Control Of Nonlinear Multibody Flexible Space Structures Lecture Notes In Control And Information Sciences

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Control Of Nonlinear Multibody Flexible Space Structures Lecture Notes In Control And Information Sciences ***2022-12-27***

EVELIN QUINN

Robust Control of Nonlinear Flexible Multibody Systems Using Quaternion Feedback and Dissapative Compensation
Springer
Underactuated multibody systems are intriguing mechatronic systems, as they posses fewer control inputs than degrees of freedom. Some examples are modern light-weight flexible robots and articulated manipulators with passive joints. This book investigates such underactuated multibody systems from an integrated perspective. This includes all major steps from the modeling of rigid and flexible multibody systems, through nonlinear control theory, to optimal system design. The underlying theories and techniques from these different fields are presented using a self-contained and unified approach and notation system. Subsequently, the book focuses on applications to large multibody systems with multiple degrees of freedom, which require a combination of symbolical and numerical

procedures. Finally, an integrated, optimization-based design procedure is proposed, whereby both structural and control design are considered concurrently. Each chapter is supplemented by illustrated examples.

Workshop on High Performance Computing and Gigabit Local Area Networks

Springer

"The primary purpose of this book is to develop methods for the dynamic analysis of multibody systems (MBS) that consist of interconnected rigid and deformable components. In that sense, the objective may be considered as a generalization of methods of structural and rigid body analysis. Many mechanical and structural systems such as vehicles, space structures, robotics, mechanisms, and aircraft consist of interconnected components that undergo large translational and rotational displacements. Figure 1.1 shows examples of such systems that can be modeled as multibody systems. In general, a multibody system is defined to be a collection of subsystems called bodies, components, or substructures. The motion of the subsystems is kinematically constrained because of different types of joints, and each subsystem or component may undergo large translations and rotational displacements"--

Applied Mechanics Reviews Cambridge University Press

Control technology permeates every aspect of our lives. We rely on them to perform a wide

variety of tasks without giving much thought to the origins of the technology or how it became such an important part of our lives. Control System Applications covers the uses of control systems, both in the common and in the uncommon areas of our lives. From the everyday to the unusual, it's all here. From process control to human-in-the-loop control, this book provides illustrations and examples of how these systems are applied. Each chapter contains an introduction to the application, a section defining terms and references, and a section on further readings that help you understand and use the techniques in your work environment. Highly readable and comprehensive, Control System Applications explores the uses of control systems. It illustrates the diversity of control systems and provides examples of how the theory can be applied to specific practical problems. It contains information about aspects of control that are not fully captured by the theory, such as techniques for protecting against controller failure and the role of cost and complexity in specifying controller designs.

Control of Nonlinear Multibody Flexible Space Structures BoD – Books on Demand

The volume contains 19 contributions by international experts in the field of multibody system dynamics, robotics and control. The book aims to bridge the gap between the

modeling of mechanical systems by means of multibody dynamics formulations and robotics. In the classical approach, a multibody dynamics model contains a very high level of detail, however, the application of such models to robotics or control is usually limited. The papers aim to connect the different scientific communities in multibody dynamics, robotics and control. Main topics are flexible multibody systems, humanoid robots, elastic robots, nonlinear control, optimal path planning, and identification.

Smart Materials and Structures Springer

The problem of controlling a class of nonlinear multibody flexible space systems consisting of a flexible central body to which a number of articulated appendages are attached is considered. Collocated actuators and sensors are assumed, and global asymptotic stability of such systems is established under a nonlinear dissipative control law. The stability is shown to be robust to unmodeled dynamics and parametric uncertainties. For a special case in which the attitude motion of the central body is small, the system, although still nonlinear, is shown to be stabilized by linear dissipative control laws. Two types of linear controllers are considered: static dissipative (constant gain) and dynamic dissipative. The static dissipative control law is also shown to provide robust stability in the presence of certain classes of actuator and

sensor nonlinearities and actuator dynamics. The results obtained for this special case can also be readily applied for controlling single-body linear flexible space structures. For this case, a synthesis technique for the design of a suboptimal dynamic dissipative controller is also presented. The results obtained in this paper are applicable to a broad class of multibody and single-body systems such as flexible multilink manipulators, multipayload space platforms, and space antennas. The stability proofs use the Lyapunov approach and exploit the inherent passivity of such systems. Joshi, Suresh M. and Kelkar, Atul G. and Maghami, Peiman G. Langley Research Center RTOP 233-01-01-05...

Dynamics of Multibody Systems Springer Science & Business Media

The development and launch of the first artificial satellite Sputnik more than five decades ago propelled both the scientific and engineering communities to new heights as they worked together to develop novel solutions to the challenges of spacecraft system design. This symbiotic relationship has brought significant technological advances that have enabled the design of systems that can withstand the rigors of space while providing valuable space-based services. With its 26 chapters divided into three sections, this book brings together critical contributions from renowned international researchers to provide an

outstanding survey of recent advances in spacecraft technologies. The first section includes nine chapters that focus on innovative hardware technologies while the next section is comprised of seven chapters that center on cutting-edge state estimation techniques. The final section contains eleven chapters that present a series of novel control methods for spacecraft orbit and attitude control.

Dynamics of Underactuated Multibody Systems John Wiley & Sons

This book is the result of over ten (10) years of research and development in flexible robots and structures at Sandia National Laboratories. The authors de cided to collect this wealth of knowledge into a set of viewgraphs in order to teach a graduate class in Flexible Robot Dynamics and Controls within the Mechanical En gineering Department at the University of New Mexico (UNM). These viewgraphs, encouragement from several students, and many late nights have produced a book that should provide an upper-level undergraduate and graduate textbook and a reference for experienced professionals. The content of this book spans several disciplines including structural dynam ics, system identification, optimization, and linear, digital, and nonlinear control theory which are developed from several points of view including electrical, me chanical, and aerospace engineering as well as

engineering mechanics. As a result, the authors believe that this book demonstrates the value of solid applied theory when developing hardware solutions to real world problems. The reader will find many real world applications in this book and will be shown the applicability of these techniques beyond flexible structures which, in turn, shows the value of mul tidisciplinary education and teaming.

Nonlinear Dynamics and Control of Flexible Structures Routledge

This book is an essential guide to nonlinear dynamics and vibration control, detailing both the theory and the practical industrial applications within all aspects of engineering. Demonstrating how to improve efficiency through reducing unwanted vibration, it will aid both students and engineers in practically and safely improving flexible structures through control methods. Increasing demand for light-weight robotic systems and space applications has actuated the design and construction of more flexible structures. These flexible structures, involving numerous dynamic systems, experience unwanted vibrations, impacting accuracy, operating speed, safety and, importantly, efficiency. This book aids engineers in assuaging this issue through vibration control methods, including nonlinear dynamics. It covers topics such as dynamic modeling of nonlinear system,

nonlinear oscillators, and modal analyses of multiple-mode system. It also looks at vibration control methods including linear control, nonlinear control, intelligent control, and command smoothers. These control methods are effective and reliable methods to counteract unwanted vibrations. The book is practically minded, using industrial applications throughout, such as bridge cranes, tower cranes, aerial cranes and liquid sloshing. It also discusses cable-suspension structures, light-weight links, and fluid motions which exhibit flexible-structure dynamics. The book will be of interest to students and engineers alike, in the field of mechatronics, mechanical systems and signal processing, nonlinear dynamics, vibration, and control engineering.

Dynamics of Underactuated Multibody Systems

Springer

Addressing the difficult problem of controlling flexible spacecraft having multiple articulated appendages is the aim of this volume. Such systems are needed for space mission concepts including multi-payload space platforms and autonomous space-based manipulators. These systems are characterised by highly nonlinear dynamics, flexibility in members and joints, low inherent damping, and modeling uncertainty. A complete nonlinear rotational dynamic model of a generic multibody flexible system is derived, and is shown to possess certain passivity

properties. The main result is a class of passivity-based nonlinear and linear output feedback control laws that enable globally stable closed-loop manoeuvres. The control laws are robust to parametric uncertainties, unmodeled uncertainties, and in some cases, actuator and sensor nonlinearities. All results given are also applicable to flexible terrestrial manipulators.

Flexible Multibody Dynamics Springer Science & Business Media

These papers were presented at the first EC-TMR Nonlinear Control Network Workshop, on Stability and Stabilization of Nonlinear Systems, that took place in March 1999, Ghent, Belgium. The TMR programme offers a unique opportunity for the academic community to expand their knowledge, share their experience and identify and discuss strategic issues in aspects of nonlinear control engineering. The aim is to create a resource centre of available expertise and research interests. This outstanding reference volume presents current and emerging research directions, including: Stability analysis of nonlinear dynamical systems and converse Lyapunov theorems; Stabilization and regulation of nonlinear dynamical control systems; Control of physical systems using physics-based Lyapunov functions and passivity, as well as bifurcation analysis and optimal control. This collection of peer-reviewed papers provides a comprehensive overview of this field of

research for graduate students and researchers in engineering and applied mathematics. **Advances in Spacecraft Technologies** Springer Modern Flexible Multi-Body Dynamics Modeling Methodology for Flapping Wing Vehicles presents research on the implementation of a flexible multi-body dynamic representation of a flapping wing ornithopter that considers aero-elasticity. This effort brings advances in the understanding of flapping wing flight physics and dynamics that ultimately leads to an improvement in the performance of such flight vehicles, thus reaching their high performance potential. In using this model, it is necessary to reduce body accelerations and forces of an ornithopter vehicle, as well as to improve the aerodynamic performance and enhance flight kinematics and forces which are the design optimization objectives. This book is a useful reference for postgraduates in mechanical engineering and related areas, as well as researchers in the field of multibody dynamics. Uses Lagrange equations of motion in terms of a generalized coordinate vector of the rigid and flexible bodies in order to model the flexible multi-body system Provides flight verification data and flight physics of highly flexible ornithoptic vehicles Includes an online companion site with files/codes used in application examples **A Class of Stabilizing Controllers for Flexible Multibody Systems** CRC

Press
Arun K. Banerjee is one of the foremost experts in the world on the subject of flexible multibody dynamics. This book describes how to build mathermatical models of multibody systems with elastic components. Examples of such systems include the human body itself, construction cranes, cares with trailers, helicopers, spacecraft deploying antennas, tethered satellites, and underwater maneuvering vehicles. This book provides methods of analysis of complex mechanical systems that can be simulated in less computer time than other methods. It equips the reader with knowledge of algorithms that provide accurate results in reduced simulation time.
Modern Flexible Multi-Body Dynamics Modeling Methodology for Flapping Wing Vehicles Springer
This report summarizes the main results obtained in the ARO funded research project performed at the University of Illinois at Chicago. The objectives of this research project were to provide a comprehensive study and to develop new computational methodologies in the area of mechanics, and control of constrained deformable bodies as applied to large scale flexible mechanical systems. In this research project, a new finite element procedure, the absolute nodal coordinate formulation, was developed. This new procedure can be used for the large deformation and rotation analysis of

flexible multibody systems. It leads to exact modeling of the rigid body dynamics, and to a constant mass matrix for the finite elements in two- and three-dimensional applications. As a consequence, the vector of Coriolis and centrifugal forces is identically equal to zero. The new formulation captures the effect of the geometric centrifugal stiffness and accounts for the effect of the elastic nonlinearities. Several large deformation multibody problems were examined, and the results obtained using the new procedure were compared with the results obtained using existing finite element formulations. The results obtained in this research project are documented in several publications listed in this report.

Technology for Large Space Systems CRC Press Underactuated multibody systems are intriguing mechatronic systems, as they posses fewer control inputs than degrees of freedom. Some examples are modern light-weight flexible robots and articulated manipulators with passive joints. This book investigates such underactuated multibody systems from an integrated perspective. This includes all major steps from the modeling of rigid and flexible multibody systems, through nonlinear control theory, to optimal system design. The underlying theories and techniques from these different fields are presented using a self-contained and unified approach and notation system. Subsequently, the book focuses on

applications to large multibody systems with multiple degrees of freedom, which require a combination of symbolical and numerical procedures. Finally, an integrated, optimization-based design procedure is proposed, whereby both structural and control design are considered concurrently. Each chapter is supplemented by illustrated examples.

Control of Nonlinear Flexible Space Structures

CRC Press

The combination of fast, low-latency networks and high-performance, distributed tools for mathematical software has resulted in widespread, affordable scientific computing facilities. Practitioners working in the fields of computer communication networks, distributed computing, computational algebra and numerical analysis have been brought together to contribute to this volume and explore the emerging distributed and parallel technology in a scientific environment. This collection includes surveys and original research on both software infrastructure for parallel applications and hardware and architecture infrastructure. Among the topics covered are switch-based high-speed networks, ATM over local and wide area networks, network performance, application support, finite element methods, eigenvalue problems, invariant subspace decomposition, QR factorization and Todd-Coxseter coset enumeration.

Finite-Spectrum

Assignment for Time-Delay Systems
Createspace Independent Publishing Platform
The ECCOMAS Thematic Conference “Multibody Dynamics 2009” was held in Warsaw, representing the fourth edition of a series which began in Lisbon (2003), and was then continued in Madrid (2005) and Milan (2007), held under the auspices of the European Community on Computational Methods in Applied Sciences (ECCOMAS). The conference provided a forum for exchanging ideas and results of several topics related to computational methods and applications in multibody dynamics, through the participation of 219 scientists from 27 countries, mostly from Europe but also from America and Asia. This book contains the revised and extended versions of invited conference papers, reporting on the state-of-the-art in the advances of computational multibody models, from the theoretical developments to practical engineering applications. By providing a helpful overview of the most active areas and the recent efforts of many prominent research groups in the field of multibody dynamics, this book can be highly valuable for both experienced researches who want to keep updated with the latest developments in this field and researches approaching the field for the first time.
NASA Langley Scientific and Technical Information Output, 1995 Academic Press

This book contains an edited versIOn of lectures presented at the NATO ADVANCED STUDY INSTITUTE on VIRTUAL NONLINEAR MUL TIBODY SYSTEMS which was held in Prague, Czech Republic, from 23 June to 3 July 2002. It was organized by the Department of Mechanics, Faculty of Mechanical Engineering, Czech Technical University in Prague, in cooperation with the Institute B of Mechanics, University of Stuttgart, Germany. The ADVANCED STUDY INSTITUTE addressed the state of the art in multibody dynamics placing special emphasis on nonlinear systems, virtual reality, and control design as required in mechatronics and its corresponding applications. Eighty-six participants from twenty-two countries representing academia, industry, government and research institutions attended the meeting. The high qualification of the participants contributed greatly to the success of the ADVANCED STUDY INSTITUTE in that it promoted the exchange of experience between leading scientists and young scholars, and encouraged discussions to generate new ideas and to define directions of research and future developments. The full program of the ADVANCED STUDY INSTITUTE included also contributed presentations made by participants where different topics were explored, among them: Such topics include: nonholonomic systems; flexible multibody systems; contact, impact

and collision; numerical methods of differential-algebraical equations; simulation approaches; virtual modelling; mechatronic design; control; biomechanics; space structures and vehicle dynamics. These presentations have been reviewed and a selection will be published in this volume, and in special issues of the journals Multibody System Dynamics and Mechanics of Structures and Machines.

A Class of Stabilizing Controllers for Flexible Multibody Systems Springer Science & Business Media

This is the biggest, most comprehensive, and most prestigious compilation of articles on control systems imaginable. Every aspect of control is expertly covered, from the mathematical foundations to applications in robot and manipulator control. Never before has such a massive amount of authoritative, detailed, accurate, and well-organized information been available in a single volume. Absolutely everyone working in any aspect of systems and controls must have this book!

Large Space Structures & Systems in the Space Station Era CRC Press

This book is about dynamical systems that are "hybrid" in the sense that they contain both continuous and discrete state variables. Recently there has been increased research interest in the study of the interaction between discrete and continuous dynamics. The present volume provides

a first attempt in book form to bring together concepts and methods dealing with hybrid systems from various areas, and to look at these from a unified perspective. The authors have chosen a mode of exposition that is largely based on illustrative examples rather than on the abstract theorem-proof format because the systematic study of hybrid systems is still in its infancy. The examples are taken from many different application areas, ranging from power converters to communication protocols and from chaos to mathematical finance. Subjects covered include the following: definition of hybrid systems; description formats; existence and uniqueness of solutions; special subclasses (variable-structure systems, complementarity systems); reachability and verification; stability and stabilizability; control design methods. The book will be of interest to scientists from a wide range of disciplines including: computer science, control theory, dynamical system theory, systems modeling and simulation, and operations research. Nonlinear Dynamics and Vibration Control of Flexible Systems Springer Significant changes have occurred in materials science, including increasing demands on life extensions, and the reliability and exploitability of components, materials, and structures. These changes provide smart technologies with excellent application

opportunities in aerospace, civil and electrical engineering, transportation, manufacturing, communications, defense, and medicine. Smart Materials and Structures presents an overview of current developments in the characterization and applications of materials and actuators, issues surrounding their control, and the integration of smart systems and technologies. This compendium provides a valuable synopsis of this rapidly expanding and topical research field for engineers, program managers, technologists, physicists, materials scientists, and mathematicians working to advance smart materials, research methods, their applications, and robotic technologies.