Nonlinear Control And Analytical Mechanics A Computational Approach Control Engineering

In this work, the authors present a global perspective on the methods available for analysis and design of non-linear control systems and detail specific applications. They provide a tutorial exposition of the major non-linear systems analysis techniques followed by a discussion of available non-linear design methods.

Whereas power systems have traditionally been designed with a focus on protecting them from routine component failures and atypical user demand, we now also confront the fact that deliberate attack intended to cause maximum disruption is a real possibility. In response to this changing environment, new concepts and tools have emerged that address many of the issues facing power system operation today. This book is aimed at introducing these ideas to practicing power systems engineers, control systems engineers interested in power systems, and graduate students in these areas. The ideas are examined with an emphasis on how they can be applied to improve our understanding of power system behavior and help design better control systems. The book is supplemented by a Mathematica package enabling readers to work out nontrivial examples and problems. Also included is a set of Mathematica tutorial notebooks providing detailed solutions of the worked examples in the text. In addition to Mathematica, simulations are carried out using Simulink with Stateflow. Furthering the aim of reducing human exposure to hazardous environments, this monograph presents a detailed study of the modeling and control of vehicle-manipulator systems. The text shows how complex interactions can be performed at remote locations using systems that combine the manipulability of robotic manipulators with the ability of mobile robots to locomote over large areas. The first part studies the kinematics and dynamics of rigid bodies and standard robotic manipulators and can be used as an introduction to robotics focussing on robust mathematical modeling. The monograph then moves on to study vehicle-manipulator systems in great detail with emphasis on combining two different configuration spaces in a mathematically sound way. Robustness of these systems is extremely important and Modeling and Control of Vehicle-manipulator Systems effectively represents the dynamic equations using a mathematically robust framework. Several tools from Lie theory and differential geometry are used to obtain globally valid representations of the dynamic equations of vehicle-manipulator systems. The specific characteristics of several different types of vehicle-manipulator systems are included and the various application areas of these systems are discussed in detail. For underwater robots buoyancy and gravity, drag forces, added mass properties, and ocean currents are considered. For space robotics the effects of free fall environments and the strong dynamic coupling between the spacecraft and the manipulator are discussed. For wheeled robots wheel kinematics and non-holonomic motion is

treated, and finally the inertial forces are included for robots mounted on a forced moving base. Modeling and Control of Vehicle-manipulator Systems will be of interest to researchers and engineers studying and working on many applications of robotics: underwater, space, personal assistance, and mobile manipulation in general, all of which have similarities in the equations required for modeling and control.

This monograph presents a novel method of sliding mode control for switch-regulated nonlinear systems. The Delta Sigma modulation approach allows one to implement a continuous control scheme using one or multiple, independent switches, thus effectively merging the available linear and nonlinear controller design techniques with sliding mode control. Sliding Mode Control: The Delta-Sigma Modulation Approach, combines rigorous mathematical derivation of the unique features of Sliding Mode Control and Delta-Sigma modulation with numerous illustrative examples from diverse areas of engineering. In addition, engineering case studies demonstrate the applicability of the technique and the ease with which one can implement the exposed results. This book will appeal to researchers in control engineering and can be used as graduate-level textbook for a first course on sliding mode control.

In this book, the author deals with the mathematical modelling, nonlinear control and performance evaluation of a conceptual anti-aircraft gun based mobile air defence system engaging an attacking three-dimensional aerial target. This book is of interest to academic faculty, graduate students and industry professionals working in the fields of mathematical modelling and control, ground vehicles, mobile air defence systems and other related topics.

This monograph provides readers with tools for the analysis, and control of systems with fewer control inputs than degrees of freedom to be controlled, i.e., underactuated systems. The text deals with the consequences of a lack of a general theory that would allow methodical treatment of such systems and the ad hoc approach to control design that often results, imposing a level of organization whenever the latter is lacking. The authors take as their starting point the construction of a graphical characterization or control flow diagram reflecting the transmission of generalized forces through the degrees of freedom. Underactuated systems are classified according to the three main structures by which this is found to happen—chain, tree, and isolated vertex—and control design procedures proposed. The procedure is applied to several well-known examples of underactuated systems: acrobot; pendubot; Tora system; ball and beam; inertia wheel; and robotic arm with elastic joint. The text is illustrated with MATLABsup®/sup/Simulink® simulations that demonstrate the effectiveness of the methods detailed./ppReaders interested in aircraft, vehicle control or various forms of walking robot will be able to learn from iUnderactuated Mechanical Systems

Nonholonomic systems are a widespread topic in several scientific and commercial domains, including robotics, locomotion and space exploration. This

work sheds new light on this interdisciplinary character through the investigation of a variety of aspects coming from several disciplines. The main aim is to illustrate the idea that a better understanding of the geometric structures of mechanical systems unveils new and unknown aspects to them, and helps both analysis and design to solve standing problems and identify new challenges. In this way, separate areas of research such as Classical Mechanics, Differential Geometry, Numerical Analysis or Control Theory are brought together in this study of nonholonomic systems.

Computational Science is the scienti?c discipline that aims at the development and understanding of new computational methods and techniques to model and simulate complex systems. The area of application includes natural systems – such as biology, envir- mental and geo-sciences, physics, and chemistry – and synthetic systems such as electronics and ?nancial and economic systems. The discipline is a bridge b- ween 'classical' computer science – logic, complexity, architecture, algorithms – mathematics, and the use of computers in the aforementioned areas. The relevance for society stems from the numerous challenges that exist in the various science and engineering disciplines, which can be tackled by advances made in this ?eld. For instance new models and methods to study environmental issues like the quality of air, water, and soil, and weather and climate predictions through simulations, as well as the simulation-supported development of cars, airplanes, and medical and transport systems etc. Paraphrasing R. Kenway (R.D. Kenway, Contemporary Physics. 1994): 'There is an important message to scientists, politicians, and industrialists: in the future science, the best industrial design and manufacture, the greatest medical progress, and the most accurate environmental monitoring and forecasting will be done by countries that most rapidly exploit the full potential ofcomputational science'. Nowadays we have access to high-end computer architectures and a large range of computing environments, mainly as a consequence of the enormous s- mulus from the various international programs on advanced computing, e.g.

The ICMEA2014 will provide an excellent international academic forum for sharing knowledge and results in theory, methodology and applications of Mechanical Engineering and Automation. The ICMEA2014 is organized by Advanced Information Science Research Center (AISRC) and is co-sponsored by Chongqing University, Changsha University of Science & Technology, Huazong University of Science and Technology and China Three Gorges University. This ICMEA2014 proceedings tends to collect the up-to-date, comprehensive and worldwide state-of-art knowledge on mechanical engineering and automation, including control theory and application, mechanic manufacturing system and automation, and Computer Science and applications. All of accepted papers were subjected to strict peer-reviewing by 2-4 expert referees. The papers have been selected for this volume because of quality and the relevance to the conference. We hope this book will not only provide the readers a broad overview of the latest research results, but also provide the readers a valuable summary and reference in these fields. ICMEA2014 organizing committee would like to express our sincere appreciations to all authors for their contributions to this book. We would like to extend our thanks to all the referees for their constructive comments on all papers; especially, we would

like to thank to organizing committee for their hard working.

Nonlinear System Theory

The inverse dynamics problem was developed in order to provide researchers with the state of the art in inverse problems for dynamic and vibrational systems. Contrasted with a forward problem, which solves for the system output in a straightforward manner, an inverse problem searches for the system input through a procedure contaminated with errors and uncertainties. An inverse problem, with a focus on structural dynamics, determines the changes made to the system and estimates the inputs, including forces and moments, to the system, utilizing measurements of structural vibration responses only. With its complex mathematical structure and need for more reliable input estimations, the inverse problem is still a fundamental subject of research among mathematicians and engineering scientists. This book contains 11 articles that touch upon various aspects of inverse dynamic problems.

This is the first book to view problems of electromechanics through the lens of analytical mechanics. It offers fundamental results in the theory of non-linear electromechanical systems and includes examples of industrial applications.

This textbook on the differential geometric approach to nonlinear control grew out of a set of lecture notes , which were prepared for a course on nonlinear system theory , given by us for the first time during the fall semester of 1988 . The audience consisted mostly of graduate students , taking part in the Dutch national Graduate Program on Systems and Control . The aim of this course is to give a general introduction to modern nonlinear control theory (with an emphasis on the differential geometric approach), as well as to provide students specializing in nonlinear control theory with a firm starting point for doing research in this area . One of our primary objectives was to give a self-contained treatment of all the topics to be included. Since the literature on nonlinear geometric control theory is rapidly expanding this forced us to limit ourselves in the choice of topics . The task of selecting topics was further aggravated by the continual shift in emphasis in the nonlinear control literature over the last years . Therefore, we decided to concentrate on some rather solid and clear-cut achievements of modern nonlinear control , which can be expected to be of remaining interest in the near future. Needless to say, there is also a personal bias in the topics we have finally selected.

This book, which presents the peer-reviewed post-proceedings of CSNDD 2012 and CSNDD 2014, addresses the important role that relevant concepts and tools from nonlinear and complex dynamics could play in present and future engineering applications. It includes 22 chapters contributed by outstanding researchers and covering various aspects of applications, including: structural health monitoring, diagnosis and damage detection, experimental methodologies, active vibration control and smart structures, passive control of structures using nonlinear energy sinks, vibro-impact dynamic MEMS/NEMS/AFM, energy-harvesting materials and structures, and time-delayed feedback control, as well as aspects of deterministic versus stochastic dynamics and control of nonlinear phenomena in physics. Researchers and engineers interested in the challenges posed and opportunities offered by nonlinearities in the development of passive and active control strategies, energy harvesting, novel design criteria, modeling and characterization will find the book to be an outstanding introduction.

Model-Based Control of Nonlinear Systems presents model-based control techniques for nonlinear, constrained systems. It covers constructive control design methods with an emphasis on modeling constrained systems, generating dynamic control models, and designing tracking control algorithms for the models. The book's interdisciplinary approach illustrates how system modeling and control theory are essential to control design projects. Organized according to the steps in a control design project, the text first discusses kinematic and dynamic modeling methods, including programmed constraints, Lagrange's equations, Boltzmann?Hamel equations, and generalized programmed motion equations. The next

chapter describes basic control concepts and the use of nonlinear control theory. After exploring stabilization strategies for nonlinear systems, the author presents existing model-based tracking control algorithms and path-following strategies for nonlinear systems. The final chapter develops a new model reference tracking strategy for programmed motion. Throughout the text, two examples of mechanical systems are used to illustrate the theory and simulation results. The first example is a unicycle model (nonholonomic system) and the second is a two-link planar manipulator model (holonomic system). With a focus on constructive modeling and control methods, this book provides the tools and techniques to support the control design process.

In the last two decades, the development of specific methodologies for the control of systems described by nonlinear mathematical models has attracted an ever increasing interest. New breakthroughs have occurred which have aided the design of nonlinear control systems. However there are still limitations which must be understood, some of which were addressed at the IFAC Symposium in Capri. The emphasis was on the methodological developments, although a number of the papers were concerned with the presentation of applications of nonlinear design philosophies to actual control problems in chemical, electrical and mechanical engineering.

Nonlinear Control and Analytical MechanicsA Computational ApproachSpringer Science & Business Media

Humanoid Robots: Modeling and Control provides systematic presentation of the models used in the analysis, design and control of humanoid robots. The book starts with a historical overview of the field, a summary of the current state of the art achievements and an outline of the related fields of research. It moves on to explain the theoretical foundations in terms of kinematic, kineto-static and dynamic relations. Further on, a detailed overview of biped balance control approaches is presented. Models and control algorithms for cooperative object manipulation with a multi-finger hand, a dual-arm and a multi-robot system are also discussed. One of the chapters is devoted to selected topics from the area of motion generation and control and their applications. The final chapter focuses on simulation environments, specifically on the step-by-step design of a simulator using the Matlab® environment and tools. This book will benefit readers with an advanced level of understanding of robotics, mechanics and control such as graduate students, academic and industrial researchers and professional engineers. Researchers in the related fields of multi-legged robots, biomechanics, physical therapy and physics-based computer animation of articulated figures can also benefit from the models and computational algorithms presented in the book. Provides a firm theoretical basis for modelling and control algorithm design Gives a systematic presentation of models and control algorithms Contains numerous implementation examples demonstrated with 43 video clips

This is a translation of Lurie's famous monograph on analytical mechanics. It includes developments in the cosmic dynamics, results in the theory of optimal control and in the theory of nonlinear elasticity.

Nonlinear Differential Equations and Nonlinear Mechanics provides information pertinent to nonlinear differential equations, nonlinear mechanics, control theory, and other related topics. This book discusses the properties of solutions of equations in standard form in the infinite time interval. Organized into 49 chapters, this book starts with an overview of the characteristic types of differential equation systems with small parameters. This text then explains the structurally stable fields on a differentiable two

manifold are the ones that exhibit the simplest features. Other chapters explore the canonic system of hyperbolic partial differential equations with fixed characteristics. This book discusses as well the monofrequent oscillations that are predominantly near one or the other of the linear modes of motion. The final chapter deals with the existence and asymptotic character of solutions of the nonlinear boundary value problem. This book is a valuable resource for pure and applied mathematicians. Aircraft engineers will also find this book useful.

Now in its third edition, this standard reference is a comprehensive treatment of nonsmooth mechanical systems refocused to give more prominence to issues connected with control and modelling. It covers Lagrangian and Newton–Euler systems, detailing mathematical tools such as convex analysis and complementarity theory. The ways in which nonsmooth mechanics influence and are influenced by well-posedness analysis, numerical analysis and simulation, modelling and control are explained. Contact/impact laws, stability theory and trajectory-tracking control are given detailed exposition connected by a mathematical framework formed from complementarity systems and measure-differential inclusions. Links are established with electrical circuits with set-valued nonsmooth elements as well as with other nonsmooth dynamical systems like impulsive and piecewise linear systems. Nonsmooth Mechanics (third edition) retains the topical structure familiar from its predecessors but has been substantially rewritten, edited and updated to account for the significant body of results that have emerged in the twenty-first century—including developments in: the existence and uniqueness of solutions; impact models; extension of the Lagrange–Dirichlet theorem and trajectory tracking; and well-posedness of contact complementarity problems with and without friction. Many figures (both new and redrawn to improve the clarity of the presentation) and examples are used to illustrate the theoretical developments. Material introducing the mathematics of nonsmooth mechanics has been improved to reflect the broad range of applications interest that has developed since publication of the second edition. The detail of some mathematical essentials is provided in four appendices. With its improved bibliography of over 1,300 references and wide-ranging coverage, Nonsmooth Mechanics (third edition) is sure to be an invaluable resource for researchers and postgraduates studying the control of mechanical systems, robotics, granular matter and relevant fields of applied mathematics. "The book's two best features, in my view are its detailed survey of the literature... and its detailed presentation of many examples illustrating both the techniques and their limitations... For readers interested in the field, this book will serve as an excellent introductory survey." Andrew Lewis in Automatica "It is written with clarity, contains the latest research results in the area of impact problems for rigid bodies and is recommended for both applied mathematicians and engineers." Panagiotis D. Panagiotopoulos in Mathematical Reviews "The presentation is excellent in combining rigorous mathematics with a great number of examples... allowing the reader to understand the basic concepts." Hans Troger in Mathematical Abstracts "/i> The book first introduces the concept of nonlinear normal modes (NNMs) and their two main definitions. The fundamental differences between classical linear normal modes (LNMs) and NNMs are explained and illustrated using simple examples. Different methods for computing NNMs from a mathematical model are presented. Both advanced analytical and numerical methods are described. Particular attention is

devoted to the invariant manifold and normal form theories. The book also discusses nonlinear system identification.

The goal of this book is to introduce the visional application by excellent researchers in the world currently and offer the knowledge that can also be applied to another field widely. This book collects the main studies about machine vision currently in the world, and has a powerful persuasion in the applications employed in the machine vision. The contents, which demonstrate that the machine vision theory, are realized in different field. For the beginner, it is easy to understand the development in the vision servoing. For engineer, professor and researcher, they can study and learn the chapters, and then employ another application method.

This volume on mathematical control theory contains high quality articles covering the broad range of this field. The internationally renowned authors provide an overview of many different aspects of control theory, offering a historical perspective while bringing the reader up to the very forefront of current research.

A trend of investigation of Nonlinear Control Systems has been present over the last few decades. As a result the methods for its analysis and design have improved rapidly. This book includes nonlinear design topics such as Feedback Linearization, Lyapunov Based Control, Adaptive Control, Optimal Control and Robust Control. All chapters discuss different applications that are basically independent of each other. The book will provide the reader with information on modern control techniques and results which cover a very wide application area. Each chapter attempts to demonstrate how one would apply these techniques to real-world systems through both simulations and experimental settings.

A comprehensive overview of nonlinear H? control theory for both continuous-time and discrete-time systems, Nonlinear H?-Control, Hamiltonian Systems and Hamilton-Jacobi Equations covers topics as diverse as singular nonlinear H?-control, nonlinear H? -filtering, mixed H2/ H?-nonlinear control and filtering, nonlinear H?-almost-disturbance-decoupling, and algorithms for solving the ubiquitous Hamilton-Jacobi-Isaacs equations. The link between the subject and analytical mechanics as well as the theory of partial differential equations is also elegantly summarized in a single chapter. Recent progress in developing computational schemes for solving the Hamilton-Jacobi equation (HJE) has facilitated the application of Hamilton-Jacobi theory in both mechanics and control. As there is currently no efficient systematic analytical or numerical approach for solving them, the biggest bottle-neck to the practical application of the nonlinear equivalent of the H?-control theory has been the difficulty in solving the Hamilton-Jacobi-Isaacs partial differential-equations (or inequalities). In light of this challenge, the author hopes to inspire continuing research and discussion on this topic via examples and simulations, as well as helpful notes and a rich bibliography. Nonlinear H?-Control, Hamiltonian Systems and Hamilton-Jacobi Equations was written for practicing professionals, educators, researchers and graduate students in electrical, computer, mechanical, aeronautical, chemical, instrumentation, industrial and systems engineering, as well as applied mathematics, economics and management.

Illustrating the power, simplicity, and generality of the concept of flatness, this reference explains how to identify, utilize, and apply flatness in system planning and design. The book includes a large assortment of exercises and models that range from elementary to complex classes of systems. Leading students and professionals through a vast

array of designs, simulations, and analytical studies on the traditional uses of flatness, Differentially Flat Systems contains an extensive amount of examples that showcase the value of flatness in system design, demonstrate how flatness can be assessed in the context of perturbed systems and apply static and dynamic feedback controller design techniques.

This is a comprehensive, state-of-the-art, treatise on the energetic mechanics of Lagrange and Hamilton, that is, classical analytical dynamics, and its principal applications to constrained systems (contact, rolling, and servoconstraints). It is a book on advanced dynamics from a unified viewpoint, namely, the kinetic principle of virtual work, or principle of Lagrange. As such, it continues, renovates, and expands the grand tradition laid by such mechanics masters as Appell, Maggi, Whittaker, Heun, Hamel, Chetaev, Synge, Pars, Luré, Gantmacher, Neimark, and Fufaev. Many completely solved examples complement the theory, along with many problems (all of the latter with their answers and many of them with hints). Although written at an advanced level, the topics covered in this 1400-page volume (the most extensive ever written on analytical mechanics) are eminently readable and inclusive. It is of interest to engineers, physicists, and mathematicians; advanced undergraduate and graduate students and teachers; researchers and professionals; all will find this encyclopedic work an extraordinary asset; for classroom use or self-study. In this edition, corrections (of the original edition, 2002) have been incorporated.

Contents:IntroductionBackground: Basic Concepts and Equations of Particle and Rigid-Body MechanicsKinematics of Constrained SystemsKinetics of Constrained SystemsImpulsive MotionNonlinear Nonholonomic ConstraintsDifferential Variational Principles, and Associated Generalized Equations of Motion of Nielsen, Tsenov, et al.Time-Integral Theorems and Variational PrinciplesIntroduction to Hamiltonian/Canonical Methods: Equations of Hamilton and Routh; Canonical Formalism Readership: Students and researchers in engineering, physics, and applied mathematics. Key Features:No book of this scope (comprehensiveness and state-of-the-art level) has ever been written, in any language, there are no real competitors. This (like the author's other books) is an entirely original work; several of its topics are based on the author's own research, and appear for the first time in book formReadability ("reader friendliness") in spite of its advanced levelEconomy of thinking: Unified treatment based on Lagrange's kinetic principle of virtual workSuperior and clear notation: both indicial and direct notations for vectors, Cartesian tensors etc.Self-contained exposition: All background mathematics and mechanics are summarized in the handbook like chapter 1Keywords:Analytical Mechanics;Classical Mechanics;Classical Dynamics;Theoretical Mechanics;Advanced Engineering Dynamics;Applied MechanicsReviews: "A monumental treatise … which is going to become a reference book on the subject … It should not be missed by anybody working in the area of analytical dynamics or only wanting to understand major problems of the subject … This landmark reference source … [is] the most comprehensive exposition available of the advanced engineering-oriented dynamics." Zentralblatt für Math. "This unique treatise should be part of every scientific library and scholarly collection in engineering science." IEEE Control Systems Magazine "I recommend without hesitation Prof Papastravridis' treatise as a reference source to be acquired by every library of Mathematics, Physics, or Mechanical/Aeronautical/Electrical Engineering

department. It is a different book, especially in our Internet era where instant satisfaction is often the primary (sometimes sole) goal of the student or researcher. Putting together 1392 (!!) pages of carefully prepared text and 172 figures (which then become somehow sparse) represents a major effort, to say the least." Bulletin of the American Mathematical Society "Recipient of the annual competition award, in engineering, of the Association of American Publishers." The Outstanding Professional and Scholarly Titles of 2002 (March 2003) "Unique in Contents and Perspective … has no Competition in Depth and Breadth." Dr George Simitses Professor of Engineering Science, Mechanics, and Aerospace Engineering University of Cincinatti and Georgia Institute of Technology, USA "Probably the best of its kind and likely to become standard reference." Dr Alex Dalgarno FRS, member of US National Academy of Sciences, and "father of molecular astrophysics" and Phillips Professor of Astronomy, Harvard University, and Harvard-Smithsonian Center for Astrophysics, USA "The reviewer shares the author's statement that this book with its almost 1,400 pages is unique among the comparable treatises in the breadth and the depth of the covered material. Regarding technicalities — the students and the young scientists will find a lot of interesting examples and solved up to their very end problems. I recommend you to read this special book in analytical mechanics. It is a useful tool to undergraduate and graduate students, professors and researchers in the area of applied mechanics, engineering science, and mechanical, aerospace, and structural engineering, as well for the physicists and applied mathematicians." Journal of Geometry and Symmetry in Physics

Saturation nonlinearities are ubiquitous in engineering systems. In control systems, every physical actuator or sensor is subject to saturation owing to its maximum and minimum limits. A digital filter is subject to saturation if it is implemented in a finite word length format. Saturation nonlinearities are also purposely introduced into engineering systems such as control sys tems and neural network systems. Regardless of how saturation arises, the analysis and design of a system that contains saturation nonlinearities is an important problem. Not only is this problem theoretically challenging, but it is also practically imperative. This book intends to study control systems with actuator saturation in a systematic way. It will also present some related results on systems with state saturation or sensor saturation. Roughly speaking, there are two strategies for dealing with actuator sat uration. The first strategy is to neglect the saturation in the first stage of the control design process, and then to add some problem-specific schemes to deal with the adverse effects caused by saturation. These schemes, known as anti-windup schemes, are typically introduced using ad hoc modifications and extensive simulations. The basic idea behind these schemes is to intro duce additional feedbacks in such a way that the actuator stays properly within its limits. Most of these schemes lead to improved performance but poorly understood stability properties.

During the past decade we have had to confront a series of control design prob lems - involving, primarily, multibody electro-mechanical systems - in which nonlinearity plays an essential role. Fortunately, the geometric theory of non linear control system analysis progressed substantially during the 1980s and 90s, providing crucial conceptual tools that addressed many of our needs. However, as any control systems engineer can attest, issues of modeling, computation, and implementation quickly

become the dominant concerns in practice. The prob lems of interest to us present unique challenges because of the need to build and manipulate complex mathematical models for both the plant and controller. As a result, along with colleagues and students, we set out to develop computer algebra tools to facilitate model building, nonlinear control system design, and code generation, the latter for both numerical simulation and real time con an outgrowth of that continuing effort. As trol implementation. This book is a result, the unique features of the book includes an integrated treatment of nonlinear control and analytical mechanics and a set of symbolic computing software tools for modeling and control system design. By simultaneously considering both mechanics and control we achieve a fuller appreciation of the underlying geometric ideas and constructions that are common to both. Control theory has had a fruitful association with analytical mechanics from its birth in the late 19th century.

Robot Hands and Multi-Fingered Haptic Interfaces is a monograph focusing on the comparison of human hands with robot hands, the fundamentals behind designing and creating the latter, and robotics' latest advancements in haptic technology. This work discusses the design of robot hands; contact models at grasping; kinematic models of constraint; dynamic models of the multi-fingered hand; the stability theorem of non-linear control systems; robot hand control; design and control of multi-fingered haptic interfaces; application systems using multi-fingered haptic interfaces; and telecontrol of robot hands using a multi-fingered haptic interface. Robot Hands and Multi-Fingered Haptic Interfaces is intended mainly for readers who have a foundation in basic robot arm engineering. To understand robot hand manipulation, readers must study kinematic constraint models of fingers, hand dynamics with constraints, stability theorems of non-linear control, and multi-fingered hand control — this book will benefit readers' understanding of this full range of issues regarding robot hand manipulation. Contents:The Human Hand and the Robotic HandKinematics of Multi-Fingered HandsKinematic Constraint and ControllabilityRobot DynamicsStability Theory of Non-Linear SystemsRobot Hand ControlMulti-Fingered Haptic InterfaceTeleoperation of Robot Hands Readership: Academic and Professional, Researchers, Graduate and Post-Graduate Engineering students specializing in robotics. Keywords:Robot Dynamics;Robot Control;Robot Hand;Haptic InterfaceKey Features:Most available books only focus on "robot" and "robot control" for robot arms. This book treats multi-fingered robot handsMulti-fingered haptic interface: this is a novel research area in robot hand application and there is no book on multi-fingered haptic interfacesTeleoperation for multi-fingered robot hands will be realized by using multi-fingered haptic interfaces

This book explores connections between control theory and geometric mechanics. The author links control theory with a geometric view of classical mechanics in both its Lagrangian and Hamiltonian formulations, and in particular with the theory of mechanical systems subject to motion constraints. The synthesis is appropriate as there is a rich connection between mechanics and nonlinear control theory. The book provides a unified treatment of nonlinear control theory and constrained mechanical systems that incorporates material not available in other recent texts. The book benefits graduate students and researchers in the area who want to enhance their understanding and enhance their techniques.

Bifurcation control refers to the task of designing a controller that can modify the bifurcation properties of a given nonlinear system, so as to achieve some desirable dynamical behaviors. There exists no similar control theory-oriented book available in the market that is devoted to the subject of bifurcation control, written by control engineers for control engineers. World-renowned leading experts in the field provide their state-of-the-art survey about the extensive research that has been done over the last few years in this subject. The book is not only aimed at active researchers in the field of bifurcation control and its applications, but also at a general audience in related fields.

Classical and Analytical Mechanics: Theory, Applied Examples, and Practice provides a bridge between the theory and practice related to mechanical, electrical, and electromechanical systems. It includes rigorous mathematical and physical explanations while maintaining an interdisciplinary engineering focus. Applied problems and exercises in mechanical, mechatronic, aerospace, electrical, and control engineering are included throughout and the book provides detailed techniques for designing models of different robotic, electrical, defense, and aerospace systems. The book starts with multiple chapters covering kinematics before moving onto coverage of dynamics and non-inertial and variable mass systems. Euler's dynamic equations and dynamic Lagrange equations are covered next with subsequent chapters discussing topics such as equilibrium and stability, oscillation analysis, linear systems, Hamiltonian formalism, and the Hamilton-Jacobi equation. The book concludes with a chapter outlining various electromechanical models that readers can implement and adapt themselves. Bridges theory and practice by providing readers techniques for solving common problems through mechanical, electrical, and electromechanical models alongside the underlying theoretical foundations Describes variable mass, non-inertial systems, dynamic Euler's equations, gyroscopes, and other related topics Includes a broad offering of practical examples, problems, and exercises across an array of engineering disciplines The area of analysis and control of mechanical systems using differential geometry is flourishing. This book collects many results over the last decade and provides a comprehensive introduction to the area.

Using relevant mathematical proofs and case studies illustrating design and application issues, this book demonstrates this powerful technique in the light of research on neural networks, which allow the identification of nonlinear models without the complicated and costly development of models based on physical laws.