Adaptive Control Tutorial Advances In Design And Control

This book introduces the state-of-the-art technologies in mechatronics, robotics, and MEMS devices in order to improve their methodologies. It provides a follow-up to "Advanced Mechatronics and MEMS Devices" (2013) with an exploration of the most up-to-date technologies and their applications, shown through examples that give readers insights and lessons learned from actual projects. Researchers on mechatronics, robotics, and MEMS as well as graduate students in mechanical engineering will find chapters on: Fundamental design and working principles on MEMS accelerometers Innovative mobile technologies Force/tactile sensors development Control schemes for reconfigurable robotic systems Inertial microfluidics Piezoelectric force sensors and dynamic calibration techniques ...And more. Authors explore applications in the areas of agriculture, biomedicine, advanced manufacturing, and space. Micro-assembly for current and future industries is also considered, as well as the design and development of micro and intelligent manufacturing.

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 linear 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 is for a first course in robotics, especially in unmanned aerial or underwater vehicles. The five digital forces (mobility and pervasive computing, cloud, big data, artificial intelligence and robotics, and social media) are poised to bring great academic and industrial breakthroughs. All stakeholders want to understand how to best harness these forces to their advantage. Driven by aerospace applications the focus of the book is primarily on continuous-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.

Uncertainty and risk are integral to engineering because real systems have inherent ambiguities that arise naturally or due to our inability to model complex physics. The authors discuss probability theory, stochastic processes, estimation, and stochastic control strategies and show how probability can be used to model uncertainty in control and estimation problems. The material is practical and rich in research opportunities.

This book is for a first course in robotics, especially in unmanned aerial or underwater vehicles. The five digital forces (mobility and pervasive computing, cloud, big data, artificial intelligence and robotics, and social media) are poised to bring great academic and industrial breakthroughs. All stakeholders want to understand how to best harness these forces to their advantage. While literature exists for understanding each force independently, there is a lack of knowledge on how to utilize all the forces together to realize future enterprises. Advanced Digital Architectures for Model-Driven Adaptive Enterprises is an essential reference source that explores the potential in unifying the five digital forces to achieve increased levels of agility, efficiency, and scale. Featuring coverage on a wide range of topics including socio-technical systems, adaptive architectures, and enterprise modeling, this book is ideally designed for managers, executives, programmers, designers, computer engineers, entrepreneurs, tool builders, digital practitioners, researchers, academicians, and students at the graduate level.

Adaptive Control Tutorial SIAM

This book reports on advances in sensing, modeling and control methods for different robotic platforms such as multi-degree of freedom robotic arms, unmanned aerial vehicles and autonomous mobile platforms. Based on 2018 Symposium on Mechatronics, Robotics, and Control (SMTRC'18), held as part of the 2018 CSME International Congress, in York University, Toronto, Canada, the book covers a variety of topics, from filtering and state estimation to adaptive control of reconfigurable robots and more. Next-generation systems with advanced
control, planning, perception and interaction capabilities will achieve functionalities far beyond today's technology. Two key challenges remaining for advanced robot technologies are related to sensing and control in robotic systems. Advanced perception is needed to navigate changing environments. Adaptive and intelligent control systems must be developed to enable operation in unstructured and dynamic environments. The selected chapters in this book focus on both of the aforementioned areas and highlight the main trends and challenges in robot sensing and control. The first part of the book introduces chapters which focus on advanced perception and sensing for robotics applications. They include sensor filtering and state estimation for bipedal robots and motion capture systems analysis. The second part focuses on different modeling and control methods for robotic systems including flight control for UAVs, multi-variable robust control for modular and reconfigurable robotics and control for precision micromanipulation.

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. Designed to meet the needs of a wide audience without sacrificing mathematical depth and rigour, 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; graduate students who 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. This volume surveys three decades of modern robot control theory and describes how the work of Suguru Arimoto shaped its development. Twelve survey articles written by experts associated with Suguru Arimoto at various stages in his career treat the subject comprehensively. This book provides an important reference for graduate students and researchers, as well as for mathematicians, engineers and scientists whose work involves robot control theory.

The proceedings is a collection of research papers presented, at the 9th International Conference on Robotics, Vision, Signal Processing & Power Applications (ROVISIP 2016), by researchers, scientists, engineers, academicians as well as industrial professionals from all around the globe to present their research results and development activities for oral or poster presentations. The topics of interest are as follows but are not limited to: • Robotics, Control, Mechatronics and Automation • Vision, Image, and Signal Processing • Artificial Intelligence and Computer Applications • Electronic Design and Applications • Telecommunication Systems and Applications • Power System and Industrial Applications • Engineering Education

Adaptive Control (second edition) shows how a desired level of system performance can be maintained automatically and in real time, even when modes 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 updated 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 monographs in adaptive control for discrete-time linear systems... suitable (at least in part) for use in graduate courses in adaptive control.

Practical emphasis to teach students to use the powerful ideas of adaptive control in real applications Custom-made Matlab® functionality to facilitate the design and construction of self-tuning controllers for different processes and systems Examples, tutorial exercises and clearly laid-out flowcharts and formulae to make the subject simple to follow for students and to help tutors with class preparation Stringent demands on modern guided weapon systems require new approaches to guidance, control, and estimation. There are requirements for pinpoint accuracy, low cost per round, easy upgrade paths, enhanced performance in countermeasure environments, and the ability to track low-observable targets. Advances in Missile Guidance, Control, and Estimation

The implementation of effective control systems can help to achieve a wide range of benefits, not least in terms of real cost-savings. Education plays a vital role in ensuring continued success and its importance is well recognized by IFAC with a specifically designated technical committee in this area. This invaluable publication brings together the results of international research and experience in the latest control education techniques, as presented at the most recent symposium. Information on course curricula is presented, as well as teachware, including software and laboratory experimental apparatus. 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.

This book gathers papers presented at Mechatronics 2019, an international conference held in Warsaw, Poland, from September 16 to 18, 2019. The contributions discuss the numerous, multidisciplinary technological advances in the field of applied mechatronics that the emerging Industry 4.0 has already yielded. Each chapter presents a particular example of interdisciplinary theoretical knowledge, numerical modelling and simulation, or the application of artificial intelligence techniques. Further, the papers show how both software and physical devices can be incorporated into mechatronic systems to increase production efficiency and resource savings. The results and guidelines presented here will benefit both scientists and engineers looking for solutions to specific industrial and research problems.

This book contains a selection of the best papers given at an international conference on advanced computer systems. The Advanced Computer Systems Conference was held in October 2006, in Miedzyzdroje, Poland. The book is organized into four topical areas: Artificial Intelligence; Computer Security and Safety; Image Analysis, Graphics and Biometrics; and Computer Simulation and Data Analysis.

Written in a self-contained tutorial fashion, this monograph successfully brings the latest theoretical advances in the design of robust adaptive systems to the realm of industrial applications. It provides a theoretical basis for verifying some of the reported industrial successes of existing adaptive control schemes and enables readers to synthesize adaptive versions of their own robust internal model control schemes.

This book constitutes the refereed proceedings of the 13th Conference on Towards Autonomous Robotic Systems, TAROS 2012 and the 15th Robot World Congress, FIRA 2012, held as joint conference in Bristol, UK, in August 2012. The 36 revised full papers presented together with 25 extended abstracts were carefully reviewed and selected from 89 submissions. The papers cover various topics in the field of autonomous robotics.

At publication, The Control Handbook immediately became the definitive resource that engineers working with modern control systems required. Among its many accolades, that first edition was cited by the AAP as the Best Engineering Handbook of 1996. Now, 15 years later, William Levine has once again compiled the most comprehensive and authoritative resource on control engineering. He has fully reorganized the text to reflect the technical advances achieved since the last edition and has expanded its contents to include the multidisciplinary perspective that is making control engineering a critical component in so many fields. Now expanded from one to three volumes, The Control Handbook, Second Edition organizes cutting-edge contributions from more than 200 leading experts. The third volume, Control System Advanced Methods, includes design and analysis methods for MIMO linear and LTI systems, Kalman filters and observers, hybrid systems, and nonlinear systems. It also covers advanced considerations regarding — Stability Adaptive controls System identification Stochastic control Control of distributed parameter systems Networks and networked controls As with the first edition, the new edition not only stands as a record of accomplishment in control engineering but provides researchers with the means to make further advances. Progressively organized, the first two volumes in the set include: Control System Fundamentals Control System Applications

Classical vehicle dynamics, which is the basis for manned ground vehicle design, has exhausted its potential for providing novel design concepts to a large degree. At the same time, unmanned ground vehicle (UGV) dynamics is still in its infancy and is currently being developed using general analytical dynamics principles with very little input from actual vehicle dynamics theory. This technical book presents outcomes from the NATO Advanced Study Institute (ASI) ‘Advanced Autonomous Vehicle Design for Severe Environments’, held in Coventry, UK, in July 2014. The ASI provided a platform for world class professionals to meet and discuss leading-edge research, engineering accomplishments and future trends in manned and unmanned ground vehicle dynamics, terrain mobility and energy efficiency. The outcomes of this collective effort serve as an analytical foundation for autonomous vehicle design. Topics covered include: historical aspects, pivotal accomplishments and the analysis of future trends in on- and off-road manned and unmanned vehicle dynamics; terramechanics, soil dynamic characteristics, uncertainties and stochastic characteristics of vehicle-environment interaction for agile vehicle dynamics modeling; new methods and techniques in on-line control and learning for vehicle autonomy; fundamentals of agility and severe environments; mechatronics and cyber-physics issues of agile vehicle dynamics to design for control, energy harvesting and cyber security; and case studies of agile and inverse vehicle dynamics and vehicle systems design, including optimisation of suspension and driveline systems. The book targets graduate students, who desire to advance further in leading-edge vehicle dynamics topics in manned and unmanned ground vehicles, PhD students continuing their research work and building advanced curricula in academia and industry, and researchers in government agencies and private companies.

Applied Control System Design examines several methods for building up systems models based on real experimental data from typical industrial processes and incorporating system identification techniques. The text takes a comparative approach to the models derived in this way judging their suitability for use in different systems and under different operational circumstances. A broad spectrum of control methods including various forms of filtering, feedback and feedforward control is applied to the models and the guidelines derived from the closed-loop responses are then composed into a concrete self-tested recipe to serve as a check-list for industrial engineers or control designers. System identification and control design are given equal weight in model derivation and testing to reflect their equality of importance in the proper design and optimization of high-performance control systems. Readers’ assimilation of the material discussed is assisted by the provision of problems and examples. Most of these exercises use MATLAB® to make computation and visualization more straightforward. Applied Control System Design will be of interest to academic researchers for its comparison of different systems models and their response to different control methods and will assist graduate students in learning the practical necessities of advanced control system design. The consistent reference to
real systems coupled with self-learning tools will assist control practitioners who wish to keep up to date with the latest control design ideas. Since the foundation and up to the current state-of-the-art in control engineering, the problems of PID control steadily attract great attention of numerous researchers and remain inexhaustible source of new ideas for process of control system design and industrial applications. PID control effectiveness is usually caused by the nature of dynamical processes, conditioned that the majority of the industrial dynamical processes are well described by simple dynamic model of the first or second order. The efficacy of PID controllers vastly falls in case of complicated dynamics, nonlinearities, and varying parameters of the plant. This gives a pulse to further researches in the field of PID control. Consequently, the problems of advanced PID control system design methodologies, rules of adaptive PID control, self-tuning procedures, and particularly robustness and transient performance for nonlinear systems, still remain as the areas of the lively interests for many scientists and researchers at the present time. The recent research results presented in this book provide new ideas for improved performance of PID control applications.

This contributed volume is written by key specialists working in multidisciplinary fields in electrical engineering, linking control theory, power electronics, artificial neural networks, embedded controllers and signal processing. The authors of each chapter report the state of the art of the various topics addressed and present results of their own research, laboratory experiments and successful applications. The presented solutions concentrate on three main areas of interest: · motion control in complex electromechanical systems, including sensorless control; · fault diagnosis and fault tolerant control of electric drives; · new control algorithms for power electronics converters. The chapters and the complete book possess strong monograph attributes. Important practical and theoretical problems are deeply and accurately presented on the background of an exhaustive state-of-the-art review. Many results are completely new and were never published before. Well-known control methods like field oriented control (FOC) or direct torque control (DTC) are referred as a starting point for modifications or are used for comparison. Among numerous control theories used to solve particular problems are: nonlinear control, robust control, adaptive control, Lyapunov techniques, observer design, model predictive control, neural control, sliding mode control, signal filtration and processing, fault diagnosis, and fault tolerant control. 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.

"This book introduces and explains Higher Order Neural Networks (HONNs) to people working in the fields of computer science and computer engineering, and how to use HONNS in these areas"--Provided by publisher. In the era of cyber-physical systems, the area of control of complex systems has grown to be one of the hardest in terms of algorithmic design techniques and analytical tools. The 23 chapters, written by international specialists in the field, cover a variety of interests within the broader field of learning, adaptation, optimization and networked control. The editors have grouped these into the following 5 sections: “Introduction and Background on Control Theory”, “Adaptive Control and Neuroscience”, “Adaptive Learning Algorithms”, “Cyber-Physical Systems and Cooperative Control”, “Applications”. The diversity of the research presented gives the reader a unique opportunity to explore a comprehensive overview of a field of great interest to control and system theorists. This book is intended for researchers and control engineers in machine learning, adaptive control, optimization and automatic control systems, including Electrical Engineers, Computer Science Engineers, Mechanical Engineers, Aerospace/Autotive Engineers, and Industrial Engineers. It could be used as a text or reference for advanced courses in complex control systems. • Collection of chapters from several well-known professors and researchers that will showcase their recent work • Presents different state-of-the-art control approaches and theory for complex systems • Gives algorithms that take into consideration the presence of modelling uncertainties, the unavailability of the model, the possibility of cooperative/non-cooperative goals and malicious attacks compromising the security of networked teams • Real system examples and figures throughout, make ideas concrete Includes chapters from several well-known professors and researchers that showcases their recent work Presents different state-of-the-art control approaches and theory for complex systems Explores the presence of modelling uncertainties, the unavailability of the model, the possibility of cooperative/non-cooperative goals, and malicious attacks compromising the security of networked teams Serves as a helpful reference for researchers and control engineers working with machine learning, adaptive control, and automatic control systems A cutting-edge guide to modelling complex systems with differential-algebraic equations, suitable for applied mathematicians, engineers and computational scientists. The authors have developed a methodology for control of nonlinear systems in the presence of long delays, with large and rapid variation in the actuation or sensing path, or in the presence of long delays affecting the internal state of a system. In addition to control synthesis, they introduce tools to quantify the performance and the robustness properties of the designs provided in the book. The book is based on the concept of predictor feedback and infinite-dimensional backstepping transformation for linear systems and the authors guide the reader from the basic ideas of the concept?with constant delays only on the input?all the way through to nonlinear systems with state-dependent delays on the input as well as on system states. Readers will find the book useful because the authors provide elegant and systematic treatments of long-standing problems in delay systems, such as systems with state-dependent delays that arise in many applications. In addition, the authors give all control designs by explicit formulae, making the book especially useful for engineers who have faced delay-related challenges and are concerned with actual implementations and they accompany all control designs with Lyapunov-based analysis for establishing
stability and performance guarantees. Reinforcement Learning (RL) is a very dynamic area in terms of theory and application. This book brings together many different aspects of the current research on several fields associated to RL which has been growing rapidly, producing a wide variety of learning algorithms for different applications. Based on 24 Chapters, it covers a very broad variety of topics in RL and their application in autonomous systems. A set of chapters in this book provide a general overview of RL while other chapters focus mostly on the applications of RL paradigms: Game Theory, Multi-Agent Theory, Robotic, Networking Technologies, Vehicular Navigation, Medicine and Industrial Logistic. The objective of this workshop was to bring together engineers from industry and scientists from universities to focus attention on new developments and practical enhancements for using adaptive control in industry. The workshop provided a forum for a tutorial introduction to the state-of-the-art in adaptive control and helped focus attention on an in-depth view of the problems and needs of adaptive control engineers in industry. The volume includes papers concerned with recent theoretical advances in adaptive control, experimental application of adaptive control in industry and the role of filters in adaptive control. As future generation electrical, information engineering and mechatronics become specialized and fragmented, it is easy to lose sight of the fact that many topics in these areas have common threads and, because of this, advances in one discipline may be transmitted to others. The 2011 International Conference on Electrical, Information Engineering and Mechatronics (EIEM 2011) is the first conference that attempts to follow the above idea of hybridization in electrical, information engineering, mechatronics and applications. This Proceedings of the 2011 International Conference on Electrical, Information Engineering and Mechatronics provides a forum for engineers and scientists to address the most innovative research and development including technical challenges and social, legal, political, and economic issues, and to present and discuss their ideas, results, works in progress and experience on all aspects of electrical, information engineering, mechatronics and applications. Engineers and scientists in academia, industry, and government will find a insights into the solutions that combine ideas from multiple disciplines in order to achieve something more significant than the sum of the individual parts in all aspects of electrical, information engineering, mechatronics and applications.