Adaptive Control Of Systems With Actuator And Sensor Nonlinearities Adaptive And Cognitive Dynamic Systems Signal Processing Learning Communications And Control

Presented in a tutorial style, this comprehensive treatment unifies, simplifies, and explains most of the techniques for designing and analyzing adaptive control systems. Numerous examples clarify procedures and methods. 1995 edition.

In this book, we study theoretical and practical aspects of computing methods for mathematical modelling of nonlinear systems. A number of computing techniques are considered, such as methods of operator approximation with any given accuracy; operator interpolation techniques including a non-Lagrange interpolation; methods of system representation subject to constraints associated with concepts of causality, memory and stationarity; methods of system representation with an accuracy that is the best within a given class of models; methods of covariance matrix estimation; methods for low-rank matrix approximations; hybrid methods based on a combination of iterative procedures and best operator approximation; and methods for information compression and filtering under condition that a filter model should satisfy restrictions associated with causality and different types of memory. As a result, the book represents a blend of new methods in general computational analysis, and specific, but also generic, techniques for study of systems theory ant its particular branches, such as optimal filtering and information compression. - Best operator approximation, - Non-Lagrange interpolation, - Generic Karhunen-Loeve transform - Generalised low-rank matrix approximation - Optimal data compression - Optimal nonlinear filtering

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.

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.

The authors present an effective approach to handle some of the most common types of component imperfections encountered in industrial automation, consumer electroncis, and defence and transportation systems.

This book presents innovative technologies and research results on adaptive control of dynamic systems with quantization, uncertainty and nonlinearity including theoretical success and practical development such as approaches for stability analysis, treatment of subsystem interactions, improvement of system tracking and transient performance.

This book shows readers new ways to compensate for disturbances in control systems prolonging the intervals between time-consuming and/or expensive fault diagnosis procedures, keeping them up to date in the increasingly important field of adaptive control.

"Uncertainty is inherent in control systems. Consider the following example: as an aircraft flies, it consumes fuel, which causes its mass to decrease. In order to maintain stability, the autopilot mechanism must adapt to this (a priori unknown) change in mass. Delays also pose a challenge in control systems. If you have tried to maintain a comfortable water temperature while showering in a building with outdated plumbing, you will understand the difficulties that arise when a control system has significant delays: the controller (you) is forced to make decisions based on "old" information. The intersection of these two problems (estimating unknown parameters when a system has delays) poses a significant mathematical challenge. Delay-Adaptive Linear Control presents new mathematical techniques to handle the intersection of the two distinct types of uncertainty described above: adaptive constraints, and uncertainties caused by delays. Traditionally, the problems of adaption and delays have been treated separately. This book considers the intersection of these two problems, developing new techniques for addressing different combinations of uncertainty-all within a single, unified framework. This work has applications in electrical and mechanical engineering (unmanned aerial vehicles, robotic manipulators), biomedical engineering (3D printing, neuromuscular electrical stimulation), and management and traffic science (supply chains, traffic flow), among others. Beyond its practical importance, this work is also of significant theoretical interest, as it addresses mathematical challenges involved in the analysis and design of these systems"--

This book introduces non-identifier-based adaptive control (with and without internal model) and its application to the current, speed and position control of mechatronic systems such as electrical synchronous machines, wind turbine systems, industrial servo systems, and rigid-link, revolute-joint robots. In mechatronics, there is often only rough knowledge of the system. Due to parameter uncertainties, nonlinearities and unknown disturbances, model-based control strategies can reach their performance or stability limits without iterative controller design and performance evaluation, or system identification and parameter estimation. The non-identifier-based adaptive control presented is an alternative that neither identifies the system nor estimates its parameters but ensures stability. The adaptive controllers are easy to implement, compensate for disturbances and are inherently robust to parameter uncertainties and nonlinearities. For controller implementation only structural system knowledge (like relative degree, input-to-state stable zero dynamics and known sign of the high-frequency gain) is required. Moreover, the presented controllers guarantee reference tracking with prescribed asymptotic or transient accuracy, i.e. the tracking error eventually tends to or for all time evolves within an a priori specified region. The book presents the theory, modeling and application in a general but detailed and self-contained manner, making it easy to read and understand, particularly for newcomers to the topics covered
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.
This book introduces a comprehensive methodology for adaptive control design of parabolic partial differential equations with unknown functional parameters, including reaction-convection-diffusion systems ubiquitous in chemical, thermal, biomedical, aerospace, and energy systems. Andrey Smyshlyaev and Miroslav Krstic develop explicit feedback laws that do not require real-time solution of Riccati or other algebraic operator-valued equations. The book emphasizes stabilization by boundary control and using boundary sensing for unstable PDE systems with an infinite relative degree. The book also presents a rich collection of methods for system identification of PDEs, methods that employ Lyapunov, passivity, observer-based, swapping-based, gradient, and least-squares tools and parameterizations, among others. Including a wealth of stimulating ideas and providing the mathematical and control-systems background needed to follow the designs and proofs, the book will be of great use to students and researchers in mathematics, engineering, and physics. It also makes a valuable supplemental text for graduate courses on distributed parameter systems and adaptive control.
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.

The authors here provide a detailed treatment of the design of robust adaptive controllers for nonlinear systems with uncertainties. They employ a new tool based on the ideas of system immersion and manifold invariance. New algorithms are delivered for the construction of robust asymptotically-stabilizing and adaptive control laws for nonlinear systems. The methods proposed lead to modular schemes that are easier to tune than their counterparts obtained from Lyapunov redesign.

Nonlinear and Adaptive Control Systems treats nonlinear control and adaptive control in a unified framework, presenting the major results at a moderate mathematical level, suitable to MSc students and engineers with undergraduate degrees.

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.

This graduate-level text offers a thorough understanding of the global stability properties essential to designing adaptive systems. Its self-contained, unified presentation includes detailed case studies and numerous problems. 1989 edition.

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.

The theory of adaptive control is concerned with construction of strategies so that the controlled system behaves in a desirable way, without assuming the complete knowledge of the system. The models considered in this comprehensive book are of Markovian type. Both partial observation and partial information cases are analyzed. While the book focuses on discrete time models, continuous time ones are considered in the final chapter. The book provides a novel perspective by summarizing results on adaptive control obtained in the Soviet Union, which are not well known in the West. Comments on the interplay between the Russian and Western methods are also included.
Adaptive control has been one of the main problems studied in control theory. The subject is well understood, yet it has a very active research frontier. This book focuses on a specific subclass of adaptive control, namely, learning-based adaptive control. As systems evolve during time or are exposed to unstructured environments, it is expected that some of their characteristics may change. This book offers a new perspective about how to deal with these variations. By merging together Model-Free and Model-Based learning algorithms, the author demonstrates, using a number of mechatronic examples, how the learning process can be shortened and optimal control performance can be reached and maintained. Includes a good number of Mechatronics Examples of the techniques. Compares and blends Model-free and Model-based learning algorithms. Covers fundamental concepts, state-of-the-art research, necessary tools for modeling, and control.
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.
An introduction to a new design for nonlinear control systems--backstepping--written by its own architects. This innovative book breaks new ground in nonlinear and adaptive control design for systems with uncertainties. Introducing the recursive backstepping methodology, it shows--for the first time--how uncertain systems with severe nonlinearities can be successfully controlled with this new powerful design tool.

Communicative and accessible at a level not usually present in research texts, Nonlinear and Adaptive Control Design can be used as either a stand-alone or a supplemental text in courses on nonlinear or adaptive control, as well as in control research and applications. It eases the reader into the subject matter, assuming only standard undergraduate knowledge of control theory, and provides a pedagogical presentation of the material, most of which is completely new and not available in other textbooks. Written by the creators of backstepping, the book: * Introduces the basic design tools and demonstrates their effectiveness through worked examples * Provides detailed proofs and application examples (active suspension, jet engine, induction motor, and many others) * Develops adaptive backstepping, tuning functions, and modular designs with full state feedback * Generalizes the methodology to nonlinear systems with output feedback * Describes the advantages of the new adaptive nonlinear techniques over traditional methods * Offers a systematic methodology for performance improvement * Provides new designs for linear systems which can be used independently from therest of the book * Is self-contained with an extensive summary of stability and passivity prerequisites * Includes sixty illustrations and tables with design algorithms Nonlinear and Adaptive Control Design is an absolute must for researchers and graduate students with an interest in nonlinear systems, adaptive control, stability and differential equations and for anyone who would like to find out about the new and exciting advances in these areas.

Includes a solution manual for problems. Provides MATLAB code for examples and solutions. Deals with robust systems in both theory and practice.

Suitable either as a reference for practising engineers or as a text for a graduate course in adaptive control systems, this is a self-contained compendium of readily implementable adaptive control algorithms. These algorithms have been developed and applied by the authors for over fifteen years to a wide variety of engineering problems including flexible structure control, blood pressure control, and robotics. As such, they are suitable for a wide variety of multiple input-output control systems with uncertainty and external disturbances. The text is intended to enable anyone with knowledge of basic linear multivariable systems to adapt the algorithms to problems in a wide variety of disciplines. Thus, in addition to developing the theoretical details of the algorithms presented, the text gives considerable emphasis to designing algorithms and to representative applications in flight control, flexible structure control, robotics, and drug-infusion control. This second edition makes good use of MATLAB programs for the illustrative examples; these programs are described in the text and can be obtained from the MathWorks file server.

Control Applications of Adaptive covers the proceedings of the 197 Workshop on Applications of Adaptive Control, held in Yale University. This book is organized into five parts encompassing 18 chapters that summarize the potential application of adaptive control to many practical problems. Part I contains tutorials that bring together important result s in two of the most studied approaches to adaptive control, namely, self-tuning regulators and model reference adaptive control (MRAC), with a particular emphasis on the importance of error models in the stability analysis of MRAC. Part II examines the algorithms used for adaptive signal processing, while Part III describes the types of power systems problems that could benefit from application of adaptive control and how to apply adaptive control algorithms for controlling large electric

generators. Part IV highlights adaptive control in aircraft systems. This part also considers how adaptive control fell into disfavor in the flight control community, illustrating the existence of residual negative bias. The desirability of cost elimination of air data sensors in less-sophisticated flight control systems is also discussed. Part V addresses the application of process control to chemical processes and to electromechanical systems. This part also shows the robustness and superior tracking and regulation properties of model reference adaptive control applied to liquid level control. Discussion on various classes of model reference adaptive controllers in a common framework from the viewpoint of microcomputer implementation is also included. This book will be of value to control system theorists and practitioners.
Identifying the input-output relationship of a system or discovering the evolutionary law of a signal on the basis of observation data, and applying the constructed mathematical model to predicting, controlling or extracting other useful information constitute a problem that has been drawing a lot of attention from engineering and gaining more and more importance in econo metrics, biology, environmental science and other related areas. Over the last 30-odd years, research on this problem has rapidly developed in various areas under different terms, such as time series analysis, signal processing and system identification. Since the randomness almost always exists in real systems and in observation data, and since the random process is sometimes used to model the uncertainty in systems, it is reasonable to consider the object as a stochastic system. In some applications identification can be carried out off line, but in other cases this is impossible, for example, when the structure or the parameter of the system depends on the sample, or when the system is time-varying. In these cases we have to identify the system on line and to adjust the control in accordance with the model which is supposed to be approaching the true system during the process of identification. This is why there has been an increasing interest in identification and adaptive control for stochastic systems from both theorists and practitioners.
This book, published in honor of Professor Laurent Praly on the occasion of his 65th birthday, explores the responses of some leading international authorities to new challenges in nonlinear and adaptive control. The mitigation of the effects of uncertainty and nonlinearity – ubiquitous features of real-world engineering and natural systems – on closed-loop stability and robustness being of crucial importance, the contributions report the latest research into overcoming these difficulties in: autonomous systems; reset control systems; multiple-input–multiple-output nonlinear systems; input delays; partial differential equations; population games; and data-driven control. Trends in Nonlinear and Adaptive Control presents research inspired by and related to Professor Praly’s lifetime of contributions to control theory and is a valuable addition to the literature of advanced control.
Suitable for advanced undergraduates and graduate students, this overview introduces theoretical and practical aspects of adaptive control, with emphasis on deterministic and stochastic viewpoints. 1995 edition.
Adaptive Control provides techniques for automatic, real-time adjustments in controller parameters with a view to achieving and/or maintaining a desirable level of system performance in the presence of unknown or variable process parameters. Many aspects of the field are dealt with in coherent and orderly fashion, starting with the problems posed by system uncertainties and moving on to the presentation of solutions

and their practical significance. Within the general context of recent developments, the book looks at: • synthesis and analysis of parameter adaptation algorithms; • recursive plant-model identification in open and closed loop; • robust digital control for adaptive control; • direct and indirect adaptive control; and • practical aspects and applications. To reflect the importance of digital computers for the application of adaptive control techniques, discrete-time aspects are emphasized. To guide the reader, the book contains various applications of adaptive control techniques.

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

A systematic and unified presentation of the fundamentals of adaptive control theory in both continuous time and discrete time Today, adaptive control theory has grown to be a rigorous and mature discipline. As the advantages of adaptive systems for developing advanced applications grow apparent, adaptive control is becoming more popular in many fields of engineering and science. Using a simple, balanced, and harmonious style, this book provides a convenient introduction to the subject and improves one's understanding of adaptive control theory. Adaptive Control Design and Analysis features: Introduction to systems and control Stability, operator norms, and signal convergence Adaptive parameter estimation State feedback adaptive control designs Parametrization of state observers for adaptive control Unified continuous and discrete-time adaptive control L1+a robustness theory for adaptive systems Direct and indirect adaptive control designs Benchmark comparison study of adaptive control designs Multivariate adaptive control Nonlinear adaptive control Adaptive compensation of actuator nonlinearities End-of-chapter discussion, problems, and advanced topics As either a textbook or reference, this self-contained tutorial of adaptive control design and analysis is ideal for practicing engineers, researchers, and graduate students alike.

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.

Contains results not yet published in technical journals and conference proceedings.

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.

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

The focus of this book is the application of artificial neural networks in uncertain dynamical systems. It explains how to use neural networks in concert with adaptive techniques for system identification, state estimation, and control problems. The authors begin with a brief historical overview of adaptive control, followed by a review of mathematical preliminaries. In the subsequent chapters, they present several neural network-based control schemes. Each chapter starts with a concise introduction to the problem under study, and a neural network-based control strategy is designed for the simplest case scenario. After these designs are discussed, different practical limitations (i.e., saturation constraints and unavailability of all system states) are gradually added, and other control schemes are developed based on the primary scenario. Through these exercises, the authors present structures that not only provide mathematical tools for navigating control problems, but also supply solutions that are pertinent to real-life systems.

This volume presents a theoretical framework and control methodology for a class of complex dynamical systems characterised by high state space dimension, multiple inputs and outputs, significant nonlinearity, parametric uncertainty, and unmodeled dynamics. A unique feature of the authors' approach is the combination of rigorous concepts and methods of nonlinear control (invariant and attracting submanifolds, Lyapunov functions, exact linearisation, passification) with approximate decomposition results based on singular perturbations and decentralisation. Some results published previously in the Russian literature and not well known in the West are brought to light. Basic concepts of modern nonlinear control and motivating examples are given. Audience: This book will be useful for researchers, engineers, university lecturers and postgraduate students specialising in the fields of applied mathematics and engineering, such as automatic control, robotics, and control of vibrations.

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.