Techniques for Adaptive Control L1 Adaptive Control Theory Adaptive Control Systems

Designed to meet the needs of a wide audience without sacrificing mathematical depth and rigor, Adaptive Control Tutorial presents the design, analysis, and application of a wide variety of algorithms that can be used to manage dynamical systems with unknown parameters. Its tutorial-style presentation of the fundamental techniques and algorithms in adaptive control make it suitable as a textbook. Adaptive Control Tutorial is designed to serve the needs of three distinct groups of readers: engineers and students interested in learning how to design, simulate, and implement parameter estimators and adaptive control schemes without having to fully understand the analytical and technical proofs; graduate students who, in addition to attaining the aforementioned objectives, also want to understand the analysis of simple schemes and get an idea of the steps involved in more complex proofs; and advanced students and researchers who want to study and understand the details of long and technical proofs with an eye toward pursuing research in adaptive control or related topics. The authors achieve these multiple objectives by enriching the book with examples demonstrating the design procedures and basic analysis steps and by detailing their proofs in both an appendix and electronically available supplementary material; online examples are also available. A solution manual for instructors can be obtained by contacting SIAM or the authors. Preface; Acknowledgements; List of Acronyms; Chapter 1: Introduction; Chapter 2: Parametric Models; Chapter 3: Parameter Identification: Continuous Time; Chapter 4: Parameter Identification: Discrete Time; Chapter 5: Continuous-Time Model Reference Adaptive Control; Chapter 6: Continuous-Time Adaptive Pole Placement Control; Chapter 7: Adaptive Control for Discrete-Time Systems; Chapter 8: Adaptive Control of Nonlinear Systems; Appendix; Bibliography; Index Adaptive control is no longer just an important theoretical field of study, but is also providing solutions to real-world problems. Adaptive techniques will transform the world of control. The leading world practitioners of adaptive control have contributed to this handbook which is the most important work yet in this field. Not only are techniques described in theory, but detailed control algorithms are given, making this a practical cookbook of adaptive control for both control professionals and practising engineers.The book presents the most advanced techniques and algorithms of adaptive control. These include various robust techniques, performance enhancement techniques, techniques with less a-priori knowledge, nonlinear adaptive control techniques and intelligent adaptive techniques. Each technique described has been developed to provide a practical solution to a real-life problem. This volume will therefore not only advance the field of adaptive control as an area of study, but will also show how the potential of this technology can be realised and offer significant benefits. Practical cookbook of adaptive control Contains important research Many of the non-smooth, non-linear phenomena covered in this well-balanced book are of vital importance in almost any field of engineering. Contributors from all over the world ensure that no one area’s slant on the subjects predominates. Robust and Adaptive Control shows the reader how to produce consistent and accurate controllers that operate in the presence of uncertainties and unforeseen events. Driven by aerospace applications the focus of the book is primarily on continuous-dynamical systems. The text is a three-part treatment, beginning with robust and optimal linear control methods and moving on to a self-contained presentation of the design and analysis of model reference adaptive control (MRAC) for nonlinear uncertain dynamical systems. Recent extensions and modifications to MRAC design are included, as are guidelines for combining robust optimal and MRAC controllers. Features of the text include: · case studies that demonstrate the benefits of robust and adaptive control for piloted, autonomous and experimental aerial platforms; · detailed background material for each chapter to motivate theoretical developments; · realistic examples and simulation data illustrating key features of the methods described; and · problem solutions for instructors and MATLAB® code provided electronically. The theoretical content and practical applications reported address real-life aerospace problems, being based on numerous transitions of control-theoretic results into operational systems and airborne vehicles that are drawn from the authors’ extensive professional experience with The Boeing Company. The systems covered are challenging, often open-loop unstable, with uncertainties in their dynamics, and thus requiring both persistently reliable control and the ability to track commands either from a pilot or a guidance computer. Readers are assumed to have a basic understanding of root locus, Bode diagrams, and Nyquist plots, as well as linear algebra, ordinary differential equations, and the use of state-space methods in analysis and modeling of dynamical systems. Robust and Adaptive Control is intended to methodically teach senior undergraduate and graduate students how to construct stable and predictable control algorithms for realistic industrial applications. Practicing engineers and academic researchers will also find the book of great instructional value. Thema dieses Buches ist die Anwendung neuronaler Netze und Fuzzy-Logic-Methoden zur Identifikation und Steuerung nichtlinear-dynamischer Systeme. Dabei werden fortgeschrittene Konzepte der herkömmlichen Steuerungstheorie mit den intuitiven Eigenschaften intelligenter Systeme kombiniert, um praxisrelevante Steuerungsaufgaben zu lösen. Die Autoren bieten viel Hintergrundmaterial; ausgearbeitete Beispiele und Übungsaufgaben helfen Studenten und Praktikern beim Vertiefen des Stoffes. Lösungen zu den Aufgaben sowie MATLAB-Codebeispiele sind ebenfalls enthalten. This book presents a comprehensive overview of the recently developed L1 adaptive control theory, including detailed proofs of the main results. The key feature of the L1 adaptive control theory is the decoupling of adaptation from robustness. The architectures of L1 adaptive control theory have guaranteed transient performance and robustness in the presence of fast adaptation, without enforcing persistent excitation, applying gain-scheduling, or resorting to high-gain feedback. Safe Adaptive Control gives a formal and complete algorithm for assuring the stability of a switched control system when at least one of the available candidate controllers is stabilizing. The possibility of having an unstable switched system even in the presence of a stabilizing candidate controller is demonstrated by referring to several well-known adaptive control approaches, where the system goes unstable when a large mismatch between the unknown plant and the available models exists ("plant-model mismatch instability"). Sufficient conditions for this possibility to be avoided are formulated, and a "recipe" to be followed by the control system designer to guarantee stability and desired performance is provided. The problem is placed in a standard optimization setting. Unlike the finite controller sets considered elsewhere, the candidate controller set is allowed to be continuously parametrized so that it can deal with plants with a very large range of uncertainties. Techniques for Adaptive Control compiles chapters from a team of expert contributors that allow readers to gain a perspective into a number of different approaches to adaptive control. In order to do this, each contributor provides an overview of a particular product, how it works, and reasons why a user would want it as well as an in depth explanation of their particular method. This is one of the latest technologies to emerge in the instrumentation and control field. These latest control methodologies offer a means to revolutionize plant and process efficiency, response time and profitability by allowing a process to be regulated by a form of rule-based AI, without human intervention. Rather than the common academic-based approach that books on this subject generally take, the contributions here outline practical applications of adaptive control technology allowing for a real look inside the industry and the new technologies available. * Written by a team of contributors from the industry's best-known product manufacturers and software developers * Provides real insight into new technologies available in the industry * Outlines practical applications of adaptive control technology Unique in its systematic approach to stochastic systems, this book presents a wide range of techniques that lead to novel strategies for effecting intelligent control of complex systems that are typically characterised by uncertainty, nonlinear dynamics, component failure, unpredictable disturbances, multi-modality and high dimensional spaces. This book focuses on the applications of robust and adaptive control approaches to practical systems. The proposed control systems hold two important features: (1) The system is robust with the variation in plant parameters and disturbances (2) The system adapts to parametric uncertainties even in the unknown plant structure by self-training and self-estimating the unknown factors. The various kinds of robust adaptive controls represented in this book are composed of sliding mode control, model-reference adaptive control, gain-scheduling, H-infinity, model-predictive control, fuzzy logic, neural networks, machine learning, and so on. The control objects are very abundant, from cranes, aircrafts, and wind turbines to automobile, medical and sport machines, combustion engines, and electrical machines. Presenting current trends in the development and applications of intelligent systems in engineering, this monograph focuses on recent research results in system identification and control. The recurrent neurofuzzy and the fuzzy cognitive network (FCN) models are presented. Both models are suitable for partially-known or unknown complex time-varying systems. Neurofuzzy Adaptive Control contains rigorous proofs of its statements which result in concrete conclusions for the selection of the design parameters of the algorithms presented. The neurofuzzy model combines concepts from fuzzy systems and recurrent high-order neural networks to produce powerful system approximations that are used for adaptive control. The FCN model stems from fuzzy cognitive maps and uses the notion of "concepts" and their causal relationships to capture the behavior of complex systems. The book shows how, with the benefit of proper training algorithms, these models are potent system emulators suitable for use in engineering systems. All chapters are supported by illustrative simulation experiments, while separate chapters are devoted to the potential industrial applications of each model including projects in: • contemporary power generation; • process control and • conventional benchmarking problems. Researchers and graduate students working in adaptive estimation and intelligent control will find Neurofuzzy Adaptive Control of interest both for the currency of its models and because it demonstrates their relevance for real systems. The monograph also shows industrial engineers how to test intelligent adaptive control easily using proven theoretical results. This tutorial-style presentation of the fundamental techniques and algorithms in adaptive control is designed to meet the needs of a wide audience without sacrificing mathematical depth or rigor. The text explores the design, analysis, and application of a wide variety of algorithms that can be used to manage dynamical systems with unknown parameters. Topics include models for dynamic systems, stability, online parameter estimation, parameter identifiers, model reference adaptive control, adaptive pole placement control, and robust adaptive laws. Engineers and students interested in learning how to design, stimulate, and implement parameter estimators and adaptive control schemes will find that this treatment does not require a full understanding of the analytical and technical proofs. This volume will also serve graduate students who wish to examine the analysis of simple schemes and discover the steps involved in more complex proofs. Advanced students and researchers will find it a guide to the grasp of long and technical proofs. Numerous examples demonstrating design procedures and the techniques of basic analysis enrich the text. This book summarizes the main results achieved in a four-year European Project on nonlinear and adaptive control. The project involves leading researchers from top-notch institutions: Imperial College London (Prof A Astolfi), Lund University (Prof A Rantzer), Supelec Paris (Prof R Ortega), University of Technology of Compiegne (Prof R Lozano), Grenoble Polytechnic (Prof C Canudas de Wit), University of Twente (Prof A van der Schaft), Politecnico of Milan (Prof S Bittanti), and Polytechnic University of Valencia (Prof P Albertos).The book also provides an introduction to theoretical advances in nonlinear and adaptive control and an overview of novel applications of advanced control theory, particularly topics on the control of partially known systems, under-actuated systems, and bioreactors. This volume surveys the major results and techniques of analysis in the field of adaptive control. Focusing on linear, continuous time, single-input, single-output systems, the authors offer a clear, conceptual presentation of adaptive methods, enabling a critical evaluation of these techniques and suggesting avenues of further development. 1989 edition. The objective of the EU Nonlinear Control Network Workshop was to bring together scientists who are already active in nonlinear control and young researchers working in this field. This book presents selectively invited contributions from the workshop, some describing state-of-the-art subjects that already have a status of maturity while others propose promising future directions in nonlinear control. Amongst others, following topics of nonlinear and adaptive control are included: adaptive and robust control, applications in physical systems, distributed parameter systems, disturbance attenuation, dynamic feedback, optimal control, sliding mode control, and tracking and motion planning. Exploring connections between adaptive control theory and practice, this book treats the techniques of linear quadratic optimal control and estimation (Kalman filtering), recursive identification, linear systems theory and robust arguments. Suitable for advanced undergraduates and graduate students, this text introduces theoretical and practical aspects of adaptive control. It offers an excellent perspective on techniques as well as an active knowledge of key approaches. Readers will acquire a well-developed sense of when to use adaptive techniques and when other methods are more appropriate. Starting with a broad overview, the text explores real-time estimation, self-tuning regulators and model-reference adaptive systems, stochastic adaptive control, and automatic tuning of regulators. Additional topics include gain scheduling, robust high-gain control and self-oscillating controllers, and suggestions for implementing adaptive controllers. Concluding chapters feature a summary of applications and a brief review of additional areas closely related to adaptive control. Both authors are Professors at the Lund Institute of Technology in Sweden, and this text has evolved from their many years of research and teaching. Their insights into properties, design procedures, and implementation of adaptive controllers are complemented by the numerous examples, simulations, and problems that appear throughout the book. Mathematics in Science and Engineering, Volume 39: Statistical Decision Theory in Adaptive Control Systems focuses on the combination of control theory with statistical decision theory. This volume is divided into nine chapters. Chapter 1 reviews the history of control theory and introduces statistical decision theory. The mathematical description of random processes is covered in Chapter 2. In Chapter 3, the basic concept of statistical decision theory is treated, while in Chapter 4, the method of solving statistical decision problems is described. The application of statistical decision concepts to control problems is explained in Chapter 5. Chapter 6 elaborates a method of designing an adaptive control system. An application of the sequential decision procedure to the design of decision adaptive control systems is illustrated in Chapter 7. Chapter 8 is devoted to the description of a method of the adaptive adjustment of parameters contained in nonlinear control systems, followed by a discussion of the future problems in applications of statistical decision theory to control processes in the last chapter. This book is recommended for students and researchers concerned with statistical decision theory in adaptive control systems. Suitable either as a reference or as a text for a graduate course in adaptive control systems, this book is a self-contained compendium of easily implementable adaptive control algorithms that have been developed and applied by the authors for over 10 years. These algorithms do not require explicit process parameter identification and have been successfully applied to a wide variety of engineering problems including flexible structure control, blood pressure control and robotics. In general, these algorithms are suitable for a wide class of multiple input-output control systems containing significant uncertainty as well as disturbances. Adaptive Control (second edition) shows how a desired level of system performance can be maintained automatically and in real time, even when process or disturbance parameters are unknown and variable. It is a coherent exposition of the many aspects of this field, setting out the problems to be addressed and moving on to solutions, their practical significance and their application. Discrete-time aspects of adaptive control are emphasized to reflect the importance of digital computers in the application of the ideas presented. The second edition is thoroughly revised to throw light on recent developments in theory and applications with new chapters on: multimodel adaptive control with switching, direct and indirect adaptive regulation and adaptive feedforward disturbance compensation. Many algorithms are newly presented in MATLAB® m-file format to facilitate their employment in real systems. Classroom-tested slides for instructors to use in teaching this material are also now provided. All of this supplementary electronic material can be downloaded from fill in URL. The core material is also up-dated and re-edited to keep its perspective in line with modern ideas and more closely to associate algorithms with their applications giving the reader a solid grounding in: synthesis and analysis of parameter adaptation algorithms, recursive plant model identification in open and closed loop, robust digital control for adaptive control; • robust parameter adaptation algorithms, practical considerations and applications, including flexible transmission systems, active vibration control and broadband disturbance rejection and a supplementary introduction on hot dip galvanizing and a phosphate drying furnace. Control researchers and applied mathematicians will find Adaptive Control of significant and enduring interest and its use of example and application will appeal to practitioners working with unknown- and variable-parameter plant. Praise for the first edition: ...well written, interesting and easy to follow, so that it constitutes a valuable addition to the monographies in adaptive control for discrete-time linear systems... suitable (at least in part) for use in graduate courses in adaptive control. This book is a simple and didactic account of the developments and practical applications of predictive, adaptive predictive, and optimized adaptive control from a perspective of stability, including the latest methodology of adaptive predictive expert (ADEX) control. ADEX Optimized Adaptive Control Systems is divided into six parts, with exercises and real-time simulations provided for the reader as appropriate. The text begins with the conceptual and intuitive knowledge of the technology and derives the stability conditions to be verified by the driver block and the adaptive mechanism of the optimized adaptive controller to guaranty the desired control performance. The second and third parts present strategic considerations of predictive control and related adaptive systems necessary for the proper design of driver block and adaptive mechanism and thence their technical realization. The authors then proceed to detail the stability theory that supports predictive, adaptive predictive and optimized adaptive control methodologies. Benchmark applications of these methodologies (distillation column and pulp-factory bleaching plant) are treated next with a focus on practical implementation issues. The final part of the book describes ADEX platforms and illustrates their use in the design and implementation of optimized adaptive control systems to three different challenging-to-control industrial processes: waste-water treatment; sulfur recovery; and temperature control of superheated steam in coal-fired power generation. The presentation is completed by a number of appendices containing technical background associated with the main text including a manual for the ADEX COP platform developed by the first author to exploit the capabilities of adaptive predictive control in real plants. ADEX Optimized Adaptive Control Systems provides practicing process control engineers with a multivariable optimal control solution which is adaptive and resistant to perturbation and the effects of noise. Its pedagogical features also facilitate its use as a teaching tool for formal university and Internet-based open-education-type graduate courses in practical optimal adaptive control and for self-study. Using a pedagogical style along with detailed proofs and illustrative examples, this book opens a view to the largely unexplored area of nonlinear systems with uncertainties. The focus is on adaptive nonlinear control results introduced with the new recursive design methodology--adaptive backstepping. Describes basic tools for nonadaptive backstepping design with state and output feedbacks. impossible to access. It has been widely scattered in papers, reports, and proceedings ofsymposia, with different authors employing different symbols and terms. But now thereis a book that covers all aspects of this dynamic topic in a systematic manner.Featuring consistent terminology and compatible notation, and emphasizing unifiedstrategies, Adaptive Control Systems provides a comprehensive, integrated accountof basic concepts, analytical tools, algorithms, and a wide variety of application trendsand techniques.Adaptive Control Systems deals not only with the two principal approachesmodelreference adaptive control and self-tuning regulators-but also considers otheradaptive strategies involving variable structure systems, reduced order schemes, predictivecontrol, fuzzy logic, and more. In addition, it highlights a large number of practical applicationsin a range of fields from electrical to biomedical and aerospace engineering ...and includes coverage of industrial robots.The book identifies current trends in the development of adaptive control systems ...delineates areas for further research . : . and provides an invaluable bibliography of over1,200 references to the literature.The first authoritative reference in this important area of work, Adaptive ControlSystems is an essential information source for electrical and electronics, R&D,chemical, mechanical, aerospace, biomedical, metallurgical, marine, transportation, andpower plant engineers. It is also useful as a text in professional society seminars and inhousetraining programs for personnel involved with the control of complex systems, andfor graduate students engaged in the study of adaptive control systems. A self-contained introduction to adaptive inverse control Now featuring a revised preface that emphasizes the coverage of both control systems and signal processing, this reissued edition of Adaptive Inverse Control takes a novel approach that is not available in any other book. Written by two pioneers in the field, Adaptive Inverse Control presents methods of adaptive signal processing that are borrowed from the field of digital signal processing to solve problems in dynamic systems control. This unique approach allows engineers in both fields to share tools and techniques. Clearly and intuitively written, Adaptive Inverse Control illuminates theory with an emphasis on practical applications and commonsense understanding. It covers: the adaptive inverse control concept; Weiner filters; adaptive LMS filters; adaptive modeling; inverse plant modeling; adaptive inverse control; other configurations for adaptive inverse control; plant disturbance canceling; system integration; Multiple-Input Multiple-Output (MIMO) adaptive inverse control systems; nonlinear adaptive inverse control systems; and more. Complete with a glossary, an index, and chapter summaries that consolidate the information presented, Adaptive Inverse Control is appropriate as a textbook for advanced undergraduate- and graduate-level courses on adaptive control and also serves as a valuable resource for practitioners in the fields of control systems and signal processing. This unified survey focuses on linear discrete-time systems and explores natural extensions to nonlinear systems. It emphasizes discrete-time systems, summarizing theoretical and practical aspects of a large class of adaptive algorithms. 1984 edition. This book presents the results of the second workshop on Neural Adaptive Control Technology, NACT II, held on September 9-10, 1996, in Berlin. The workshop was organised in connection with a three-year European-Union-funded Basic Research Project in the ESPRIT framework, called NACT, a collaboration between Daimler-Benz (Germany) and the University of Glasgow (Scotland).The NACT project, which began on 1 April 1994, is a study of the fundamental properties of neural-network-based adaptive control systems. Where possible, links with traditional adaptive control systems are exploited. A major aim is to develop a systematic engineering procedure for designing neural controllers for nonlinear dynamic systems. The techniques developed are being evaluated on concrete industrial problems from within the Daimler-Benz group of companies.The aim of the workshop was to bring together selected invited specialists in the fields of adaptive control, nonlinear systems and neural networks. The first workshop (NACT I) took place in Glasgow in May 1995 and was mainly devoted to theoretical issues of neural adaptive control. Besides monitoring further development of theory, the NACT II workshop was focused on industrial applications and software tools. This context dictated the focus of the book and guided the editors in the choice of the papers and their subsequent reshaping into substantive book chapters. Thus, with the project having progressed into its applications stage, emphasis is put on the transfer of theory of neural adaptive engineering into industrial practice. The contributors are therefore both renowned academics and practitioners from major industrial users of neurocontrol. This book collects together in one volume a number of suggested control engineering solutions which are intended to be representative of solutions applicable to a broad class of control problems. It is neither a control theory book nor a handbook of laboratory experiments, but it does include both the basic theory of control and associated practical laboratory set-ups to illustrate the solutions proposed. This monograph demonstrates how the performance of various well-known adaptive controllers can be improved significantly using the dual effect. The modifications to incorporate dual control are realized separately and independently of the main adaptive controller without complicating the algorithms. A new bicriterial approach for dual control is developed and applied to various types of popular linear and nonlinear adaptive controllers. Practical applications of the designed controllers to several real-time problems are presented. This monograph is the first book providing a complete exposition on the dual control problem from the inception in the early 1960s to the present state of the art aiming at students and researchers in adaptive control as well as design engineers in industry. This textbook provides readers with a good working knowledge of adaptive control theory through applications. It is intended for students beginning masters or doctoral courses, and control practitioners wishing to get up to speed in the subject expeditiously. Readers are taught a wide variety of adaptive control techniques starting with simple methods and extending step-by-step to more complex ones. Stability proofs are provided for all adaptive control techniques without obfuscating reader understanding with excessive mathematics. The book begins with standard model-reference adaptive control (MRAC) for first-order, second-order, and multi-input, multi-output systems. Treatment of least-squares parameter estimation and its extension to MRAC follow, helping readers to gain a different perspective on MRAC. Function approximation with orthogonal polynomials and neural networks, and MRAC using neural networks are also covered. Robustness issues connected with MRAC are discussed, helping the student to appreciate potential pitfalls of the technique. This appreciation is encouraged by drawing parallels between various aspects of robustness and linear time-invariant systems wherever relevant. Following on from the robustness problems is material covering robust adaptive control including standard methods and detailed exposition of recent advances, in particular, the author's work on optimal control modification. Interesting properties of the new method are illustrated in the design of adaptive systems to meet stability margins. This method has been successfully flight-tested on research aircraft, one of various flight-control applications detailed towards the end of the book along with a hybrid adaptive flight control architecture that combines direct MRAC with least-squares indirect adaptive control. In addition to the applications, understanding is encouraged by the use of end-of-chapter exercises and associated MATLAB® files. Readers will need no more than the standard mathematics for basic control theory such as differential equations and matrix algebra; the book covers the foundations of MRAC and the necessary mathematical preliminaries. Adaptive control has been considered as an alternative in designing high-performance control systems, from the beginning of the 1950s. Since then, most of the adaptive control schemes have been formulated either in the continuous-time or in the discrete-time framework. Both approaches commonly use black-box" models for describing the process to be controlled; models with known structure but unknown parameters. These models have the advantage that they are general but also the disadvantage that many parameters have to be estimated. There are in practice, however, many adaptive problems where the system can be described as partially known in the sense that part of the system dynamics is known and another part unknown. This is the kind of system considered in this book. Most of the adaptive algorithms that are reliable - in the sense that they guarantee closed-loop stability and some performance behaviour - require to a certain extent some system knowledge and a checking procedure for the caution update of the parameter estimates. The robotic mechanism and its controller make a complete system. As the robotic mechanism is reconfigured, the control system has to be adapted accordingly. The need for the reconfiguration usually arises from the changing functional requirements. This book will focus on the adaptive control of robotic manipulators to address the changed conditions. The aim of the book is to summarise and introduce the state-of-the-art technologies in the field of adaptive control of robotic manipulators in order to improve the methodologies on the adaptive control of robotic manipulators. Advances made in the past decades are described in the book, including adaptive control theories and design, and application of adaptive control to robotic manipulators. Over the last thirty years an abundance of papers have been writ ten on adaptive dynamic control systems. Nevertheless, now it may be predicted with confidence that the adaptive mechanics, a new division, new line of inquiry in one of the violently developing fields of cybernetic mechanics, is emerging. The birth process falls far short of being com pleted. There appear new problems and methods of their solution in the framework of adaptive nonlinear dynamics. Therefore, the present work cannot be treated as a certain polished, brought-to-perfection school textbook. More likely, this is an attempt to show a number of well known scientific results in the parametric synthesis of nonlinear systems (this, strictly speaking, accounts for the availability of many reviews), as well as to bring to notice author's developments on this question undoubtedly modern and topical. The nonlinear, and practically La grangian, systems cover a wide class of classical objects in theoretical mechanics, and primarily solid-body (robotic, gyroscopic, rocket-cosmic, and other) systems. And what is rather important, they have a direct trend to practical application. To indicate this discussion, I should like to notice that it does not touch upon the questions concerned with the linear and stochastic con trolobjects. Investigated are only nonlinear deterministic systems being in the conditions when some system parameters are either unknown or beyond the reach of measurement, or they execute an unknown limited and fairly smooth drift in time. Using a common unifying framework, this volume explores the main topics of Linear Quadratic control, predictive control, and adaptive predictive control -- in terms of theoretical foundations, analysis and design methodologies, and application-orient ed tools.Presents LQ and LQG control via two alternative approaches: the Dynamic Programming (DP) and the Polynomial Equation (PE) approach. Discusses predicable control, an important tool in industrial applications, within the framework of LQ control, and presents innovative predictive control schemes having guaranteed stability properties. Offers a unique, thorough presentation of indirect adaptive multi-step predictive controllers, with detailed proofs of globally convergent schemes for both the ideal and the bounded disturbance case. Extends the self-tuning property of one-step-ahead control to multi-step control.For engineers and mathematicians interested in the theory, analysis and design methodologies, and application-oriented tools of optimal, predictive and adaptive control. Written as a result of a seven year research project using computational intelligence techniques for solving mineral processing problems at the U.S. Bureau of Mines, this book is about intelligent, adaptive process control. It brings together ideas from the field of computational intelligence , a part of the larger field of artificial intelligence, including fuzzy mathematics, genetic algorithms, and neural networks and uses these ideas to develop a generic architecture for accomplishing adaptive process control. In the development of this architecture, the requisite tools are described and then demonstrated on a number of problems. Moreover, most of the examples are of interest in industrial settings (although some simple examples are provided in the beginning so that the reader can focus on technique and not be overburdened with the complexity of the problems being solved.) The focus of Practical Applications of Computational Intelligence for Adaptive Control is on practical applications. It provides practicing engineers and scientists with the information they need to solve process control problems in industry and academia. If the reader is interested in solving difficult control problems or interested in the mechanics of basic computational intelligence techniques, then this book is an excellent place to start. This volume offers a glimpse of the status of research in adaptive and learning systems in 1985. In recent years these areas have spawned a multiplicity of ideas so rapidly that the average research worker or practicing engineer is overwhelmed by the flood of information. The Yale Workshop on Applications of Adaptive Systems Theory was organized in 1979 to provide a brief respite from this deluge, wherein critical issues may be examined in a calm and collegial environment. The fourth of the series having been held in May 1985, it has now become well established as a biennial forum for the lively exchange of ideas in the ever changing domain of adaptive systems. The scope of this book is broad and ranges from theoretical investigations to practical applications. It includes twenty eight papers by leaders in the field, selected from the Pro ceedings of the Fourth Yale Workshop and divided into five sections. I have provided a brief introduction to each section so that it can be read as a self-contained unit. The first section, devoted to adaptive control theory, suggests the intensity of activity in the field and reveals signs of convergence towards some common themes by workers with rather different moti vation. Preliminary results concerning the reduced order model problem are dramatically changing the way we view the field and bringing it closer to other areas such as robust linear control where major advances have been recently reported.

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