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Analysis and Control of Underactuated Mechanical Systems

 Springer

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Joacim Rocklöv



Analysis And Control Of Underactuated Mechanical Systems:

Analysis and Control of Underactuated Mechanical Systems Amal Choukchou-Braham, Brahim Cherki, Mohamed Djemaï, Krishna Busawon, 2013-11-18 This monograph provides readers with tools for the analysis and control of systems with fewer control inputs than degrees of freedom to be controlled i.e. underactuated systems. The text deals with the consequences of a lack of a general theory that would allow methodical treatment of such systems and the ad hoc approach to control design that often results imposing a level of organization whenever the latter is lacking. The authors take as their starting point the construction of a graphical characterization or control flow diagram reflecting the transmission of generalized forces through the degrees of freedom. Underactuated systems are classified according to the three main structures by which this is found to happen: chain tree and isolated vertex and control design procedures proposed. The procedure is applied to several well known examples of underactuated systems: acrobot, pendubot, Tora system, ball and beam, inertia wheel and robotic arm with elastic joint. The text is illustrated with MATLAB^{sup} Simulink simulations that demonstrate the effectiveness of the methods detailed. Readers interested in aircraft vehicle control or various forms of walking robot will be able to learn from it. **Underactuated Mechanical Systems**

Analysis and Control of Underactuated Mechanical Systems Yang Liu, 2010 *Geometric Analysis and Control of Underactuated Mechanical Systems* Jason Nightingale, 2012 *Control of Underactuated Mechanical Systems* Afef Hfaiedh, Ahmed Chemori, 2025-04-01 **Control of Underactuated Mechanical Systems** Stabilization and Limit Cycle Generation clearly explains stabilization and limit cycle generation in underactuated mechanical systems. UMS addressing control design challenges and demonstrating concepts through real time experiments. The book begins with advancements in UMS introducing key concepts such as stabilization and limit cycle generation supported by literature examples. It then focuses on the inertia wheel inverted pendulum presenting a detailed discussion. The second part tackles stabilization offering various control solutions validated through numerical simulations and real time experiments. The final part addresses stable limit cycle generation detailing three proposed control solutions and their validation through different case studies. This book is a valuable resource for PhD and Master students, engineers, researchers and educators. It provides guidance in robotics and automatic control utilizing a simplified methodology for controlling underactuated mechanical systems. Addresses stabilization and stable limit cycle generation in underactuated mechanical systems amid perturbations. Explores the design, development and validation of robust control solutions. Illustrates concepts through case studies. Validates control solutions with numerical simulations and real time experiments. **Non-linear Control for Underactuated Mechanical Systems** Isabelle Fantoni, Rogelio Lozano, 2002 This book deals with the application of modern control theory to some important underactuated mechanical systems. It presents modelling and control of the following systems: the inverted pendulum, a convey crane system, the pendubot system, the Furuta pendulum, the inertia wheel pendulum, the planar flexible joint robot, the planar manipulator with two prismatic and one

revolute joints the ball the hovercraft model the planar vertical and take off landing PVTOL aircraft the helicopter model on a platform the helicopter model In every case the model is obtained in detail using either the Euler Lagrange formulation or the Newton's second law The text develops control algorithms for every particular system using techniques such as passivity energy based Lyapunov functions forwarding backstepping or feedback linearization techniques This book is designed for PhD students and researchers in the areas of non linear control systems mechanical systems robotics and control of helicopters It will help the reader gain experience in the modelling of mechanical systems and familiarize with new control methods for non linear systems

Motion Control of Underactuated Mechanical Systems Javier

Moreno-Valenzuela, Carlos Aguilar-Avelar, 2017-07-11 This volume is the first to present a unified perspective on the control of underactuated mechanical systems Based on real time implementation of parameter identification this book provides a variety of algorithms for the Furuta pendulum and the inertia wheel pendulum which are two degrees of freedom mechanical systems Specifically this work addresses and solves the problem of motion control via trajectory tracking in one joint coordinate while another joint is regulated Besides discussions on extensions to higher degrees of freedom systems are given The book aimed at control engineers as well as graduate students ranges from the problem of parameter identification of the studied systems to the practical implementation of sophisticated motion control algorithms Offering real world solutions to manage the control of underactuated systems this book provides a concise tutorial on recent breakthroughs in the field original procedures to achieve bounding of the error trajectories convergence and gain tuning guidelines

Control Design and Analysis for Underactuated Robotic Systems Xin Xin, Yannian Liu, 2014-01-03 The last two decades have witnessed considerable progress in the study of underactuated robotic systems URSs Control Design and Analysis for Underactuated Robotic Systems presents a unified treatment of control design and analysis for a class of URSs which include systems with multiple degree of freedom and or with underactuation degree two It presents novel notions features design techniques and strictly global motion analysis results for these systems These new materials are shown to be vital in studying the control design and stability analysis of URSs Control Design and Analysis for Underactuated Robotic Systems includes the modelling control design and analysis presented in a systematic way particularly for the following examples 1 directly and remotely driven Acrobots 1 Pendubot 1 rotational pendulum 1 counter weighted Acrobot 2 link underactuated robot with flexible elbow joint 1 variable length pendulum 1 3 link gymnastic robot with passive first joint 1 n link planar robot with passive first joint 1 n link planar robot with passive single joint double or two parallel pendulums on a cart 1 3 link planar robots with underactuation degree two 2 link free flying robot The theoretical developments are validated by experimental results for the remotely driven Acrobot and the rotational pendulum Control Design and Analysis for Underactuated Robotic Systems is intended for advanced undergraduate and graduate students and researchers in the area of control systems mechanical and robotics systems nonlinear systems and oscillation This text will not only enable the reader to gain a better

understanding of the power and fundamental limitations of linear and nonlinear control theory for the control design and analysis for these URSs but also inspire the reader to address the challenges of more complex URSs

Control of Underactuated Manipulators Jundong Wu, Pan Zhang, Qingxin Meng, Yawu Wang, 2023-05-13 This book investigates in detail cutting edge technologies of underactuated manipulator control which is a frontier topic in robotics that possesses great significance in energy conservation as well as fault tolerance for industrial applications It is also the crucial technology associated with systems in special environments including underwater or aerospace environments So far the topic of underactuated manipulator control has attracted engineers and scientists from various disciplines such as applied physics material automation and robotics Pursuing a holistic approach the book establishes a fundamental framework for this topic while emphasizing the importance of design and optimization in the control of underactuated manipulators Chapters of the book cover a wide variety of manipulator systems including vertical underactuated manipulator planar underactuated manipulator with first order nonholonomic constraint planar underactuated manipulator with second order nonholonomic constraint and flexible underactuated manipulator The book is intended for undergraduate and graduate students that are interested in underactuated manipulators researchers that investigate the design and optimization for controllers of underactuated manipulators and engineers working with underactuated systems

Non-linear Control for Underactuated Mechanical Systems Isabelle Fantoni, Rogelio Lozano, 2012-12-06 This book deals with the application of modern control theory to some important underactuated mechanical systems from the inverted pendulum to the helicopter model It will help readers gain experience in the modelling of mechanical systems and familiarize with new control methods for non linear systems

Analysis and Control of Underactuated Mechanical Nonminimum-phase Systems Philippe Müllhaupt, 1999

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