

SYSTEMS ENGINEERING METHODS, DEVELOPMENTS AND TECHNOLOGY

NETWORKED CONTROL SYSTEMS

THEORY,
APPLICATIONS
AND ANALYSIS

SHIWEN TONG • DIANWEI QIAN
EDITORS

NOVA

Networked Control Systems Theory And Applications

J Elliott



Networked Control Systems Theory And Applications:

Networked Control Systems Fei-Yue Wang, Derong Liu, 2008-06-17 Networked control systems NCS confer advantages of cost reduction system diagnosis and flexibility minimizing wiring and simplifying the addition and replacement of individual elements efficient data sharing makes taking globally intelligent control decisions easier with NCS The applications of NCS range from the large scale of factory automation and plant monitoring to the smaller networks of computers in modern cars places and autonomous robots Networked Control Systems presents recent results in stability and robustness analysis and new developments related to networked fuzzy and optimal control Many chapters contain case studies experimental simulation or other application related work showing how the theories put forward can be implemented The state of the art research reported in this volume by an international team of contributors makes it an essential reference for researchers and postgraduate students in control electrical computer and mechanical engineering and computer science

Networked Control Systems Fei-Yue Wang, 1st, Derong Liu, 2nd, 2006-11-01 **Networked Control Systems** Shiwen Tong, Dianwei Qian, 2021 Networked Control System NCS can be regarded as a special type of control system in which sensors controllers and actuators are connected to a closed loop Media sharing characteristics time delay data packet dropout and data displacement are inevitable phenomena in such a control system which can greatly degrade the control performance and even make the control system unstable Alleviating these effects has become one of the most attractive research hotspots in the last two decades All the above three problems can be summarized as the time delay issue There are two kinds of time delay compensation strategies one is active compensation and the other is passive compensation For the former prediction is the core idea Selecting the appropriate candidate predicted control action according to the time delay information is a feasible solution For the latter making the system insensitive to delay is a good choice This book covers the design modeling control simulation and application of the networked control system This book addresses some original contributions reporting the latest advances in networked control It aims to gather the latest research on state of the art methods simulations and applications of networked control techniques The editor hopes it can reveal some tendencies in this research field and benefit readers including professional researchers and students This is an interesting collection of networked control techniques such as date based control tracking control event triggered control formation control etc

Intelligent Unmanned Systems: Theory and Applications Agus Budiyo, Bambang Riyanto, Endra Joelianto, 2009-03-20 The book largely represents the extended version of select papers from the International Conference on Intelligent Unmanned System ICIUS 2007 which was jointly organized by the Center for Unmanned System Studies at Institut Teknologi Bandung Artificial Muscle Research Center at Konkuk University and Institute of Bio inspired Structure and Surface Engineering Nanjing University of Aeronautics and Astronautics The joint event was the 3rd conference extending from International Conference on Emerging System Technology ICEST in 2005 and International Conference on Technology

Fusion ICTF in 2006 both conducted in Seoul ICIUS 2007 was focused on both theory and application primarily covering the topics on robotics autonomous vehicles and intelligent unmanned technologies The conference was arranged into three parallel symposia with the following scope of topics Unmanned Systems Micro air vehicle Underwater vehicle Micro satellite manned aerial vehicle Multi agent systems Autonomous ground vehicle Blimp Swarm intelligence learning and control Robotics and Biomimetics Artificial muscle actuators Smart sensors Design and applications of MEMS NEMS system Intelligent robot system Evolutionary algorithm Control of biological systems AI and expert systems Biological learning control systems Neural networks Genetic algorithm Control and Intelligent System Distributed intelligence Distributed decentralized intelligent control Distributed or decentralized control methods Distributed and bedded systems Embedded intelligent control Complex systems Discrete event systems Hybrid systems Networked control systems Delay systems Fuzzy systems Identification and estimation Nonlinear systems Precision motion control Control applications Control engineering education

Networked Control Systems Alberto Bemporad, Maurice Heemels, Mikael Johansson, 2010-10-15 This book finds its origin in the WIDE PhD School on Networked Control Systems which we organized in July 2009 in Siena Italy Having gathered experts on all the aspects of networked control systems it was a small step to go from the summer school to the book certainly given the enthusiasm of the lecturers at the school We felt that a book collecting overview on the important developments and open problems in the field of networked control systems could stimulate and support future research in this appealing area Given the tremendous current interests in distributed control exploiting wired and wireless communication networks the time seemed to be right for the book that lies now in front of you The goal of the book is to set out the core techniques and tools that are available for the modeling analysis and design of networked control systems Roughly speaking the book consists of three parts The first part presents architectures for distributed control systems and models of wired and wireless communication networks In particular in the first chapter important technological and architectural aspects on distributed control systems are discussed The second chapter provides insight in the behavior of communication channels in terms of delays packet loss and information constraints leading to suitable modeling paradigms for communication networks

Advanced and Optimization Based Sliding Mode Control: Theory and Applications Antonella Ferrara, Gian Paolo Incremona, Michele Cucuzella, 2019-07-01 A compendium of the authors recently published results this book discusses sliding mode control of uncertain nonlinear systems with a particular emphasis on advanced and optimization based algorithms The authors survey classical sliding mode control theory and introduce four new methods of advanced sliding mode control They analyze classical theory and advanced algorithms with numerical results complementing the theoretical treatment Case studies examine applications of the algorithms to complex robotics and power grid problems Advanced and Optimization Based Sliding Mode Control Theory and Applications is the first book to systematize the theory of optimization based higher order sliding mode control and illustrate advanced algorithms and their applications to real problems It presents systematic

treatment of event triggered and model based event triggered sliding mode control schemes including schemes in combination with model predictive control and presents adaptive algorithms as well as algorithms capable of dealing with state and input constraints Additionally the book includes simulations and experimental results obtained by applying the presented control strategies to real complex systems This book is suitable for students and researchers interested in control theory It will also be attractive to practitioners interested in implementing the illustrated strategies It is accessible to anyone with a basic knowledge of control engineering process physics and applied mathematics

Control Strategies and Co-Design of Networked Control Systems Héctor Benítez-Pérez, Jorge L. Ortega-Arjona, Paul E. Méndez-Monroy, Ernesto Rubio-Acosta, Oscar A. Esquivel-Flores, 2018-07-31 This book presents Networked Control System NCS as a particular kind of a real time distributed system RTDS composed of a set of nodes interconnected by a network and able to develop a complete control process It describes important parts of the control process such as sensor and actuator activities which rely on a real time operating system and a real time communication network As the use of common bus network architecture introduces different forms of uncertainties between sensors actuators and controllers several approaches such as reconfigurable systems have been developed to tackle this problem Moreover modeling NCS is a challenging procedure since there are several non linear situations like local saturations uncertain time delays dead zones or local situations it is necessary to deal with The book describes a novel strategy for modelling and control based on a fuzzy control approach and codesign strategies

Optimal Networked Control Systems with MATLAB Jagannathan Sarangapani, Hao Xu, 2018-09-03 Optimal Networked Control Systems with MATLAB discusses optimal controller design in discrete time for networked control systems NCS The authors apply several powerful modern control techniques in discrete time to the design of intelligent controllers for such NCS Detailed derivations rigorous stability proofs computer simulation examples and downloadable MATLAB codes are included for each case The book begins by providing background on NCS networked imperfections dynamical systems stability theory and stochastic optimal adaptive controllers in discrete time for linear and nonlinear systems It lays the foundation for reinforcement learning based optimal adaptive controller use for finite and infinite horizons The text then Introduces quantization effects for linear and nonlinear NCS describing the design of stochastic adaptive controllers for a class of linear and nonlinear systems Presents two player zero sum game theoretic formulation for linear systems in input output form enclosed by a communication network Addresses the stochastic optimal control of nonlinear NCS by using neuro dynamic programming Explores stochastic optimal design for nonlinear two player zero sum games under communication constraints Treats an event sampled distributed NCS to minimize transmission of state and control signals within the feedback loop via the communication network Covers distributed joint optimal network scheduling and control design for wireless NCS as well as the effect of network protocols on the wireless NCS controller design An ideal reference for graduate students university researchers and practicing engineers Optimal Networked Control Systems with MATLAB instills a solid

understanding of neural network controllers and how to build them *Networked Control Systems with Intermittent Feedback* Domagoj Tolić, Sandra Hirche, 2017-03-31 Networked Control Systems NCSs are spatially distributed systems for which the communication between sensors actuators and controllers is realized by a shared wired or wireless communication network NCSs offer several advantages such as reduced installation and maintenance costs as well as greater flexibility over conventional control systems in which parts of control loops exchange information via dedicated point to point connections The principal goal of this book is to present a coherent and versatile framework applicable to various settings investigated by the authors over the last several years This framework is applicable to nonlinear time varying dynamic plants and controllers with delayed dynamics a large class of static dynamic probabilistic and priority oriented scheduling protocols delayed noisy lossy and intermittent information exchange decentralized control problems of heterogeneous agents with time varying directed not necessarily balanced communication topologies state and output feedback off line and on line intermittent feedback optimal intermittent feedback through Approximate Dynamic Programming ADP and Reinforcement Learning RL and control systems with exogenous disturbances and modeling uncertainties Co-design Approaches to Dependable Networked Control Systems Daniel Simon, Ye-Qiong Song, Christophe Aubrun, 2013-03-04 Networked Control Systems NCS is a growing field of application and calls for the development of integrated approaches requiring multidisciplinary skills in control real time computing and communication protocols This book describes co design approaches and establishes the links between the QoC Quality of Control and QoS Quality of Service of the network and computing resources The methods and tools described in this book take into account at design level various parameters and properties that must be satisfied by systems controlled through a network Among the important network properties examined are the QoC the dependability of the system and the feasibility of the real time scheduling of tasks and messages Correct exploitation of these approaches allows for efficient design diagnosis and implementation of the NCS This book will be of great interest to researchers and advanced students in automatic control real time computing and networking domains and to engineers tasked with development of NCS as well as those working in related network design and engineering fields **Estimation and Control for Networked Systems with Packet Losses without Acknowledgement** Hong Lin, Hongye Su, Peng Shi, Zhan Shu, Zheng-Guang Wu, 2016-09-21 This book discusses recent advances in the estimation and control of networked systems with unacknowledged packet losses systems usually known as user datagram protocol like It presents both the optimal and sub optimal solutions in the form of algorithms which are designed to be implemented easily by computer routines It also provides MATLAB routines for the key algorithms It shows how these methods and algorithms can solve estimation and control problems effectively and identifies potential research directions and ideas to help readers grasp the field more easily The novel auxiliary estimator method which is able to deal with estimators that consist of exponentially increasing terms is developed to analyze the stability and convergence of the optimal estimator The book also explores the structure and

solvability of the optimal control i.e. linear quadratic Gaussian control. It develops various sub-optimal but efficient solutions for estimation and control for industrial and practical applications and analyzes their stability and performance. This is a valuable resource for researchers studying networked control systems especially those related to non-TCP like networks. The practicality of the ideas included makes it useful for engineers working with networked control.

Analysis and Synthesis of Delta Operator Systems Hongjiu Yang, Yuanqing Xia, Peng Shi, Ling Zhao, 2012-04-23. This book is devoted to analysis and design on delta operator systems. When sampling is fast a dynamical system will become difficult to control which can be seen in wide real world applications. Delta operator approach is very effective to deal with fast sampling systems. Moreover it is easy to observe and analyze the control effect with different sampling periods in delta operator systems. The framework of this book has been carefully constructed for delta operator systems to handle sliding mode control, time delays, filter design, finite frequency and networked control. These problems indeed are especially important and significant in automation and control systems design. Through the clear framework of the book readers can easily go through the learning process on delta operator systems via a precise and comfortable learning sequence. Following this enjoyable trail readers will come out knowing how to use delta operator approach to deal with control problems under fast sampling case. This book should be a good reference for academics, post graduates, scientists and engineers working in the field of control science and control engineering.

Analysis and Synthesis of Networked Control Systems Yuanqing Xia, Mengyin Fu, Guo-Ping Liu, 2011-03-14. Analysis and Synthesis of Networked Control Systems focuses on essential aspects of this field including quantization over networks, data fusion over networks, predictive control over networks and fault detection over networks. The networked control systems have led to a complete new range of real world applications. In recent years the techniques of Internet of Things are developed rapidly; the research of networked control systems plays a key role in Internet of Things. The book is self-contained providing sufficient mathematical foundations for understanding the contents of each chapter. It will be of significant interest to scientists and engineers engaged in the field of Networked Control Systems. Dr. Yuanqing Xia, a professor at Beijing Institute of Technology, has been working on control theory and its applications for over ten years.

14th International Conference on Theory and Application of Fuzzy Systems and Soft Computing - ICAFS-2020

Rafik A. Aliev, Janusz Kacprzyk, Witold Pedrycz, Mo Jamshidi, Mustafa Babanli, Fahreddin M. Sadikoglu, 2021-01-04. This book presents the proceedings of the 14th International Conference on Applications of Fuzzy Systems, Soft Computing and Artificial Intelligence Tools (ICAFS 2020) held in Budva, Montenegro on August 27-28, 2020. It includes contributions from diverse areas of fuzzy systems, soft computing, AI tools such as uncertain computation, decision making under imperfect information, deep learning and others. The topics of the papers include theory and application of soft computing, neuro-fuzzy technology, intelligent control, deep learning, machine learning, fuzzy logic in data analytics, evolutionary computing, fuzzy logic and artificial intelligence in engineering, social sciences, business, economics, material sciences and others.

Robust

Control for Uncertain Networked Control Systems with Random Delays Dan Huang, Sing Kiong Nguang, 2009-07-06

Robust Control for Uncertain Networked Control Systems with Random Delays addresses the problem of analysis and design of networked control systems when the communication delays are varying in a random fashion. The random nature of the time delays is typical for commercially used networks such as a DeviceNet which is a controller area network and Ethernet network. The main technique used in this book is based on the Lyapunov Razumikhin method which results in delay dependent controllers. The existence of such controllers and fault estimators are given in terms of the solvability of bilinear matrix inequalities. Iterative algorithms are proposed to change this non convex problem into quasi convex optimization problems which can be solved effectively by available mathematical tools. Finally to demonstrate the effectiveness and advantages of the proposed design method in the book numerical examples are given in each designed control system.

Optimal and Robust Scheduling for Networked Control Systems Stefano Longo, Tingli Su, Guido Herrmann, Phil Barber, 2018-09-03. Optimal and Robust Scheduling for Networked Control Systems tackles the problem of integrating system components controllers sensors and actuators in a networked control system. It is common practice in industry to solve such problems heuristically because the few theoretical results available are not comprehensive and cannot be readily applied by practitioners. This book offers a solution to the deterministic scheduling problem that is based on rigorous control theoretical tools but also addresses practical implementation issues. Helping to bridge the gap between control theory and computer science it suggests that the consideration of communication constraints at the design stage will significantly improve the performance of the control system. Technical Results Design Techniques and Practical Applications. The book brings together well known measures for robust performance as well as fast stochastic algorithms to assist designers in selecting the best network configuration and guaranteeing the speed of offline optimization. The authors propose a unifying framework for modelling NCSs with time triggered communication and present technical results. They also introduce design techniques including for the codesign of a controller and communication sequence and for the robust design of a communication sequence for a given controller. Case studies explore the use of the FlexRay TDMA and time triggered control area network CAN protocols in an automotive control system. Practical Solutions to Your Time Triggered Communication Problems. This unique book develops ready to use engineering tools for large scale control system integration with a focus on robustness and performance. It emphasizes techniques that are directly applicable to time triggered communication problems in the automotive industry and in avionics robotics and automated manufacturing.

Secure Control of Networked Control Systems and Its Applications Dong Yue, Songlin Hu, Zihao Cheng, 2021-02-15. This book shows some secure control methods of networked control systems related to linear control system nonlinear control system multi agent system and its applications in power systems. The proposed secure control methods provide some useful results about modeling of network attacks resilient analysis and synthesis methods active defense control method. The contents of this book are listed as follows: 1

Modeling of DoS attacks deception attacks and replay attacks 2 Secure control methods are proposed by combining delay system method switched system method and event based control method 3 Active control methods are proposed by using model predictive control and redundant control 4 The proposed control methods are applied to the security problem of power system The methods of this book include DoS attacks modeling such as periodic jamming attack model model based average dwell time model deception attack modeling and relay attack modeling piece wise Lyapunov Krasovskii functional method stochastic control method the results including resilient conditions of networked control system and related resilient control design method with linear matrix inequalities LMIs From this book readers can learn about the general network attack modeling methods resilient analysis and synthesis methods active control methods from viewpoint of redundancy control and secure conditions of power systems Some fundamental knowledge prepared to read this book includes delay system theory event triggered mechanism T S fuzzy system theory and frequency voltage control of power system

Analysis and Design for Networked Teleoperation System Changchun Hua, Yana Yang, Xian Yang, Xiping Guan, 2019-05-24 This book presents cutting edge results on stability analysis and control scheme designs for networked teleoperation systems It highlights new research on commonly encountered nonlinear teleoperation systems including the stability analysis of teleoperation systems with asymmetric time varying delays stability analysis of teleoperation systems with interval time delays and so on Moreover the book presents several high performance control scheme designs for teleoperation systems when the velocity is available and unavailable and for systems with nonlinear input The results presented here mark a substantial contribution to nonlinear teleoperation system theory robotic control theory and networked control system theory As such the book will be of interest to university researchers R D engineers and graduate students in control theory and control engineering who wish to learn about the core principles methods algorithms and applications of networked teleoperation systems robotic systems and nonlinear control systems

Intelligent Monitoring, Control, and Security of Critical Infrastructure Systems Elias Kyriakides, Marios Polycarpou, 2014-09-13 This book describes the challenges that critical infrastructure systems face and presents state of the art solutions to address them How can we design intelligent systems or intelligent agents that can make appropriate real time decisions in the management of such large scale complex systems What are the primary challenges for critical infrastructure systems The book also provides readers with the relevant information to recognize how important infrastructures are and their role in connection with a society s economy security and prosperity It goes on to describe state of the art solutions to address these points including new methodologies and instrumentation tools e g embedded software and intelligent algorithms for transforming and optimizing target infrastructures The book is the most comprehensive resource to date for professionals in both the private and public sectors while also offering an essential guide for students and researchers in the areas of modeling and analysis of critical infrastructure systems monitoring control risk impact evaluation fault diagnosis fault tolerant control and infrastructure dependencies interdependencies The importance of the

research presented in the book is reflected in the fact that currently for the first time in human history more people live in cities than in rural areas and that by 2050 roughly 70% of the world's total population is expected to live in cities

Stochastic Networked Control Systems Serdar Yüksel, Tamer Başar, 2013-05-21 Networked control systems are increasingly ubiquitous today with applications ranging from vehicle communication and adaptive power grids to space exploration and economics. The optimal design of such systems presents major challenges requiring tools from various disciplines within applied mathematics such as decentralized control, stochastic control, information theory, and quantization. A thorough self-contained book, *Stochastic Networked Control Systems: Stabilization and Optimization under Information Constraints*, aims to connect these diverse disciplines with precision and rigor while conveying design guidelines to controller architects. Unique in the literature, it lays a comprehensive theoretical foundation for the study of networked control systems and introduces an array of concrete tools for work in the field. Salient features included: Characterization, comparison, and optimal design of information structures in static and dynamic teams; Operational, structural, and topological properties of information structures in optimal decision making with a systematic program for generating optimal encoding and control policies; The notion of signaling and its utilization in stabilization and optimization of decentralized control systems; Presentation of mathematical methods for stochastic stability of networked control systems using random time state dependent drift conditions and martingale methods; Characterization and study of information channels leading to various forms of stochastic stability such as stationarity, ergodicity, and quadratic stability, and connections with information and quantization theories; Analysis of various classes of centralized and decentralized control systems; Jointly optimal design of encoding and control policies over various information channels and under general optimization criteria, including a detailed coverage of linear quadratic Gaussian models; Decentralized agreement and dynamic optimization under information constraints. This monograph is geared toward a broad audience of academic and industrial researchers interested in control theory, information theory, optimization, economics, and applied mathematics. It could likewise serve as a supplemental graduate text. The reader is expected to have some familiarity with linear systems, stochastic processes, and Markov chains, but the necessary background can also be acquired in part through the four appendices included at the end. Characterization, comparison, and optimal design of information structures in static and dynamic teams; Operational, structural, and topological properties of information structures in optimal decision making with a systematic program for generating optimal encoding and control policies; The notion of signaling and its utilization in stabilization and optimization of decentralized control systems; Presentation of mathematical methods for stochastic stability of networked control systems using random time state dependent drift conditions and martingale methods; Characterization and study of information channels leading to various forms of stochastic stability such as stationarity, ergodicity, and quadratic stability, and connections with information and quantization theories; Analysis of various classes of centralized and decentralized control systems; Jointly optimal design of

encoding and control policies over various information channels and under general optimization criteria including a detailed coverage of linear quadratic Gaussian models Decentralized agreement and dynamic optimization under information constraints This monograph is geared toward a broad audience of academic and industrial researchers interested in control theory information theory optimization economics and applied mathematics It could likewise serve as a supplemental graduate text The reader is expected to have some familiarity with linear systems stochastic processes and Markov chains but the necessary background can also be acquired in part through the four appendices included at the end

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