Reduction of Nonlinear Control Systems

Reduction Of Nonlinear Control Systems A Differential Geometric Approach Mathematics And Its Appli

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Reduction of Nonlinear Control Systems V.I. Elkin,1999-02-28 Advances in science and technology necessitate the use of increasingly complicated dynamic control processes Undoubtedly sophisticated mathematical models are also concurrently elaborated for these processes In particular linear dynamic control systems iJ Ay Bu y E M C Rn U E RT 1 where A and B are constants are often abandoned in favor of nonlinear dynamic control systems 2 which in addition contain a large number of equations The solution of problems for multidimensional nonlinear control systems en counters serious difficulties which are both mathematical and technical in nature Therefore it is imperative to develop methods of reduction of nonlinear systems to a simpler form for example decomposition into systems of lesser dimension Approaches to reduction are diverse in particular techniques based on approxi mation methods In this monograph we elaborate the most natural and obvious in our opinion approach which is essentially inherent in any theory of math ematical entities for instance in the theory of linear spaces theory of groups etc Reduction in our interpretation is based on assigning to the initial object an isomorphic object a quotient object and a subobject In the theory of linear spaces for instance reduction consists in reducing to an isomorphic linear space quotient space and subspace Strictly speaking the exposition of any mathemat ical theory essentially begins with the introduction of these reduced objects and determination of their basic properties in relation to the initial object

Tautological Control Systems Andrew D. Lewis,2014-07-22 This brief presents a description of a new modelling framework for nonlinear geometric control theory The framework is intended to be and shown to be feedback invariant As such Tautological Control Systems provides a platform for understanding fundamental structural problems in geometric control theory Part of the novelty of the text stems from the variety of regularity classes e g Lipschitz finitely differentiable smooth real analytic with which it deals in a comprehensive and unified manner The treatment of the important real analytic class especially reflects recent work on real analytic topologies by the author Applied mathematicians interested in nonlinear and geometric control theory will find this brief of interest as a starting point for work in which feedback invariance is important Graduate students working in control theory may also find Tautological Control Systems to be a stimulating starting point for their research **Geometric Control of Mechanical Systems** Francesco Bullo,Andrew D. Lewis,2019-06-12 The primary emphasis of this book is the modeling analysis and control of mechanical systems The methods and results presented can be applied to a large class of mechanical control systems including applications in robotics autonomous vehicle control and multi body systems The book is unique in that it presents a unified rather than an inclusive treatment of control theory for mechanical systems A distinctive feature of the presentation is its reliance on techniques from differential and Riemannian geometry The book contains extensive examples and exercises and will be suitable for a growing number of courses in this area It begins with the detailed mathematical background proceeding through innovative approaches to physical modeling analysis and design techniques Numerous examples illustrate the

proposed methods and results while the many exercises test basic knowledge and introduce topics not covered in the main body of the text The audience of this book consists of two groups The first group is comprised of graduate students in engineering or mathematical sciences who wish to learn the basics of geometric mechanics nonlinear control theory and control theory for mechanical systems Readers will be able to immediately begin exploring the research literature on these subjects The second group consists of researchers in mechanics and control theory Nonlinear control theoreticians will find explicit links between concepts in geometric mechanics and nonlinear control theory Researchers in mechanics will find an overview of topics in control theory that have relevance to mechanics Optimization and Control of Bilinear Systems Panos M. Pardalos,Vitaliy A. Yatsenko,2010-03-14 The present book is based on results of scienti c investigations and on the materials of special courses o ered for graduate and undergraduate students The purpose of this book is to acquaint the reader with the developments in bilinear systems theory and its applications Particular attention is paid to control of open physical processes functioning in a nonequilibrium mode The text consists of eight chapters Chapter 1 is concerned with the problems of systems analysis of bilinear processes Chapter 2 solves the problem of optimal control of bilinear systems on the basis of di er tial geometry methods Chapter 3 deals with the progress made in an adaptive estimation technique Chapter 4 is devoted to the application of the Yang Mills elds to investigation of nonlinear control problems Chapter 5 considers intelligent sensors used to examine weak signals This chapter also describes and analyzes bilinear models of intelligent sensing elements Chapter 6 illustrates control problems of a quantum system Chapter 7 discusses the problems of control and identi cation in systems with chaotic dynamics Finally Chapter 8 examines the c trolled processes running in biomolecular systems This book is directed to students postgraduate students and speci ists engaged in the elds of control of physical processes quantum and molecular computing biophysics and physical information science **Geometrical Methods in Variational Problems** N.A. Bobylov,S.V. Emel'yanov,S. Korovin,2012-12-06 This self contained monograph presents methods for the investigation of nonlinear variational problems These methods are based on geometric and topological ideas such as topological index degree of a mapping Morse Conley index Euler characteristics deformation invariant homotopic invariant and the Lusternik Shnirelman category Attention is also given to applications in optimisation mathematical physics control and numerical methods Audience This volume will be of interest to specialists in functional analysis and its applications and can also be recommended as a text for graduate and postgraduate level courses in these fields **Nonlinear Systems** Nathan van de Wouw,Erjen Lefeber,Ines Lopez Arteaga,2016-07-07 This treatment of modern topics related to the control of nonlinear systems is a collection of contributions celebrating the work of Professor Henk Nijmeijer and honoring his 60th birthday It addresses several topics that have been the core of Professor Nijmeijer s work namely the control of nonlinear systems geometric control theory synchronization coordinated control convergent systems and the control of underactuated systems The book presents recent advances in these areas contributed by leading

international researchers in systems and control In addition to the theoretical questions treated in the text particular attention is paid to a number of applications including mobile robotics marine vehicles neural dynamics and mechanical systems generally This volume provides a broad picture of the analysis and control of nonlinear systems for scientists and engineers with an interest in the interdisciplinary field of systems and control theory The reader will benefit from the expert participants ideas on important open problems with contributions that represent the state of the art in nonlinear control

Contemporary Trends In Nonlinear Geometric Control Theory And Its Applications Alfonso Anzaldo-meneses,Bernard Bonnard,Jean Paul Gauthier,Felipe Monroy Perez,2002-01-30 Mathematical control theory has evolved from the study of practical problems in engineering and sciences to the elaboration of deep important concepts in mathematics and applied sciences This volume concerns contemporary trends in nonlinear geometric control theory and its applications It is a fine collection of papers presenting new results relevant open problems and important applications regarding academic and real world problems The book is dedicated to Velimir Jurdjevic whose scientific activity has been influential in the research of many of the authors It contains a number of articles specially written by colleagues and friends of Vel Jurdjevic all of them leading applied mathematicians and control theorists There is also place for surveys on topics of current research which present the state of the art of modern geometric control theory Finally the volume contains several new mathematical ideas generated by geometric control theory techniques which may initiate new directions of research beyond control theory

Applied Differential Geometry Vladimir G. Ivancevic,Tijana T. Ivancevic,2007 This graduate level monographic textbook treats applied differential geometry from a modern scientific perspective Co authored by the originator of the world s leading human motion simulator Human Biodynamics Engine a complex 264 DOF bio mechanical system modeled by differential geometric tools this is the first book that combines modern differential geometry with a wide spectrum of applications from modern mechanics and physics via nonlinear control to biology and human sciences The book is designed for a two semester course which gives mathematicians a variety of applications for their theory and physicists as well as other scientists and engineers a strong theory underlying their models **Algebraic Methods for Nonlinear Control Systems** Giuseppe Conte,Claude H. Moog,Anna Maria Perdon,2007-01-19 A self contained introduction to algebraic control for nonlinear systems suitable for researchers and graduate students Algebraic Methods for Nonlinear Control Systems develops a linear algebraic alternative to the usual differential geometric approach to nonlinear control using vector spaces over suitable fields of nonlinear functions It describes a range of results some of which can be derived using differential geometry but many of which cannot They include classical and generalized realization in the nonlinear context accessibility and observability recast for the linear algebraic setting discussion and solution of basic feedback problems results for dynamic and static state and output feedback Dynamic feedback and realization are shown to be dealt with and solved much more easily in the algebraic framework The second edition has been completely revised with new text examples and exercises it is divided into two parts

necessary methodology and applications to control problems *System, Structure and Control 2004* Sabine Mondie,2005-05-11 **Control Theory** J.R. Leigh,2004 For students or professionals in science math or industry with or without a background in control theory explains and illustrates the basic concepts underlying the theory with references to more detailed treatments Intended as a companion to more traditional approaches begins with simple concepts such as feedback and stability and advances to optimization distributed parameter systems and other complex ideas Annotation copyrighted by Book News Inc Portland OR *Scientific and Technical Aerospace Reports* ,1995 **Human-Like Biomechanics** Vladimir G. Ivancevic,Tijana T. Ivancevic,2008-01-11 Human Like Biomechanics is a comprehensive introduction into modern geometrical methods to be used as a unified research approach in two apparently separate and rapidly growing fields mathematical biomechanics and humanoid robotics The book contains six Chapters and an Appendix The first Chapter is an Introduction giving a brief review of mathematical techniques to be used in the text The second Chapter develops geometrical basis of human like biomechanics while the third Chapter develops its mechanical basis mainly from generalized Lagrangian and Hamiltonian perspective The fourth Chapter develops topology of human like biomechanics while the fifth Chapter reviews related nonlinear control techniques The sixth Chapter develops covariant biophysics of electro muscular stimulation The Appendix consists of two parts classical muscular mechanics and modern path integral methods which are both used frequently in the main text The whole book is based on the authors own research papers in human like biomechanics **American Book Publishing Record** ,2004 Mathematics of Complexity and Dynamical Systems Robert A. Meyers,2011-10-05 Mathematics of Complexity and Dynamical Systems is an authoritative reference to the basic tools and concepts of complexity systems theory and dynamical systems from the perspective of pure and applied mathematics Complex systems are systems that comprise many interacting parts with the ability to generate a new quality of collective behavior through self organization e g the spontaneous formation of temporal spatial or functional structures These systems are often characterized by extreme sensitivity to initial conditions as well as emergent behavior that are not readily predictable or even completely deterministic The more than 100 entries in this wide ranging single source work provide a comprehensive explication of the theory and applications of mathematical complexity covering ergodic theory fractals and multifractals dynamical systems perturbation theory solitons systems and control theory and related topics Mathematics of Complexity and Dynamical Systems is an essential reference for all those interested in mathematical complexity from undergraduate and graduate students up through professional researchers **Applications of Differential-Algebraic Equations: Examples and Benchmarks** Stephen Campbell,Achim Ilchmann,Volker Mehrmann,Timo Reis,2019-06-08 This volume encompasses prototypical innovative and emerging examples and benchmarks of Differential Algebraic Equations DAEs and their applications such as electrical networks chemical reactors multibody systems and multiphysics models to name but a few Each article begins with an exposition of modelling explaining whether the model is prototypical and for

which applications it is used This is followed by a mathematical analysis and if appropriate a discussion of the numerical aspects including simulation Additionally benchmark examples are included throughout the text Mathematicians engineers and other scientists working in both academia and industry either on differential algebraic equations and systems or on problems where the tools and insight provided by differential algebraic equations could be useful would find this book resourceful Robust Control and Linear Parameter Varying Approaches Olivier Sename,Peter Gaspar,József Bokor,2013-02-01 Vehicles are complex systems non linear multi variable where the abundance of embedded controllers should ensure better security This book aims at emphasizing the interest and potential of Linear Parameter Varying methods within the framework of vehicle dynamics e g proposed control oriented model complex enough to handle some system non linearities but still simple for control or observer design take into account the adaptability of the vehicle s response to driving situations to the driver request and or to the road sollicitations manage interactions between various actuators to optimize the dynamic behavior of vehicles This book results from the 32th International Summer School in Automatic that held in Grenoble France in September 2011 where recent methods based on robust control and LPV technics then applied to the control of vehicle dynamics have been presented After some theoretical background and a view on some recent works on LPV approaches for modelling analysis control observation and diagnosis the main emphasis is put on road vehicles but some illustrations are concerned with railway aerospace and underwater vehicles The main objective of the book is to demonstrate the value of this approach for controlling the dynamic behavior of vehicles It presents in a rm way background and new results on LPV methods and their application to vehicle dynamics Feedback Stabilization of Controlled Dynamical Systems Nicolas Petit,2017-03-23 This book is a tribute to Professor Laurent Praly and follows on from a workshop celebrating the occasion of his 60th birthday It presents new and unified visions of the numerous problems that Laurent Praly has worked on in his prolific career adaptive control output feedback and observers stability and stabilization His main contributions are the central topic of this book The book collects contributions written by prominent international experts in the control community addressing a rich variety of topics emerging ideas advanced applications and theoretical concepts Organized in three sections the first section covers the field of adaptive control where Laurent Praly started his career The second section focuses on stabilization and output feedback which is also the topic of the second half of his career Lastly the third section presents the emerging research that will form Laurent Praly s scientific legacy **Complex Nonlinearity** Vladimir G. Ivancevic,Tijana T. Ivancevic,2008-05-31 Complex Nonlinearity Chaos Phase Transitions Topology Change and Path Integrals is a book about prediction control of general nonlinear and chaotic dynamics of high dimensional complex systems of various physical and non physical nature and their underpinning geometro topological change The book starts with a textbook like expose on nonlinear dynamics attractors and chaos both temporal and spatio temporal including modern techniques of chaos control Chapter 2 turns to the edge of chaos in the form of phase transitions equilibrium and non

equilibrium oscillatory fractal and noise induced as well as the related field of synergetics While the natural stage for linear dynamics comprises of flat Euclidean geometry with the corresponding calculation tools from linear algebra and analysis the natural stage for nonlinear dynamics is curved Riemannian geometry with the corresponding tools from nonlinear tensor algebra and analysis The extreme nonlinearity chaos corresponds to the topology change of this curved geometrical stage usually called configuration manifold Chapter 3 elaborates on geometry and topology change in relation with complex nonlinearity and chaos Chapter 4 develops general nonlinear dynamics continuous and discrete deterministic and stochastic in the unique form of path integrals and their action amplitude formalism This most natural framework for representing both phase transitions and topology change starts with Feynman s sum over histories to be quickly generalized into the sum over geometries and topologies The last Chapter puts all the previously developed techniques together and presents the unified form of complex nonlinearity Here we have chaos phase transitions geometrical dynamics and topology change all working together in the form of path integrals The objective of this book is to provide a serious reader with a serious scientific tool that will enable them to actually perform a competitive research in modern complex nonlinearity It includes a comprehensive bibliography on the subject and a detailed index Target readership includes all researchers and students of complex nonlinear systems in physics mathematics engineering chemistry biology psychology sociology economics medicine etc working both in industry clinics and academia Multiple Time Scale Dynamics Christian Kuehn,2015-02-25 This book provides an introduction to dynamical systems with multiple time scales The approach it takes is to provide an overview of key areas particularly topics that are less available in the introductory form The broad range of topics included makes it accessible for students and researchers new to the field to gain a quick and thorough overview The first of its kind this book merges a wide variety of different mathematical techniques into a more unified framework The book is highly illustrated with many examples and exercises and an extensive bibliography The target audience of this book are senior undergraduates graduate students as well as researchers interested in using the multiple time scale dynamics theory in nonlinear science either from a theoretical or a mathematical modeling perspective

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