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Modeling and Control of Complex Physical Systems

The Port-Hamiltonian
Approach



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Modeling And Control Of Complex Physical Systems The Port Hamiltonian Approach:

Modeling and Control of Complex Physical Systems Vincent Duindam, Alessandro Macchelli, Stefano Stramigioli, Herman Bruyninckx, 2009-10-15 Energy exchange is a major foundation of the dynamics of physical systems and hence in the study of complex multi domain systems methodologies that explicitly describe the topology of energy exchanges are instrumental in structuring the modeling and the computation of the system's dynamics and its control This book is the outcome of the European Project Geoplex FP5 IST 2001 34166 that studied and extended such system modeling and control methodologies This unique book starts from the basic concept of port based modeling and extends it to port Hamiltonian systems This generic paradigm is applied to various physical domains showing its power and unifying flexibility for real multi domain systems

Nonlinear Control Synthesis for Electrical Power Systems Using Controllable Series Capacitors N S Manjarekar, Ravi N. Banavar, 2012-02-12 In this work we derive asymptotically stabilizing control laws for electrical power systems using two nonlinear control synthesis techniques For this transient stabilization problem the actuator considered is a power electronic device a controllable series capacitor CSC The power system is described using two different nonlinear models the second order swing equation and the third order flux decay model To start with the CSC is modeled by the injection model which is based on the assumption that the CSC dynamics is very fast as compared to the dynamics of the power system and hence can be approximated by an algebraic equation Here by neglecting the CSC dynamics the input vector $g(x)$ in the open loop system takes a complex form the injection model Using this model interconnection and damping assignment passivity based control IDA PBC methodology is demonstrated on two power systems a single machine infinite bus SMIB system and a two machine system Further IDA PBC is used to derive stabilizing controllers for power systems where the CSC dynamics are included as a first order system Next we consider a different control methodology immersion and invariance I I to synthesize an asymptotically stabilizing control law for the SMIB system with a CSC The CSC is described by a first order system As a generalization of I I we incorporate the power balance algebraic constraints in the load bus to the SMIB swing equation and extend the design philosophy to a class of differential algebraic systems The proposed result is then demonstrated on another example a two machine system with two load buses and a CSC The controller performances are validated through simulations for all cases

Mathematical Control Theory I M. Kanat Camlibel, A. Agung Julius, Ramkrishna Pasumarthy, Jacquelin M.A. Scherpen, 2015-07-15 This treatment of modern topics related to mathematical systems theory forms the proceedings of a workshop Mathematical Systems Theory From Behaviors to Nonlinear Control held at the University of Groningen in July 2015 The workshop celebrated the work of Professors Arjan van der Schaft and Harry Trentelman honouring their 60th Birthdays The first volume of this two volume work covers a variety of topics related to nonlinear and hybrid control systems After giving a detailed account of the state of the art in the related topic each chapter presents new results and discusses new directions As such this volume provides a

broad picture of the theory of nonlinear and hybrid control 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 exciting new approaches to control and system theory and their predictions of future directions for the subject that were discussed at the workshop

Modeling and Control for Efficient Bipedal Walking Robots Vincent Duindam,Stefano Stramigioli,2009-01-17 By the dawn of the new millennium robotics has undergone a major transformation in scope and dimensions This expansion has been brought about by the maturity of the field and the advances in its related technologies From a largely dominant industrial focus robotics has been rapidly expanding into the challenges of the human world The new generation of robots is expected to safely and dependably co-habitat with humans in homes workplaces and communities providing support in services entertainment education health care manufacturing and assistance Beyond its impact on physical robots the body of knowledge robotics has produced is revealing a much wider range of applications reaching across diverse research areas and scientific disciplines such as biomechanics haptics neurosciences virtual simulation animation surgery and sensor networks among others In return the challenges of the new emerging areas are providing an abundant source of stimulation and insights for the field of robotics It is indeed at the intersection of disciplines that the most striking advances happen The goal of the series of Springer Tracts in Advanced Robotics STAR is to bring in a timely fashion the latest advances and developments in robotics on the basis of their significance and quality It is our hope that the wider dissemination of research developments will stimulate more exchanges and collaborations among the research community and contribute to further advancement of this rapidly growing field

Green Process Engineering Martine Poux,Patrick Cognet,Christophe Gourdon,2015-06-02 This book has been edited by Martine Poux Patrick Cognet and Christophe Gourdon from the Laboratoire de Genie Chimique ENSIACET Toulouse It presents an ensemble of methods and new chemical engineering routes that can be integrated in industrial processing for safer more flexible economical and ecological production processes in the context of

PID Passivity-Based Control of Nonlinear Systems with Applications Romeo Ortega,Jose Guadalupe Romero,Pablo Borja,Alejandro Donaire,2021-09-03 Explore the foundational and advanced subjects associated with proportional integral derivative controllers from leading authors in the field In PID Passivity Based Control of Nonlinear Systems with Applications expert researchers and authors Drs Romeo Ortega Jose Guadalupe Romero Pablo Borja and Alejandro Donaire deliver a comprehensive and detailed discussion of the most crucial and relevant concepts in the analysis and design of proportional integral derivative controllers using passivity techniques The accomplished authors present a formal treatment of the recent research in the area and offer readers practical applications of the developed methods to physical systems including electrical mechanical electromechanical power electronics and process control The book offers the material with minimal mathematical background making it relevant to a wide audience Familiarity with the theoretical tools reported in the control systems literature is not necessary to understand the concepts contained within You

ll learn about a wide range of concepts including disturbance rejection via PID control PID control of mechanical systems and Lyapunov stability of PID controllers Readers will also benefit from the inclusion of A thorough introduction to a class of physical systems described in the port Hamiltonian form and a presentation of the systematic procedures to design PID PBC for them An exploration of the applications to electrical electromechanical and process control systems of Lyapunov stability of PID controllers Practical discussions of the regulation and tracking of bilinear systems via PID control and their application to power electronics and thermal process control A concise treatment of the characterization of passive outputs incremental models and Port Hamiltonian and Euler Lagrange systems Perfect for senior undergraduate and graduate students studying control systems PID Passivity Based Control will also earn a place in the libraries of engineers who practice in this area and seek a one stop and fully updated reference on the subject **Mechatronic Systems Design**

Klaus Janschek, 2011-09-18 In this textbook fundamental methods for model based design of mechatronic systems are presented in a systematic comprehensive form The method framework presented here comprises domain neutral methods for modeling and performance analysis multi domain modeling energy port signal based simulation ODE DAE hybrid systems robust control methods stochastic dynamic analysis and quantitative evaluation of designs using system budgets The model framework is composed of analytical dynamic models for important physical and technical domains of realization of mechatronic functions such as multibody dynamics digital information processing and electromechanical transducers Building on the modeling concept of a technology independent generic mechatronic transducer concrete formulations for electrostatic piezoelectric electromagnetic and electrodynamic transducers are presented More than 50 fully worked out design examples clearly illustrate these methods and concepts and enable independent study of the material **Soft**

Actuators Kinji Asaka, Hidenori Okuzaki, 2019-08-28 This book is the second edition of Soft Actuators originally published in 2014 with 12 chapters added to the first edition The subject of this new edition is current comprehensive research and development of soft actuators covering interdisciplinary study of materials science mechanics electronics robotics and bioscience The book includes contemporary research of actuators based on biomaterials for their potential in future artificial muscle technology Readers will find detailed and useful information about materials methods of synthesis fabrication and measurements to study soft actuators Additionally the topics of materials modeling and applications not only promote the further research and development of soft actuators but bring benefits for utilization and industrialization This volume makes generous use of color figures diagrams and photographs that provide easy to understand descriptions of the mechanisms apparatus and motions of soft actuators Also in this second edition the chapters on modeling materials design and device design have been given a wider scope and made easier to comprehend which will be helpful in practical applications of soft actuators Readers of this work can acquire the newest technology and information about basic science and practical applications of flexible lightweight and noiseless soft actuators which differ from conventional mechanical engines and

electric motors This new edition of Soft Actuators will inspire readers with fresh ideas and encourage their research and development thus opening up a new field of applications for the utilization and industrialization of soft actuators

Input-to-State Stability Andrii Mironchenko,2023-03-30 Input to State Stability presents the dominating stability paradigm in nonlinear control theory that revolutionized our view on stabilization of nonlinear systems design of robust nonlinear observers and stability of nonlinear interconnected control systems The applications of input to state stability ISS are manifold and include mechatronics aerospace engineering and systems biology Although the book concentrates on the ISS theory of finite dimensional systems it emphasizes the importance of a more general view of infinite dimensional ISS theory This permits the analysis of more general system classes and provides new perspectives on and a better understanding of the classical ISS theory for ordinary differential equations ODEs Features of the book include a comprehensive overview of the theoretical basis of ISS a description of the central applications of ISS in nonlinear control theory a detailed discussion of the role of small gain methods in the stability of nonlinear networks and an in depth comparison of ISS for finite and infinite dimensional systems The book also provides a short overview of the ISS theory for other systems classes partial differential equations hybrid impulsive and time delay systems and surveys the available results for the important stability properties that are related to ISS The reader should have a basic knowledge of analysis Lebesgue integration theory linear algebra and the theory of ODEs but requires no prior knowledge of dynamical systems or stability theory The author introduces all the necessary ideas within the book Input to State Stability will interest researchers and graduate students studying nonlinear control from either a mathematical or engineering background It is intended for active readers and contains numerous exercises of varying difficulty which are integral to the text complementing and widening the material developed in the monograph

Control Theory and Inverse Problems Kaïs Ammari, Islam Boussaada, Chaker Jammazi,2024-11-07 This volume presents a timely overview of control theory and inverse problems and highlights recent advances in these active research areas The chapters are based on talks given at the spring school Control Theory Inverse Problems held in Monastir Tunisia in May 2023 In addition to providing a snapshot of these two areas chapters also highlight breakthroughs on more specific topics such as Control of hyperbolic systems The Helffer Nier Conjecture Rapid stabilization of the discretized Vlasov system Exponential stability of a delayed thermoelastic system Control Theory and Inverse Problems will be a valuable resource for both established researchers as well as more junior members of the community

Dynamic Incentives for Optimal Control of Competitive Power Systems Kölsch, Lukas,2022-10-11 This work presents a real time dynamic pricing framework for future electricity markets Deduced by first principles analysis of physical economic and communication constraints within the power system the proposed feedback control mechanism ensures both closed loop system stability and economic efficiency at any given time The resulting price signals are able to incentivize competitive market participants to eliminate spatio temporal shortages in power supply quickly and purposively

Advances in the

Theory of Control, Signals and Systems with Physical Modeling Jean Levine, Philippe Müllhaupt, 2010-10-05 In the 60 s control signals and systems had a common linear algebraic background and according to their evolution their respective backgrounds have now dramatically differed Recovering such a common background especially in the nonlinear context is currently a fully open question The role played by physical models finite or infinite dimensional in this hypothetical convergence is extensively discussed in this book The discussion does not only take place on a theoretical basis but also in the light of two wide classes of applications among the most active in the current industrially oriented researches Electrical and Mechatronical systems Chemical Processes and systems appearing in Life Sciences In this perspective this book is a contribution to the enhancement of the dialogue between theoretical laboratories and more practically oriented ones and industries This book is a collection of articles that have been presented by leading international experts at a series of three workshops of a Bernoulli program entitled Advances in the Theory of Control Signals and Systems with Physical Modeling hosted by the Bernoulli Centre of EPFL during the first semester of 2009 It provides researchers engineers and graduate students with an unprecedented collection of topics and internationally acknowledged top quality works and surveys

Whole-Body Control for Multi-Contact Balancing of Humanoid Robots Bernd Henze, 2021-11-03 This book aims at providing algorithms for balance control of legged torque controlled humanoid robots A humanoid robot normally uses the feet for locomotion This paradigm is extended by addressing the challenge of multi contact balancing which allows a humanoid robot to exploit an arbitrary number of contacts for support Using multiple contacts increases the size of the support polygon which in turn leads to an increased robustness of the stance and to an increased kinematic workspace of the robot Both are important features for facilitating a transition of humanoid robots from research laboratories to real world applications where they are confronted with multiple challenging scenarios such as climbing stairs and ladders traversing debris handling heavy loads or working in confined spaces The distribution of forces and torques among the multiple contacts is a challenging aspect of the problem which arises from the closed kinematic chain given by the robot and its environment

Advances in Mechatronics and Biomechanics towards Efficient Robot Actuation Jörn Malzahn, Navvab Kashiri, Monica Daley, Nikos Tsagarakis, 2019-06-28

Automated Model Generation and Observer Design for Interconnected Systems : A Port-Hamiltonian Approach Martin Pfeifer, 2022-06-27 This work addresses the automated generation of physical based models and model based observers We develop port Hamiltonian methods which for the first time allow a complete and consistent automation of these two processes for a large class of interconnected systems

Control of Interactive Robotic Interfaces Cristian Secchi, Stefano Stramigioli, Cesare Fantuzzi, 2007-04-16 This monograph deals with energy based control of interactive robotic interfaces The port Hamiltonian framework is exploited both for modeling and controlling interactive robotic interfaces The book provides an energy oriented analysis and control synthesis of interactive robotic interfaces from a single robot to multi robot systems for interacting with real and virtual

possibly unstructured environments Simulation and Modeling Methodologies, Technologies and Applications Mohammad S. Obaidat, Tuncer Ören, Helena Szczerbicka, 2020-07-31 The present book includes a set of selected best extended papers from the 9th International Conference on Simulation and Modeling Methodologies Technologies and Applications SIMULTECH 2019 that was held in Prague Czech Republic from 29 to 31 July 2019 The conference brought together researchers engineers and practitioners interested in methodologies and applications of modeling and simulation New and innovative solutions are reported in this book A selection was made after the conference based also on the conference chairs assessment reviewers assessment quality of presentation and audience interest so that this book includes the extended and revised versions of the very best papers of the conference New and innovative solutions are reported in this book

Human-Friendly Robotics 2022 Pablo Borja, Cosimo Della Santina, Luka Peternel, Elena Torta, 2023-01-01 This book contains seventeen contributions in the form of independent chapters covering a broad range of topics related to human robot interaction at physical and cognitive levels Each chapter represents a novel piece of work presented during HFR 2022 by researchers in the different areas of robotics where new theories methodologies technologies challenges and empirical and experimental studies are discussed Additionally this compilation is rich in viewpoints due to the multidisciplinary nature of its authors Hence this book represents an excellent opportunity for academics researchers and industry partners to get acquainted with the most recent work on human robot interaction *Cyber-Physical Systems* Danda B. Rawat, Joel J.P.C. Rodrigues, Ivan Stojmenovic, 2015-10-28 Although comprehensive knowledge of cyber physical systems CPS is becoming a must for researchers practitioners system designers policy makers system managers and administrators there has been a need for a comprehensive and up to date source of research and information on cyber physical systems This book fills that need Cyber Physical Syst *Difference Equations, Discrete Dynamical Systems and Applications* Sorin Olaru, Jim Cushing, Saber Elaydi, René Lozi, 2024-03-01 This book presents contributions related to new research results presented at the 27th International Conference on Difference Equations and Applications ICDEA 2022 that was held at CentraleSup lec Universit Paris Saclay France under the auspices of the International Society of Difference Equations ISDE July 18 22 2022 The book aims not only to disseminate these results but to foster further advances in the fields of difference equations and discrete dynamical systems Also included are applications to economic growth modeling population dynamics epidemic modeling game theory control systems and network analysis The target audience for the book includes Ph D students researchers educators and practitioners in these fields

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