Stability Regions Of Nonlinear Dynamical Systems Theory Estimation And Applications

Nonlinear dynamics has been enjoying a vast development for nearly four decades resulting in a range of well established theory, with the potential to significantly enhance performance, effectiveness, reliability and safety of physical systems as well as offering novel technologies and designs. By critically appraising the state of the art, it is now time to develop design criteria and technology for new generation products/processes operating on principles of nonlinear interaction and in the nonlinear regime, leading to more effective, sensitive, accurate, and durable methods than what is currently available. This new approach is expected to radically influence the design, control and exploitation paradigms, in a magnitude of contexts. With a strong emphasis on experimentally calibrated and validated models, contributions by top-level international experts will foster future directions for the development of engineering technologies and design using robust nonlinear dynamics modelling and analysis.

With progress in technology, the problem of protecting human-beings, ma chines and technological processes from !>Ources of vibration and impact has become of utmost importance. Traditional "classical" methods of pro tection, based upon utilising elastic passive and dissipative elements, turn out to be inefficient in many situations and can not completely satisfy the complex and often contradictory claims imposed on modern vibration protection systems which must provide high performance at minimum di mensions. For these reasons, active vibration protection systems, which are actually systems of automatic control with independent power sources, are widely used nowadays. Appearing and developing active systems require that traditional ap proaches to the analysis and synthesis of vibration protection systems must be revised. Firstly, there exists the necessity to re-state the problem of vi bration protection from mechanical actions as an equivalent problem in closed-loop control systems design, which is to be solved by the methods of control theory. Furthermore, it turns out that certain inherent proper ties of active systems must be taken into account for a proper design. In the majority of cases, the dynamic models of the objects to be protected and the bases to which these objects are to be attached must be revised. They are no longer considered as rigid bodies but elastic bodies with weak dissipation.

The book presents nonlinear, chaotic and fractional dynamics, complex systems and networks, together with cutting-edge research on related topics. The fifteen chapters – written by leading scientists working in the areas of nonlinear, chaotic, and fractional dynamics, as well as complex systems and networks – offer an extensive overview of cutting-edge research on a range of topics, including fundamental and applied research. These include but are not limited to, aspects of synchronization in complex dynamical systems, universality features in systems with specific fractional dynamics, and chaotic scattering. As such, the book provides an excellent and timely snapshot of the current state of research, blending the insights and experiences of many prominent researchers.

"Presents new approaches to qualitative analysis of continuous, discreteptime, and impulsive nonlinear systems via Liapunov matrix-valued functions that introduce more effective tests for solving problems of estimating the domains of asymptotic stability."

Nonlinear Dynamical Systems and Control presents and develops an extensive treatment of stability analysis and control design of nonlinear dynamical systems, with an emphasis on Lyapunov-based methods. Dynamical system theory lies at the heart of mathematical sciences and engineering. The application of dynamical systems has crossed interdisciplinary boundaries from chemistry to biochemistry to chemical kinetics, from medicine to biology to population genetics, from economics to sociology to psychology, and from physics to mechanics to engineering. The increasingly complex nature of engineering systems requiring feedback control to obtain a desired system behavior also gives rise to dynamical systems. Wassim Haddad and VijaySekhar Chellaboina provide an exhaustive treatment of nonlinear systems theory and control using the highest standards of exposition and rigor. This graduate-level textbook goes well beyond standard treatments by developing Lyapunov stability theory, partial stability, boundedness, input-to-state stability, input-output stability, finite-time stability, semistability, stability of sets and periodic orbits, and stability theorems via vector Lyapunov functions. A complete and thorough treatment of dissipativity theory, absolute stability theory, stability of feedback systems, optimal control, disturbance rejection control, and robust control for nonlinear dynamical systems is also given. This book is an indispensable resource for applied mathematicians, dynamical systems theorists, control theorists, and engineers.

This book constitutes the refereed proceedings of the 13th International Workshop on Computer Algebra in Scientific Computing, CASC 2011, held in Kassel, Germany, in September 2011. The 26 full papers included in the book were carefully reviewed and selected from numerous submissions. The articles are organized in topical sections on the development of object oriented computer algebra software for the modeling of algebraic structures as typed objects; matrix algorithms; the investigation with the aid of computer algebra; the development of symbolic-numerical algorithms; and the application of symbolic computations in applied problems of physics, mechanics, social science, and engineering.

There has been an increasing interest in the application of dynamical systems to the study of development over the last decade. The explosion of the dynamical systems framework in the physical and biological sciences has opened the door to a new Zeitgeist for studying development. This appeal to dynamical systems by developmentalists is natural given the intuitive links between the established fundamental problems of development and the conceptual and operational scope of nonlinear dynamical systems. This promise of a new approach and framework within which to study development has led to some progress in recent years but also a growing appreciation of the difficulty of both fully examining the new metaphor and realizing its potential. Divided into 4 parts, this book is a result of a recent conference on dynamical systems and development held at Pennsylvania State University. The first 3 parts focus on the content domains of development that have given most theoretical and empirical attention to the potential applications of dynamical systems--physical growth and movement, cognition, and communication. These parts show that a range of nonlinear models have been applied to a host of developmental phenomena. Part 4 highlights two particular methodological issues that hold important implications for the modeling of developmental phenomena with dynamical systems techniques.

This book presents the latest algorithmic developments in the cell-mapping method for the global analysis of nonlinear dynamic systems, global solutions for multi-objective optimization problems, and global solutions for zeros of complex algebraic equations. It also discusses related engineering and scientific applications, including the nonlinear design of structures for better vibration resistance and reliability; multi-objective, structural-acoustic design for sound abatement; optimal multi-objective design of airfoils for better lift; and optimal multi-objective design of linear and nonlinear controls with or without time delay. The first book on the subject to include extensive Matlab and C++ codes, it presents various implementation algorithms of the cell-mapping method, enabling readers to understand how the method works and its programming aspects. A link to the codes on the Springer website will be provided to the readers.

The International Union of Theoretical and Applied Mechanics (IUTAM) initiated and sponsored an International Symposium on Nonlinear Dynamics in Engineering Systems held in 1989 in Stuttgart, FRG. The Symposium was intended to bring together scientists working in different fields of dynamics to exchange ideas and to discuss new trends with special emphasis on nonlinear dynamics in engineering systems. A Scientific Committee was appointed by the Bureau of IUTAM with the following members: S. Arimoto (Japan), F.L. Chernousko (USSR), P.J. Holmes (USA), C.S. Hsu (USA), G. looss (France), F.C. Moon (USA), W. Schiehlen (FRG), Chairman, G. Schmidt (GDR), W. Szemplinska-Stupnicka (Poland), J.M.T. Thompson (UK), H. Troger (Austria). This committee selected the participants to be invited and the papers to be presented at the Symposium. As a result of this procedure 78 active scientific participants from 22 countries followed the invitation, and 44 papers were presented in lecture and poster sessions. They are collected in this volume. At the Symposium an exhibition with experiments took place and the movie "An Introduction to the Analysis of Chaotic Dynamics" by E.J. Kreuzer et.al. was presented. The scientific lectures were devoted to the following topics: o Dynamic Structural Engineering Problems, o Analysis of Nonlinear Dynamic Systems, o Bifurcation Problems, o Chaotic Dynamics and Control Problems, o Miscellaneous Problems, o Experimental and Theoretical Investigations, o Chaotic Oscillations of Engineering Systems, o Characterization of Nonlinear Dynamic Systems, o Nonlinear Stochastic Systems.

We present an improved and enlarged version of our book Nonlinear - namics of Chaotic and Stochastic Systems published by Springer in 2002. Basically, the new edition of the book corresponds to its ?rst version. While preparingthiseditionwemadesomeclari?cationsinseveralsectionsandalso corrected the misprints noticed in some formulas. Besides, three new sections have been added to Chapter 2. They are “Statistical Properties of Dynamical Chaos,” “E?ects of Synchronization in Extended Self-Sustained Oscillatory Systems,” and “Synchronization in Living Systems.” The sections indicated re?ect the most interesting results obtained by the authors after publication of the ?rst edition. We hope that the new edition of the book will be of great interest for a widesectionofreaderswhoarealreadyspecialistsorthosewhoarebeginning research in the ?elds of nonlinear oscillation and wave theory, dynamical chaos, synchronization, and stochastic process theory. Saratov, Berlin, and St. Louis V.S. Anishchenko November 2006 A.B. Neiman T.E. Vadiavasova V.V. Astakhov L. Schimansky-Geier Preface to the First Edition Thisbookisdevotedtotheclassicalbackgroundandtocontemporaryresults on nonlinear dynamics of deterministic and stochastic systems. Considerable attentionisgiventothee?ectsofnoiseonvariousregimesofdynamicsystems with noise-induced order. On the one hand, there exists a rich literature of excellent books on n- linear dynamics and chaos; on the other hand, there are many marvelous monographs and textbooks on the statistical physics of far-from-equilibrium andstochasticprocesses.Thisbookisanattempttocombinetheapproachof nonlinear dynamics based on the deterministic evolution equations with the approach of statistical physics based on stochastic or kinetic equations. One of our main aims is to show the important role of noise in the organization and properties of dynamic regimes of nonlinear dissipative systems.

Chaotic behavior arises in a variety of control settings. In some cases, it is beneficial to remove this behavior; in others, introducing or taking advantage of the existing chaotic components can be useful for example in cryptography. Chaos in Automatic Control surveys the latest methods for inserting, taking advantage of, or removing chaos in a variety of applications. This book supplies the theoretical and pedagogical basis of chaos in control systems along with new concepts and recent developments in the field. Presented in three parts, the book examines open-loop analysis, closed-loop control, and applications of chaos in control systems. The first section builds a background in the mathematics of ordinary differential and difference equations on which the remainder of the book is based. It includes an introductory chapter by Christian Mira, a pioneer in chaos research. The next section explores solutions to problems arising in observation and control of closed-loop chaotic control systems. These include model-independent control methods, strategies such as H-infinity and sliding modes, polytopic observers, normal forms using homogeneous transformations, and observability normal forms. The final section explores applications in wireless transmission, optics, power electronics, and cryptography. Chaos in Automatic Control distills the latest thinking in chaos while relating it to the most recent developments and applications in control. It serves as a platform for developing more robust, autonomous, intelligent, and adaptive systems.

This is the first book which exploits concepts and tools of global nonlinear dynamics for bridging the gap between theoretical and practical stability of systems/structures, and for possibly enhancing the engineering design in macro-, micro- and nano-mechanics. Addressed topics include complementing theoretical and practical stability to achieve load carrying capacity; dynamical integrity for analyzing global dynamics, for interpreting/predicting experimental behavior, for getting hints towards engineering design; techniques for control of chaos; response of uncontrolled and controlled system/models in applied mechanics and structural dynamics by also considerung the effect of system imperfections; from relatively simple systems to multidimensional models representative of real world applications; potential and expected impact of global dynamics for engineering design.

This book presents a modern and self-contained treatment of the Liapunov method for stability analysis, in the framework of mathematical nonlinear control theory. A Particular focus is on the problem of the existence of Liapunov functions (converse Liapunov theorems) and their regularity, whose interest is especially motivated by applications to automatic control. Many recent results in this area have been collected and presented in a systematic way. Some of them are given in extended, unified versions and with new, simpler proofs. In the 2nd edition of this successful book several new sections were added and old sections have been improved, e.g., about the Zubovs method, Liapunov functions for discontinuous systems and cascaded systems. Many new examples, explanations and figures were added making this book accessible and well readable for engineers as well as mathematicians.

This book is a compilation of peer-reviewed papers from the 2018 Asia-Pacific International Symposium on Aerospace Technology (APISAT 2018). The symposium is a common endeavour between the four national aerospace societies in China, Australia, Korea and Japan, namely, the Chinese Society of Aeronautics and Astronautics (CSAA), Royal Aeronautical Society Australian Division (RAeS Australian Division), the Korean Society for Aeronautical and Space Sciences (KSAS) and the Japan Society for Aeronautical and Space Sciences (JSASS). APISAT is an annual event initiated in 2009 to provide an opportunity for researchers and engineers from Asia-Pacific countries to discuss current and future advanced topics in aeronautical and space engineering.

Learn how to implement BCU methods for fast direct stabilityassessments of electric power systems Electric power providers around the world rely on stabilityanalysis programs to help ensure uninterrupted service to theircustomers. These programs are typically based on step-by-stepnumerical integrations of power system stability models to simulatesystem dynamic behaviors. Unfortunately, this offline practice isinadequate to deal with current operating environments. For years,direct methods have held the promise of providing real-timestability assessments; however, these methods have presentedseveral challenges and limitations. This book addresses these challenges and limitations with theBCU methods developed by author Hsiao-Dong Chiang. To date, BCUmethods have been adopted by twelve major utility companies in Asiaand North America. In addition, BCU methods are the only directmethods adopted by the Electric Power Research Institute in itslatest version of DIRECT 4.0. Everything you need to take full advantage of BCU methods isprovided, including: Theoretical foundations of direct methods Theoretical foundations of energy functions BCU methods and their theoretical foundations Group-based BCU method and its applications Numerical studies on industrial models and data Armed with a solid foundation in the underlying theory of directmethods, energy functions, and BCU methods, you'll discover how toefficiently solve complex practical problems in stability analysis.Most chapters begin with an introduction and end with concludingremarks, making it easy for you to implement these tested andproven methods that will help you avoid costly and dangerous poweroutages.

Provides students with an understanding of the modeling and practice in power system stability analysis and control design, as well as the computational tools used by commercial vendors Bringing together wind, FACTS, HVDC, and several other modern elements, this book gives readers everything they need to know about power systems. It makes learning complex power system concepts, models, and dynamics simpler and more efficient while providing modern viewpoints of power system analysis. Power System Modeling, Computation, and Control provides students with a new and detailed analysis of voltage stability; a simple example illustrating the BCU method of transient stability analysis; and one of only a few derivations of the transient synchronous machine model. It offers a discussion on reactive power consumption of induction motors during start-up to illustrate the low-voltage phenomenon observed in urban load centers. Damping controller designs using power system stabilizer, HVDC systems, static var compensator, and thyristor-controlled series compensation are also examined. In addition, there are chapters covering flexible AC transmission Systems (FACTS)—including both thyristor and voltage-sourced converter technology—and wind turbine generation and modeling. Simplifies the learning of complex power system concepts, models, and dynamics Provides chapters on power flow solution, voltage stability, simulation methods, transient stability, small signal stability, synchronous machine models (steady-state and dynamic models), excitation systems, and power system stabilizer design Includes advanced analysis of voltage stability, voltage recovery during motor starts, FACTS and their operation, damping control design using various control equipment, wind turbine models, and control Contains numerous examples, tables, figures of block diagrams, MATLAB plots, and problems involving real systems Written by experienced educators whose previous books and papers are used extensively by the international scientific community Power System Modeling, Computation, and Control is an ideal textbook for graduate students of the subject, as well as for power system engineers and control design professionals.

"Control of Complex Systems: Structural Constraints and Uncertainty" focuses on control design under information structure constraints, with a particular emphasis on large-scale systems. The complexity of such systems poses serious computational challenges and severely restricts the types of feedback laws that can be used in practice. This book systematically addresses the main issues, and provides a number of applications that illustrate potential design methods, most which use Linear Matrix Inequalities (LMIs), which have become a popular design tool over the past two decades. Authors Aleksandar I. Zecevic and Dragoslav D. Siljak use their years of experience in the control field to also: Address the issues of large-scale systems as they relate to robust control and linear matrix inequalities Discuss a new approach to applying standard LMI techniques to large-scale systems, combining graphic-theoretic decomposition techniques with appropriate low-rank numerical approximations and dramatically reducing the computational effort Providing numerous examples and a wide variety of applications, ranging from electric power systems and nonlinear circuits to mechanical problems and dynamic Boolean networks "Control of Complex Systems: Structural Constraints and Uncertainty" will appeal to practicing engineers, researchers and students working in control design and other related areas.

In recent years, enormous progress has been made on nonlinear dynamics particularly on chaos and complex phenomena. This unique volume presents the advances made in theory, analysis, numerical simulation and experimental realization, promising novel practical applications on various topics of current interest on chaos and related fields of nonlinear dynamics.Particularly, the focus is on the following topics: synchronization vs. chaotic phenomena, chaos and its control in engineering dynamical systems, fractal-based dynamics, uncertainty and unpredictability measures vs. chaos, Hamiltonian systems and systems with time delay, local/global stability, bifurcations and their control, applications of machine learning to chaos, nonlinear vibrations of lumped mass mechanical/mechatronic systems (rigid body and coupled oscillator dynamics) governed by ODEs and continuous structural members (beams, plates, shells) vibrations governed by PDEs, patterns formation, chaos in micro- and nano-mechanical systems, chaotic reduced-order models, energy absorption/harvesting from chaotic, chaos vs. resonance phenomena, chaos exhibited by discontinuous systems, chaos in lab experiments.The present volume forms an invaluable source on recent trends in chaotic and complex dynamics for any researcher and newcomers to the field of nonlinear dynamics.

The three volume set LNCS 3496/3497/3498 constitutes the refereed proceedings of the Second International Symposium on Neural Networks, ISNN 2005, held in Chongqing, China in May/June 2005. The 483 revised papers presented were carefully reviewed and selected from 1.425 submissions. The papers are organized in topical sections on theoretical analysis, model design, learning methods, optimization methods, kernel methods, component analysis, pattern analysis, systems modeling, signal processing, image processing, financial analysis, control systems, robotic systems, telecommunication networks, incidence detection, fault diagnosis, power systems, biomedical applications, industrial applications, and other applications.

This third of three volumes from the inaugural NODYCON, held at the University of Rome, in February of 2019, presents papers devoted to New Trends in Nonlinear Dynamics. The collection features both well-established streams of research as well as novel areas and emerging fields of investigation. Topics in Volume III include NEMS/MEMS and nanomaterials: multi-sensors, actuators exploiting nonlinear working principles; adaptive, multifunctional, and meta material structures; nanocomposite structures (e.g., carbon nanotube/polymer composites, composites with functionalized nanoparticles); 0D,1D,2D,3D nanostructures; biomechanics applications, DNA modeling, walking dynamics, heart dynamics, neurodynamics, capsule robots, jellyfish-like robots, nanorobots; cryptography based on chaotic maps; ecosystem dynamics, social media dynamics (user behavior dynamics in multi-messages social hotspots, prediction models), financial engineering, complexity in engineering; and network dynamics (multi-agent systems, leader-follower dynamics, swarm dynamics, biological networks dynamics).

This book provides a comprehensive treatment of the development and present state of the theory of sensitivity of dynamic systems. It is intended as a textbook and reference for researchers and scientists in electrical engineering, control and information theory as well as for mathematicians. The extensive and structured bibliography provides an overview of the literature in the field and points out directions for further research.

Bifurcation and Chaos has dominated research in nonlinear dynamics for over two decades and numerous introductory and advanced books have been published on this subject. There remains, however, a dire need for a textbook which provides a pedagogically appealing yet rigorous mathematical bridge between these two disparate levels of exposition. This book is written to serve the above unfulfilled need. Following the footsteps of Poincaré, and the renowned Andronov school of nonlinear oscillations, this book focuses on the qualitative study of high-dimensional nonlinear dynamical systems. Many of the qualitative methods and tools presented in this book were developed only recently and have not yet appeared in a textbook form. In keeping with the self-contained nature of this book, all topics are developed with an introductory background and complete mathematical rigor. Generously illustrated and written with a high level of exposition, this book will appeal to both beginners and advanced students of nonlinear dynamics interested in learning a rigorous mathematical foundation of this fascinating subject. Contents:Basic ConceptsStructurally Stable Equilibrium States of Dynamical SystemsStructurally Stable Periodic Trajectories of Dynamical SystemsInvariant ToriCenter Manifold. Local CaseCenter Manifold. Non-Local Case Readership: Engineers, students, mathematicians and researchers in nonlinear dynamics and dynamical systems. Keywords:Bifurcations;Dynamical Systems;Qualitative Theory;Chaos;Strange Attractors;Nonlinear DynamicsReviews: “It is well-written and clearly organized with excellent figures … This rigorous book, with its emphasis on mathematical technique, would form an excellent basis for an engineering course if supplemented with applications.” Applied Mechanics Reviews “Short remarks concerning various, not only mathematical, aspects of the theory add an extra flavour to the text. I recommend the book for all persons interested in the qualitative theory of differential equations.” Mathematical Reviews

Engineering systems have played a crucial role in stimulating many of the modern developments in nonlinear and stochastic dynamics. After 20 years of rapid progress in these areas, this book provides an overview of the current state of nonlinear modeling and analysis for mechanical and structural systems. This volume is a coherent compendium written by leading experts from the United States, Canada, Western and Eastern Europe, and Australia. The 22 articles describe the background, recent developments, applications, and future directions in bifurcation theory, chaos, perturbation methods, stochastic stability, stochastic flows, random vibrations, reliability, disordered systems, earthquake engineering, and numerics. The book gives readers a sophisticated toolbox that will allow them to tackle modeling problems in mechanical systems that use stochastic and nonlinear dynamics ideas. An extensive bibliography and index ensure this volume will remain a reference standard for years to come.

This introduction to applied nonlinear dynamics and chaos places emphasis on teaching the techniques and ideas that will enable students to take specific dynamical systems and obtain some quantitative information about their behavior. The new edition has been updated and extended throughout, and contains a detailed glossary of terms. From the reviews: "Will serve as one of the most eminent introductions to the geometric theory of dynamical systems." --Monatshefte für Mathematik

An authoritative treatment by leading researchers covering theory and optimal estimation, along with practical applications.

"This authoritative treatment covers theory, optimal estimation and a range of practical applications. The first book on the subject, and written by leading researchers, this clear and rigorous work presents a comprehensive theory for both the stability boundary and the stability regions of a range of nonlinear dynamical systems including continuous, discrete, complex, two-time-scale and non-hyperbolic systems, illustrated with numerical examples. The authors also propose new concepts of quasi-stability region and of relevant stability regions and their complete characterisations. Optimal schemes for estimating stability regions of general nonlinear dynamical systems are also covered, and finally the authors describe and explain how the theory is applied in applications including direct methods for power system transient stability analysis, nonlinear optimisation for finding a set of high-quality optimal solutions, stabilisation of nonlinear systems, ecosystem dynamics, and immunisation problems"--

The equations used to describe dynamic properties of physical systems are often nonlinear, and it is rarely possible to find their solutions. Although numerical solutions are impractical and graphical techniques are not useful for many types of systems, there are different theorems and methods that are useful regarding qualitative properties of nonlinear systems and their solutions—system stability being the most crucial property. Without stability, a system will not have value. Nonlinear Systems Stability Analysis: Lyapunov-Based Approach introduces advanced tools for stability analysis of nonlinear systems. It presents the most recent progress in stability analysis and provides a complete review of the dynamic systems stability analysis methods using Lyapunov approaches. The author discusses standard stability techniques, highlighting their shortcomings, and also describes recent developments in stability analysis that can improve applicability of the standard methods. The text covers mostly new topics such as stability of homogonous nonlinear systems and higher order Lyapunov functions derivatives for stability analysis. It also addresses special classes of nonlinear systems including time-delayed and fuzzy systems. Presenting new methods, this book provides a nearly complete set of methods for constructing Lyapunov functions in both autonomous and nonautonomous systems, touching on new topics that open up novel research possibilities. Gathering a body of research into one volume, this text offers information to help engineers design stable systems using practice-oriented methods and can be used for graduate courses in a range of engineering disciplines.

Complexity Science and Chaos Theory are fascinating areas of scientific research with wide-ranging applications. The interdisciplinary nature and ubiquity of complexity and chaos are features that provides scientists with a motivation to pursue general theoretical tools and frameworks. Complex systems give rise to emergent behaviors, which in turn produce novel and interesting phenomena in science, engineering, as well as in the socio-economic sciences. The aim of all Symposia on Chaos and Complex Systems (CCS) is to bring together scientists, engineers, economists and social scientists, and to discuss the latest insights and results obtained in the area of corresponding nonlinear-system complex (chaotic) behavior. Especially for the “4th International Interdisciplinary Chaos Symposium on Chaos and Complex Systems,” which took place April 29th to May 2nd, 2012 in Antalya, Turkey, the scope of the symposium had been further enlarged so as to encompass the presentation of work from circuits to econophysics, and from nonlinear analysis to the history of chaos theory. The corresponding proceedings collected in this volume address a broad spectrum of contemporary topics, including but not limited to networks, circuits, systems, biology, evolution and ecology, nonlinear dynamics and pattern formation, as well as neural, psychological, psycho-social, socio-economic, management complexity and global systems.

Many problems arising in machine learning domain deal with nonlinearity and quite often demand users to obtain global optimal solutions rather than local optimal ones. Several algorithms had been proposed in the optimization literature and inherited by the machine learning community. Popularly known as the initialization problem, the ideal set of parameters required will significantly depend on the initialization values. In this thesis work, we propose TRUST-TECH (TRansformation Under STability-reTaining Equilibra CHaracterization) based methods for systematically exploring the subspace of the parameters to obtain the neighborhood local optimal solutions on the nonlinear surface. Our method explores the dynamic and geometric characteristics of stability boundaries of a nonlinear dynamical system corresponding to the nonlinear function of interest. Basically, our method coalesces the advantages of the traditional local optimizers with that of the dynamic and geometric characteristics of the stability regions of the corresponding nonlinear dynamical system. Two phases namely, the local phase and the exit phase, are repeated alternatively in the solution space to achieve improvements in the quality of the solutions. The local phase obtains the local maximum of the nonlinear function and the stability region phase helps to escape out of the local maximum by moving towards the neighboring stability regions. Our algorithms were tested on both synthetic and real datasets and the advantages of using this stability region based framework are clearly manifested. This framework not only reduces the sensitivity to initialization, but also allows the flexibility for the practitioners to use various global and local methods that work well for a particular problem of interest. Other hierarchical stochastic algorithms like genetic algorithms and smoothing algorithms are also studied and frameworks for combining these methods with TRUST-TECH have been proposed.

For nonlinear dynamical systems, which represent the majority of real devices, any study of stability requires the investigation of the domain of attraction of an equilibrium point, i.e. the set of initial conditions from which the trajectory of the system converges to equilibrium. Unfortunately, both estimating and attempting to control the domain of attraction are very difficult problems, because of the complex relationship of this set with the model of the system. Domain of Attraction addresses the estimation and control of the domain of attraction of equilibrium points via SOS programming, i.e. optimization techniques based on the sum of squares of polynomials (SOS) that have been recently developed and that amount to solving convex problems with linear matrix inequality constraints. A unified framework for addressing these issues is presented for in various cases depending on the nature of the nonlinear systems considered, including the cases of polynomial, non-polynomial, certain and uncertain systems. The methods proposed are illustrated various example systems such as electric circuits, mechanical devices, and nuclear plants. Domain of Attraction also deals with related problems that can be considered within the proposed framework, such as characterizing the equilibrium points and bounding the trajectories of nonlinear systems, and offers a concise and simple description of the main features of SOS programming, which can be used for general purpose in research and teaching.

This book summarizes the main achievements of the EC funded 6th Framework Program project COFCLUO – Clearance of Flight Control Laws Using Optimization. This project successfully contributed to the achievement of a top-level objective to meet society's needs for a more efficient, safer and environmentally friendly air transport by providing new techniques and tools for the clearance of flight control laws. This is an important part of the certification and qualification process of an aircraft – a costly and time-consuming process for the aeronautical industry. The overall objective of the COFCLUO project was to develop and apply optimization techniques to the clearance of flight control laws in order to improve efficiency and reliability. In the book, the new techniques are explained and benchmarked against traditional techniques currently used by the industry. The new techniques build on mathematical criteria derived from the certification and qualification requirements together with suitable models of the aircraft. The development of these criteria and models are also presented in the book. Because of wider applicability, the optimization-based clearance of flight control laws will open up the possibility to design innovative aircraft that today are out of the scope using classical clearance tools. Optimization-based clearance will not only increase safety but it will also simplify the whole certification and qualification process, thus significantly reduce cost. The achieved speedup will also support rapid modeling and prototyping and reduce "time to market".

This authoritative treatment covers theory, optimal estimation and a range of practical applications. The first book on the subject, and written by leading researchers, this clear and rigorous work presents a comprehensive theory for both the stability boundary and the stability regions of a range of nonlinear dynamical systems including continuous, discrete, complex, two-time-scale and non-hyperbolic systems, illustrated with numerical examples. The authors also propose new concepts of quasi-stability region and of relevant stability regions and their complete characterisations. Optimal schemes for estimating stability regions of general nonlinear dynamical systems are also covered, and finally the authors describe and explain how the theory is applied in applications including direct methods for power system transient stability analysis, nonlinear optimisation for finding a set of high-quality optimal solutions, stabilisation of nonlinear systems, ecosystem dynamics, and immunisation problems.

Although chaos theory refers to the existence between seemingly random events, it has been gaining the attention of science, technology and managements fields. The shift from traditional procedures to the dynamics of chaos and complexity theory has resulted in a new element of complexity thinking, allowing for a greater capability for analyzing and understanding key business processes. Chaos and Complexity Theory for Management: Nonlinear Dynamics explores chaos and complexity theory and its relationship with the understanding of natural chaos in the business environment. Utilizing these theories aids in comprehending the development of businesses as a complex adaptive system.