Systems & Control: Foundations & Applications

Christopher I. Byrnes
Francesco Delli Priscoli
Alberto Isidori

Output Regulation of Uncertain Nonlinear Systems

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Output Regulation Of Uncertain Nonlinear Systems Systems Control Foundations Applications:

Output Regulation of Uncertain Nonlinear Systems Christopher I. Byrnes,Francesco Delli Priscoli,Alberto Isidori,1997-06 The problem of controlling the output of a system so as to achieve asymptotic tracking of prescribed trajectories and or asymptotic re jection of undesired disturbances is a central problem in control the ory A classical setup in which the problem was posed and success fully addressed in the context of linear time invariant and finite dimensional systems is the one in which the exogenous inputs namely commands and disturbances may range over the set of all possible trajectories ofa given autonomous linear system commonly known as the exogeneous system or more the exosystem The case when the exogeneous system is a harmonic oscillator is of course classical Even in this special case the difference between state and error measurement feedback in the problem ofoutput reg ulation is profound To know the initial condition of the exosystem is to know the amplitude and phase of the corresponding sinusoid On the other hand to solve the output regulation problem in this case with only error measurement feedback is to track or attenu ate a sinusoid ofknown frequency but with unknown amplitude and phase This is in sharp contrast with alternative approaches such as exact output tracking where in lieu of the assumption that a signal is within a class of signals generated by an exogenous system one instead assumes complete knowledge of the past present and future time history of the trajectory to be tracked **Output Regulation of Uncertain Nonlinear Systems** Christopher I. Byrnes,Francesco Delli Priscoli,Alberto Isidori,2012-12-06 The problem of controlling the output of a system so as to achieve asymptotic tracking of prescribed trajectories and or asymptotic re jection of undesired disturbances is a central problem in control the ory A classical setup in which the problem was posed and success fully addressed in the context of linear time invariant and finite dimensional systems is the one in which the exogenous inputs namely commands and disturbances may range over the set of all possible trajectories ofa given autonomous linear system commonly known as the exogeneous system or more the exosystem The case when the exogeneous system is a harmonic oscillator is of course classical Even in this special case the difference between state and error measurement feedback in the problem ofoutput reg ulation is profound To know the initial condition of the exosystem is to know the amplitude and phase of the corresponding sinusoid On the other hand to solve the output regulation problem in this case with only error measurement feedback is to track or attenu ate a sinusoid ofknown frequency but with unknown amplitude and phase This is in sharp contrast with alternative approaches such as exact output tracking where in lieu of the assumption that a signal is within a class of signals generated by an exogenous system one instead assumes complete knowledge of the past present and future time history of the trajectory to be tracked *Stabilization and Regulation of Nonlinear Systems* Zhiyong Chen,Jie Huang,2014-08-30 The core of this textbook is a systematic and self contained treatment of the nonlinear stabilization and output regulation problems Its coverage embraces both fundamental concepts and advanced research outcomes and includes many numerical and practical examples Several classes of important

uncertain nonlinear systems are discussed The state of the art solution presented uses robust and adaptive control design ideas in an integrated approach which demonstrates connections between global stabilization and global output regulation allowing both to be treated as stabilization problems Stabilization and Regulation of Nonlinear Systems takes advantage of rich new results to give students up to date instruction in the central design problems of nonlinear control problems which are a driving force behind the furtherance of modern control theory and its application The diversity of systems in which stabilization and output regulation become significant concerns in the mathematical formulation of practical control solutions whether in disturbance rejection in flying vehicles or synchronization of Lorenz systems with harmonic systems makes the text relevant to readers from a wide variety of backgrounds Many exercises are provided to facilitate study and solutions are freely available to instructors via a download from springerextras com Striking a balance between rigorous mathematical treatment and engineering practicality Stabilization and Regulation of Nonlinear Systems is an ideal text for graduate students from many engineering and applied mathematical disciplines seeking a contemporary course in nonlinear control Practitioners and academic theorists will also find this book a useful reference on recent thinking in this field *Nonlinear Output Regulation* Jie Huang,2004-01-01 Nonlinear Output Regulation Theory and Applications provides a comprehensive and in depth treatment of the nonlinear output regulation problem It contains up to date research results and algorithms and tools for approaching and solving the output regulation problem and related problems such as robust stabilization of nonlinear systems Output regulation is a general mathematical formulation of many control problems encountered in daily life including cruise control of automobiles landing and takeoff of aircraft manipulation of robot arms orbiting of satellites and speed regulation of motors The book provides a self contained treatment starting with an introduction to the linear output regulation problem and a review of the fundamental nonlinear control theory The author s presentation strikes a balance between the theoretical foundation of the problem and the practical applications of the theory The book is accompanied by many examples including practical case studies with numerical simulations based on MATLAB SIMULINK Audience graduate students professors and researchers in applied mathematics electrical engineering mechanical engineering and aerospace engineering The book can be used in a graduate level control systems course as well as by control design engineers in industry *Stability and Stabilization* William J. Terrell,2009-02-15 Stability and Stabilization is the first intermediate level textbook that covers stability and stabilization of equilibria for both linear and nonlinear time invariant systems of ordinary differential equations Designed for advanced undergraduates and beginning graduate students in the sciences engineering and mathematics the book takes a unique modern approach that bridges the gap between linear and nonlinear systems Presenting stability and stabilization of equilibria as a core problem of mathematical control theory the book emphasizes the subject s mathematical coherence and unity and it introduces and develops many of the core concepts of systems and control theory There are five chapters on linear systems and nine chapters on nonlinear systems an

introductory chapter a mathematical background chapter a short final chapter on further reading and appendixes on basic analysis ordinary differential equations manifolds and the Frobenius theorem and comparison functions and their use in differential equations The introduction to linear system theory presents the full framework of basic state space theory providing just enough detail to prepare students for the material on nonlinear systems Focuses on stability and feedback stabilization Bridges the gap between linear and nonlinear systems for advanced undergraduates and beginning graduate students Balances coverage of linear and nonlinear systems Covers cascade systems Includes many examples and exercises

From Static to Dynamic Couplings in Consensus and Synchronization Among Identical and Non-Identical Systems Peter Wieland,2010 In a systems theoretic context the terms consensus and synchronization both describe the property that all individual systems in a group behave asymptotically identical i e output or state trajectories asymptotically converge to a common trajectory The objective of the present thesis is an improved understanding of some of the diverse coupling mechanisms leading to consensus and synchronization A starting point is the observation that classical consensus and synchronization results commonly deal with two distinct facets of the problem Consensus has regularly a strong focus on the interconnections and related constraints while synchronization typically addresses questions about complex individual dynamical systems Very few results exist that address both facets simultaneously A thorough analysis of static couplings in consensus algorithms provides explanations for this observation by unveiling limitations inherent to this type of couplings Novel dynamic coupling mechanisms are proposed to overcome these limitations These methods essentially rely on an internal model principle for consensus and synchronization derived in the thesis This principle provides necessary conditions for consensus and synchronization in groups of non identical systems and it establishes a link to the output regulation problem The fresh point of view revealed by this link eventually leads to a new hierarchical mechanism for consensus and synchronization among complex non identical systems with weak assumptions on the interconnections Applications include synchronization of linear systems and phase synchronization of nonlinear oscillators **Nonlinear Control of Dynamic Networks** Tengfei Liu,Zhong-Ping Jiang,David J. Hill,2018-09-03 Significant progress has been made on nonlinear control systems in the past two decades However many of the existing nonlinear control methods cannot be readily used to cope with communication and networking issues without nontrivial modifications For example small quantization errors may cause the performance of a well designed nonlinear control system to deteriorate Motivated by the need for new tools to solve complex problems resulting from smart power grids biological processes distributed computing networks transportation networks robotic systems and other cutting edge control applications Nonlinear Control of Dynamic Networks tackles newly arising theoretical and real world challenges for stability analysis and control design including nonlinearity dimensionality uncertainty and information constraints as well as behaviors stemming from quantization data sampling and impulses Delivering a systematic review of the nonlinear small gain theorems the text Supplies novel cyclic small gain theorems for

large scale nonlinear dynamic networks Offers a cyclic small gain framework for nonlinear control with static or dynamic quantization Contains a combination of cyclic small gain and set valued map designs for robust control of nonlinear uncertain systems subject to sensor noise Presents a cyclic small gain result in directed graphs and distributed control of nonlinear multi agent systems with fixed or dynamically changing topology Based on the authors recent research Nonlinear Control of Dynamic Networks provides a unified framework for robust quantized and distributed control under information constraints Suggesting avenues for further exploration the book encourages readers to take into consideration more communication and networking issues in control designs to better handle the arising challenges **Partially Observable Linear Systems Under Dependent Noises** Agamirza E. Bashirov,2003-01-23 This book discusses the methods of fighting against noise It can be regarded as a mathematical view of specific engineering problems with known and new methods of control and estimation in noisy media From the reviews An excellent reference on the complete sets of equations for the optimal controls and for the optimal filters under wide band noises and shifted white noises and their possible application to navigation of spacecraft MATHEMATICAL REVIEWS **Nonlinear Systems** Shankar Sastry,2013-04-18 There has been a great deal of excitement in the last ten years over the emer gence of new mathematical techniques for the analysis and control of nonlinear systems Witness the emergence of a set of simplified tools for the analysis of bifurcations chaos and other complicated dynamical behavior and the develop ment of a comprehensive theory of geometric nonlinear control Coupled with this set of analytic advances has been the vast increase in computational power available for both the simulation and visualization of nonlinear systems as well as for the implementation in real time of sophisticated real time nonlinear control laws Thus technological advances havebolstered the impact of analytic advances and produced a tremendous variety of new problems and applications that are nonlinear in an essential way Nonlinear controllaws have been implemented for sophisticated flight control systems on board helicopters and vertical take offand landing aircraft adaptive nonlinearcontrollaws havebeen implementedfor robot manipulators operating either singly or in cooperation on a multi fingered robot hand adaptive control laws have been implemented forjetengines andautomotive fuel injection systems as well as for automated highway systems and air traffic management systems to mention a few examples Bifurcation theory has been used to explain and understand the onset of fiutterin the dynamics of aircraft wing structures the onset of oscillations in nonlinear circuits surge and stall in aircraft engines voltage collapse in a power transmission network *Dynamical Systems, Control, Coding, Computer Vision* Giorgio Picci,D.S. Gilliam,2012-12-06 This book is a collection of essays devoted in part to new research direc tions in systems networks and control theory and in part to the growing interaction of these disciplines with new sectors of engineering and applied sciences like coding computer vision and hybrid systems These are new areas of rapid growth and of increasing importance in modern technology The essays written by world leading experts in the field reproduce and expand the plenary and minicoursejminisymposia invited lectures which were delivered at the Mathematical Theory of Networks and

Systems Sym posium MTNS 98 held in Padova Italy on July 6 10 1998 Systems control and networks theory has permeated the development of much of present day technology The impact has been visible in the past fifty years through the dramatic expansion and achievements of the aerospace and avionics industry through process control and factory au tomation robotics communication signals analysis and synthesis and more recently even finance to name just the most visible applications The theory has developed from the early phase of its history when the ba sic tools were elementary complex analysis Laplace transform and linear differential equations to present day where the mathematics ranges widely from functional analysis PDE s abstract algebra stochastic processes and differential geometry Irrespective of the particular tools however the ba sic unifying paradigms of feedback stability optimal control and recursive filtering have remained the bulk of the field and continue to be the basic motivation for the theory coming from the real world **Adaptive Critic Control with Robust Stabilization for Uncertain Nonlinear Systems** Ding Wang,Chaoxu Mu,2018-08-10 This book reports on the latest advances in adaptive critic control with robust stabilization for uncertain nonlinear systems Covering the core theory novel methods and a number of typical industrial applications related to the robust adaptive critic control field it develops a comprehensive framework of robust adaptive strategies including theoretical analysis algorithm design simulation verification and experimental results As such it is of interest to university researchers graduate students and engineers in the fields of automation computer science and electrical engineering wishing to learn about the fundamental principles methods algorithms and applications in the field of robust adaptive critic control In addition it promotes the development of robust adaptive critic control approaches and the construction of higher level intelligent systems Advances in Statistical Control, Algebraic Systems Theory, and Dynamic Systems Characteristics Chang-Hee Won,Cheryl B. Schrader,Anthony N. Michel,2010-07-08 Life has many surprises One of the best surprises is meeting a caring mentor an encouraging collaborator or an enthusiastic friend This volume is a tribute to P fessor Michael K Sain who is such a teacher colleague and friend On the beautiful fall day of October 27 2007 friends families colleagues and former students ga ered at a workshop held in Notre Dame Indiana This workshop brought together many people whose lives have been touched by Mike to celebrate his milestone 70th birthday and to congratulate him on his contributions in the elds of systems c cuits and control Mike was born on March 22 1937 in St Louis Missouri After obtaining his B S E E and M S E E at St Louis University he went on to study at the University of Illinois at Urbana Champaignfor his doctoral degree With his Ph D degree c plete he came to the University of Notre Dame in 1965 as an assistant professor He became an associate professor in 1968 a full professor in 1972 and the Frank M Freimann Chair in Electrical Engineering in 1982 He has remained at and loved the University of Notre Dame for over 40 years Mike also held a number of consu ing jobs throughout his career Most notably he consulted with the Energy Controls Division of Allied Bendix Aerospace from 1976 to 1988 and the North American Operations branch of the Research and Development Laboratory of General Motors Corporation for a decade 1984 1994 *Mathematical Results in Quantum*

Mechanics Jaroslav Dittrich,Pavel Exner,Milos Tater,1999-04-01 This book constitutes the proceedings of the QMath 7 Conference on Mathematical Results in Quantum Mechanics held in Prague Czech Republic in June 1998 The volume addresses mathematicians and physicists interested in contemporary quantum physics and associated mathematical questions presenting new results on Schr dinger and Pauli operators with regular fractal or random potentials scattering theory adiabatic analysis and interesting new physical systems such as photonic crystals quantum dots and wires

Computer, Informatics, Cybernetics and Applications Xingui He,Ertian Hua,Yun Lin,Xiaozhu Liu,2011-12-01 The Conference on Computer Informatics Cybernetics and Applications 2011 aims to facilitate an exchange of information on best practices for the latest research advances in the area of computer informatics cybernetics and applications which mainly includes computer science and engineering informatics cybernetics control systems communication and network systems technologies and applications others and emerging new topics **Reconfigurable Control of Nonlinear Dynamical Systems** Jan H. Richter,2011-02-02 This research monograph summarizes solutions to reconfigurable fault tolerant control problems for nonlinear dynamical systems that are based on the fault hiding principle It emphasizes but is not limited to complete actuator and sensor failures In the first part the monograph starts with a broad introduction of the control reconfiguration problems and objectives as well as summaries and explanations of solutions for linear dynamical systems The solution is always a reconfiguration block which consists of linear virtual actuators in the case of actuator faults and linear virtual sensors in the case of sensor faults The main advantage of the fault hiding concept is the reusability of the nominal controller which remains in the loop as an active system while the virtual actuator and sensor adapt the control input and the measured output to the fault scenario The second and third parts extend virtual actuators and virtual sensors towards the classes of Hammerstein Wiener systems and piecewise affine systems The main analyses concern stability recovery setpoint tracking recovery and performance recovery as reconfiguration objectives The fourth part concludes the monograph with descriptions of practical implementations and case studies The book is primarily intended for active researchers and practicing engineers in the field of fault tolerant control Due to many running examples it is also suitable for interested graduate students Control of Autonomous Aerial Vehicles Andrea L'Afflitto,Gokhan Inalhan,Hyo-Sang Shin,2023-11-20 Control of Autonomous Aerial Vehicles is an edited book that provides a single volume snapshot on the state of the art in the field of control theory applied to the design of autonomous unmanned aerial vehicles UAVs aka drones employed in a variety of applications The homogeneous structure allows the reader to transition seamlessly through results in guidance navigation and control of UAVs according to the canonical classification of the main components of a UAV s autopilot Each chapter has been written to assist graduate students and practitioners in the fields of aerospace engineering and control theory The contributing authors duly present detailed literature reviews conveying their arguments in a systematic way with the help of diagrams plots and algorithms They showcase the applicability of their results by means of flight tests and numerical

simulations the results of which are discussed in detail Control of Autonomous AerialVehicles will interest readers who are researchers practitioners or graduate students in control theory autonomous systems or robotics or in aerospace mechanical or electrical engineering Proceedings of 2019 Chinese Intelligent Systems Conference Yingmin Jia,Junping Du,Weicun Zhang,2019-09-07 This book showcases new theoretical findings and techniques in the field of intelligent systems and control It presents in depth studies on a number of major topics including Multi Agent Systems Complex Networks Intelligent Robots Complex System Theory and Swarm Behavior Event Triggered Control and Data Driven Control Robust and Adaptive Control Big Data and Brain Science Process Control Intelligent Sensor and Detection Technology Deep learning and Learning Control Guidance Navigation and Control of Aerial Vehicles and so on Given its scope the book will benefit all researchers engineers and graduate students who want to learn about cutting edge advances in intelligent systems intelligent control and artificial intelligence **Trends in Nonlinear and Adaptive Control** Zhong-Ping Jiang,Christophe Prieur,Alessandro Astolfi,2021-09-11 This book published in honor of Professor Laurent Praly on the occasion of his 65th birthday explores the responses of some leading international authorities to new challenges in nonlinear and adaptive control The mitigation of the effects of uncertainty and nonlinearity ubiquitous features of real world engineering and natural systems on closed loop stability and robustness being of crucial importance the contributions report the latest research into overcoming these difficulties in autonomous systems reset control systems multiple input multiple output nonlinear systems input delays partial differential equations population games and data driven control Trends in Nonlinear and Adaptive Control presents research inspired by and related to Professor Praly s lifetime of contributions to control theory and is a valuable addition to the literature of advanced control **Proceedings of the Fifth Euro-China Conference on Intelligent Data Analysis and Applications** Pavel Krömer,Hong Zhang,Yongquan Liang,Jeng-Shyang Pan,2018-12-24 This volume of Advances in Intelligent Systems and Computing highlights papers presented at the Fifth Euro China Conference on Intelligent Data Analysis and Applications ECC2018 held in Xi an China from October 12 to 14 2018 The conference was co sponsored by Springer Xi an University of Posts and Telecommunications VSB Technical University of Ostrava Czech Republic Fujian University of Technology Fujian Provincial Key Laboratory of Digital Equipment Fujian Provincial Key Lab of Big Data Mining and Applications and Shandong University of Science and Technology in China The conference was intended as an international forum for researchers and professionals engaged in all areas of computational intelligence intelligent control intelligent data analysis pattern recognition intelligent information processing and applications **Reinforcement Learning** Jinna Li,Frank L. Lewis,Jialu Fan,2023-07-24 This book offers a thorough introduction to the basics and scientific and technological innovations involved in the modern study of reinforcement learning based feedback control The authors address a wide variety of systems including work on nonlinear networked multi agent and multi player systems A concise description of classical reinforcement learning RL the basics of optimal control with dynamic programming and network

control architectures and a brief introduction to typical algorithms build the foundation for the remainder of the book Extensive research on data driven robust control for nonlinear systems with unknown dynamics and multi player systems follows Data driven optimal control of networked single and multi player systems leads readers into the development of novel RL algorithms with increased learning efficiency The book concludes with a treatment of how these RL algorithms can achieve optimal synchronization policies for multi agent systems with unknown model parameters and how game RL can solve problems of optimal operation in various process industries Illustrative numerical examples and complex process control applications emphasize the realistic usefulness of the algorithms discussed The combination of practical algorithms theoretical analysis and comprehensive examples presented in Reinforcement Learning will interest researchers and practitioners studying or using optimal and adaptive control machine learning artificial intelligence and operations research whether advancing the theory or applying it in mineral process chemical process power supply or other industries

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