DISTRIBUTED COOPERATIVE CONTROL OF MULTI-AGENT SYSTEMS

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Cooperative Control Of Distributed Multi Agent Systems

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Cooperative Control Of Distributed Multi Agent Systems:

Cooperative Control of Distributed Multi-Agent Systems Jeff Shamma,2008-02-28 The paradigm of multi agent cooperative control is the challenge frontier for new control system application domains and as a research area it has experienced a considerable increase in activity in recent years This volume the result of a UCLA collaborative project with Caltech Cornell and MIT presents cutting edge results in terms of the dimensions of cooperative control from leading researchers worldwide This dimensional decomposition allows the reader to assess the multi faceted landscape of cooperative control Cooperative Control of Distributed Multi Agent Systems is organized into four main themes or dimensions of cooperative control distributed control and computation adversarial interactions uncertain evolution and complexity management The military application of autonomous vehicles systems or multiple unmanned vehicles is primarily targeted however much of the material is relevant to a broader range of multi agent systems including cooperative robotics distributed computing sensor networks and data network congestion control Cooperative Control of Distributed Multi Agent Systems offers the reader an organized presentation of a variety of recent research advances supporting software and experimental data on the resolution of the cooperative control problem It will appeal to senior academics researchers and graduate students as well as engineers working in the areas of cooperative systems control and optimization Distributed Cooperative Control of Multi-agent Systems Wenwu Yu,Guanghui Wen,Guanrong Chen,Jinde Cao,2016-10-18 A detailed and systematic introduction to the distributed cooperative control of multi agent systems from a theoretical network perspective Features detailed analysis and discussions on the distributed cooperative control and dynamics of multi agent systems Covers comprehensively first order second order and higher order systems swarming and flocking behaviors Provides a broad theoretical framework for understanding the fundamentals of distributed cooperative control **Cooperative Control of Multi-Agent Systems** Zhongkui Li,Zhisheng Duan,2017-03-29 Distributed controller design is generally a challenging task especially for multi agent systems with complex dynamics due to the interconnected effect of the agent dynamics the interaction graph among agents and the cooperative control laws Cooperative Control of Multi Agent Systems A Consensus Region Approach offers a systematic framework for designing distributed controllers for multi agent systems with general linear agent dynamics linear agent dynamics with uncertainties and Lipschitz nonlinear agent dynamics Beginning with an introduction to cooperative control and graph theory this monograph Explores the consensus control problem for continuous time and discrete time linear multi agent systems Studies the H and H2 consensus problems for linear multi agent systems subject to external disturbances Designs distributed adaptive consensus protocols for continuous time linear multi agent systems Considers the distributed tracking control problem for linear multi agent systems with a leader of nonzero control input Examines the distributed containment control problem for the case with multiple leaders Covers the robust cooperative control problem for multi agent systems with linear nominal agent dynamics subject to heterogeneous matching

uncertainties Discusses the global consensus problem for Lipschitz nonlinear multi agent systems Cooperative Control of Multi Agent Systems A Consensus Region Approach provides a novel approach to designing distributed cooperative protocols for multi agent systems with complex dynamics The proposed consensus region decouples the design of the feedback gain matrices of the cooperative protocols from the communication graph and serves as a measure for the robustness of the protocols to variations of the communication graph By exploiting the decoupling feature adaptive cooperative protocols are presented that can be designed and implemented in a fully distributed fashion **Distributed Cooperative Control and Communication for Multi-agent Systems** Dong Yue,Huaipin Zhang,Shengxuan Weng,2021-02-15 This book investigates distributed cooperative control and communication of MASs including linear systems nonlinear systems and multiple rigid body systems The model based and data driven control method are employed to design the optimal cooperative control protocol The approaches of this book consist of model based and data driven control such as predictive control event triggered control optimal control adaptive dynamic programming etc From this book readers can learn about distributed cooperative control methods data driven control finite time stability analysis cooperative attitude control of multiple rigid bodies Some fundamental knowledge prepared to read this book is finite time stability theory event triggered sampling mechanism adaptive dynamic programming and optimal control **Cooperative Control of Distributed Multi-Agent Systems** Jeff Shamma,2008-01-22 The paradigm of multi agent cooperative control is the challenge frontier for new control system application domains and as a research area it has experienced a considerable increase in activity in recent years This volume the result of a UCLA collaborative project with Caltech Cornell and MIT presents cutting edge results in terms of the dimensions of cooperative control from leading researchers worldwide This dimensional decomposition allows the reader to assess the multi faceted landscape of cooperative control Cooperative Control of Distributed Multi Agent Systems is organized into four main themes or dimensions of cooperative control distributed control and computation adversarial interactions uncertain evolution and complexity management The military application of autonomous vehicles systems or multiple unmanned vehicles is primarily targeted however much of the material is relevant to a broader range of multi agent systems including cooperative robotics distributed computing sensor networks and data network congestion control Cooperative Control of Distributed Multi Agent Systems offers the reader an organized presentation of a variety of recent research advances supporting software and experimental data on the resolution of the cooperative control problem It will appeal to senior academics researchers and graduate students as well as engineers working in the areas of cooperative systems control and optimization *Fixed-Time Cooperative Control of Multi-Agent Systems* Zongyu Zuo,Qing-Long Han,Boda Ning,2019-05-28 This monograph presents new theories and methods for fixed time cooperative control of multi agent systems Fundamental concepts of fixed time stability and stabilization are introduced with insightful understanding This book presents solutions for several problems of fixed time cooperative control using systematic design methods The

book compares fixed time cooperative control with asymptotic cooperative control demonstrating how the former can achieve better closed loop performance and disturbance rejection properties It also discusses the differences from finite time control and shows how fixed time cooperative control can produce the faster rate of convergence and provide an explicit estimate of the settling time independent of initial conditions This monograph presents multiple applications of fixed time control schemes including to distributed optimization of multi agent systems making it useful to students researchers and engineers alike *Cooperative Control of Multi-agent Systems* He Cai,Youfeng Su,Jie Huang,2022-05-31 The main focus of this book is a pair of cooperative control problems consensus and cooperative output regulation Its emphasis is on complex multi agent systems characterized by strong nonlinearity large uncertainty heterogeneity external disturbances and jointly connected switching communication topologies The cooperative output regulation problem is a generalization of the classical output regulation problem to multi agent systems and it offers a general framework for handling a variety of cooperative control problems such as consensus formation tracking and disturbance rejection The book strikes a balance between rigorous mathematical proof and engineering practicality Every design method is systematically presented together with illustrative examples and all the designs are validated by computer simulation The methods presented are applied to several practical problems among them the leader following consensus problem of multiple Euler Lagrange systems attitude synchronization of multiple rigid body systems and power regulation of microgrids The book gives a detailed exposition of two approaches to the design of distributed control laws for complex multi agent systems the distributed observer and distributed internal model approaches Mastering both will enhance a reader s ability to deal with a variety of complex real world problems Cooperative Control of Multi agent Systems can be used as a textbook for graduate students in engineering sciences and mathematics and can also serve as a reference book for practitioners and theorists in both industry and academia Some knowledge of the fundamentals of linear algebra calculus and linear systems are needed to gain maximum benefit from this book Advances in Industrial Control reports and encourages the transfer of technology in control engineering The rapid development of control technology has an impact on all areas of the control discipline The series offers an opportunity for researchers to present an extended exposition of new work in all aspects of industrial control **Cooperative Control of Multi-Agent Systems** Yue Wang,Eloy Garcia,David Casbeer,Fumin Zhang,2017-03-20 A comprehensive review of the state of the art in the control of multi agent systems theory and applications The superiority of multi agent systems over single agents for the control of unmanned air water and ground vehicles has been clearly demonstrated in a wide range of application areas Their large scale spatial distribution robustness high scalability and low cost enable multi agent systems to achieve tasks that could not successfully be performed by even the most sophisticated single agent systems Cooperative Control of Multi Agent Systems Theory and Applications provides a wide ranging review of the latest developments in the cooperative control of multi agent systems theory and applications The applications described are mainly in the areas of

unmanned aerial vehicles UAVs and unmanned ground vehicles UGVs Throughout the authors link basic theory to multi agent cooperative control practice illustrated within the context of highly realistic scenarios of high level missions without losing site of the mathematical background needed to provide performance guarantees under general working conditions Many of the problems and solutions considered involve combinations of both types of vehicles Topics explored include target assignment target tracking consensus stochastic game theory based framework event triggered control topology design and identification coordination under uncertainty and coverage control Establishes a bridge between fundamental cooperative control theory and specific problems of interest in a wide range of applications areas Includes example applications from the fields of space exploration radiation shielding site clearance tracking classification surveillance search and rescue and more Features detailed presentations of specific algorithms and application frameworks with relevant commercial and military applications Provides a comprehensive look at the latest developments in this rapidly evolving field while offering informed speculation on future directions for collective control systems The use of multi agent system technologies in both everyday commercial use and national defense is certain to increase tremendously in the years ahead making this book a valuable resource for researchers engineers and applied mathematicians working in systems and controls as well as advanced undergraduates and graduate students interested in those areas **Distributed Cooperative Control for Multi-agent Systems** Guoguang Wen,2012 This dissertation focuses on distributed cooperative control of multi agent systems First the leader following consensus for multi agent systems with nonlinear dynamics is investigated Three consensus algorithms are proposed and some sufficient conditions are obtained for the states of followers converging to the state of virtual leader globally exponentially Second the consensus tracking for multi agent systems with nonlinear dynamics is investigated Some consensus tracking algorithms are developed and some sufficient conditions are obtained Based on these consensus tracking algorithms and sufficient conditions it is shown that in first order multi agent systems all followers can track the virtual leader in finite time and in second order multi agent systems the consensus tracking can be achieved at least globally exponentially Third the path planning and motion control of multi agent formation is studied where a practical framework is provided In order to find a collision free and deadlock free feasible path for the whole formation an optimizing algorithm is given to optimize the path generated by A search algorithm In order to realize the cohesive motion of a persistent formation in 3 dimensional space a set of decentralized control laws is designed Finally the formation keeping problem is studied We mainly focus on the closing ranks problem which deals with the addition of links to a rigid multi agent formation that is damaged by losing one of its agents in order to recover rigidity Some graph theoretical results are obtained and some systematic self repair operations are proposed to recover the rigidity in case of agent removals **Cooperative Control of Multi-Agent Systems** Frank L. Lewis,Hongwei Zhang,Kristian Hengster-Movric,Abhijit Das,2013-12-31 Cooperative Control of Multi Agent Systems extends optimal control and adaptive control design methods to multi agent systems on

communication graphs It develops Riccati design techniques for general linear dynamics for cooperative state feedback design cooperative observer design and cooperative dynamic output feedback design Both continuous time and discrete time dynamical multi agent systems are treated Optimal cooperative control is introduced and neural adaptive design techniques for multi agent nonlinear systems with unknown dynamics which are rarely treated in literature are developed Results spanning systems with first second and on up to general high order nonlinear dynamics are presented Each control methodology proposed is developed by rigorous proofs All algorithms are justified by simulation examples The text is self contained and will serve as an excellent comprehensive source of information for researchers and graduate students working with multi agent systems *Cooperative Control of Multi-Agent Systems* Jianan Wang,Chunyan Wang,Ming Xin,Zhengtao Ding,Jiayuan Shan,2020-03-25 Cooperative Control of Multi Agent Systems An Optimal and Robust Perspective reports and encourages technology transfer in the field of cooperative control of multi agent systems The book deals with UGVs UAVs UUVs and spacecraft and more It presents an extended exposition of the authors recent work on all aspects of multi agent technology Modelling and cooperative control of multi agent systems are topics of great interest across both academia research and education and industry for real applications and end users Graduate students and researchers from a wide spectrum of specialties in electrical mechanical or aerospace engineering fields will use this book as a key resource Helps shape the reader s understanding of optimal and robust cooperative control design techniques for multi agent systems Presents new theoretical control challenges and investigates unresolved open problems Explores future research trends in multi agent systems Offers a certain amount of analytical mathematics practical numerical procedures and actual implementations of some proposed approaches **Adaptive Control for Distributed Multi-agent Coordination** Jie Luo,2013 **Cooperative Control of Multi-Agent Systems** James Cooper,2017-09-19 Cooperative Control of Multi Agent Systems provides a novel approach to designing distributed cooperative protocols for multi agent systems with complex dynamics The proposed consensus region decouples the design of the feedback gain matrices of the cooperative protocols from the communication graph and serves as a measure for the robustness of the protocols to variations of the communication graph By exploiting the decoupling feature adaptive cooperative protocols are presented that can be designed and implemented in a fully distributed fashion **Distributed Coordination of Multi-agent Networks** Wei Ren,Yongcan Cao,2010-11-30 Distributed Coordination of Multi agent Networks introduces problems models and issues such as collective periodic motion coordination collective tracking with a dynamic leader and containment control with multiple leaders and explores ideas for their solution Solving these problems extends the existing application domains of multi agent networks for example collective periodic motion coordination is appropriate for applications involving repetitive movements collective tracking guarantees tracking of a dynamic leader by multiple followers in the presence of reduced interaction and partial measurements and containment control enables maneuvering of multiple followers by multiple leaders **On**

Distributed and Cooperative Control Design for Networks of Dynamical Systems Georg Seyboth,2016-06-17 This thesis contributes to the development of a cooperative control theory for homogeneous and heterogeneous multi agent systems consisting of identical and non identical dynamical agents respectively The goal is to explain fundamental effects of non identical agent dynamics on the behavior of a distributed system and primarily to develop suitable control design methods for a wide range of multi agent coordination problems Output synchronization problems as well as cooperative disturbance rejection and reference tracking problems in multi agent systems are investigated Suitable controller design methods for networks consisting of identical or non identical linear time invariant systems linear parameter varying systems and selected classes of nonlinear systems are developed These controller design methods provide a solution to a wide variety of distributed coordination and cooperative control scenarios Holonic and Multi-Agent Systems for Manufacturing Vladimir Marik,Thomas Strasser,Alois Zoitl,2009-08-25 The research of holonic and agent based systems is developing very rapidly The community around this R D topic is also growing fast despite the fact that the real life practical implementations of such systems are still surprisingly rare H ever the managers in different branches of industry feel that the holonic and agent based systems represent the only way of managing and controlling very c plex highly distributed systems exploring vast volumes of accumulated knowledge The relevant research and development activities gain more and more visible support from both industry as well as public sectors Quite naturally the number of scientific events aimed at the subject field is also growing rapidly We see new lines of conf ences like INDIN we observe a strong focus of the already well established conferences e g INCOM or ETFA being shifted toward holonic and agent based manufacturing systems We see an increased interest of the IEEE System Man and Cybernetics Society especially its Technical Committee on Distributed Intelligent Systems which leverages the experience gathered by the members of the former Ho nic Manufacuting Systems HMS consortium We see a clear orientation of the IEEE SMC Transactions part C toward applications of agent oriented solutions The same is true of the International Journal on Autonomous Agents and Multi Agent Systems JAAMAS This is a really good sign of the increasing importance of the field **Cooperative Safety Control of Multiagent Systems** Ke Zhang,Bin Jiang,Yonghao Ma,Yuhang Xu,Yuan Lu,2026-01-10 Distributed coordination in multi agent systems has garnered significant attention from researchers across diverse fields like biology physics and engineering driven by its critical applications such as satellite attitude alignment and cooperative control of unmanned aerial vehicles However designing cooperative safety control for these systems remains challenging particularly when agents face faults and external disturbances The fully actuated system approach which has gained considerable interest for its effectiveness in simplifying control design and analysis offers a promising framework for tackling complex safety control problems This book focuses on cooperative safety control design for multi agent systems based on the fully actuated system approach It presents recent theoretical advances and applications for addressing cooperative control problems under actuator faults and external disturbances Key topics

explored include prescribed time control prescribed performance control and fault tolerant game control A central feature of the book is its proposal and utilization of the fully actuated system approach for cooperative safety control offering distinct advantages by significantly reducing the complexity of control design and stability analysis This book is primarily designed for engineers researchers and postgraduate students who aspire to deepen their understanding of cooperative control in multi agent systems Additionally it serves as a valuable reference for professionals in related fields such as multi robot systems unmanned aerial vehicle formations and control engineering Moreover the content is well suited for advanced courses or seminars focused on these subjects Cooperative Control of Multi-agent Systems Stability, Optimality and Robustness Kristian Hengster Movric,ProQuest Dissertations and Theses (Electronic resource collection),University of Texas at Arlington. College of Engineering,2013 In this work design methods are given for distributed synchronization control of multi agent systems on directed communication graphs Conditions are derived based on the relation of the graph eigenvalues to a region in a complex plane that depends on the single agent system and the solution of the local Riccati equation The synchronizing region concept is used Cooperative observer design guaranteeing convergence of the local estimates to their true values is also proposed The notion of convergence region for distributed observers is introduced A duality principle is shown to hold for distributed observers and controllers on balanced graph topologies Application of cooperative observers is made to the distributed synchronization problem Three dynamic regulator architectures are proposed for cooperative synchronization In the second part this work brings together stability and optimality theory to design distributed cooperative control protocols which guarantee consensus and are globally optimal with respect to a structured performance criterion Here an inverse optimality approach is used together with partial stability to consider cooperative consensus and synchronization algorithms A new class of digraphs is defined admitting a distributed solution to the global optimal control problem The third part of this work investigates cooperative control performance under disturbances and distributed static output feedback control Control design for the state consensus in presence of disturbances is investigated Derived results are also applicable to multi agent systems with heterogeneous agents If on the other hand one constrains the control to be of the static output feedback form one needs to redefine the synchronizing region as the output feedback synchronizing region Contributions to Discrete time Multi agent Consensus ProblemThe main contribution to the discrete time multi agent consensus problem is the proposed design method based on local Riccati feedback gains guaranteeing cooperative stability and convergence to consensus Contributions to Globally Optimal Distributed Control ProblemThe globally optimal distributed synchronization control protocols are investigated The main contribution is in merging the notions of inverse optimality and partial stability to guarantee robust stabilization to the noncompact consensus manifold Furthermore second contribution is the introduction of the class of digraphs that gives a distributed solution to a structured global optimal control problem Contributions to Cooperative Robustness of Multi agent SystemsThe robustness properties of asymptotic and exponential

stability are applied in the context of cooperative stability for consensus The results are based on Lyapunov functions for noncompact manifolds and the pertinent stability and robustness properties are further elaborated Distributed and local observers are utilized for disturbance compensation Contributions to Distributed Output feedback for State SynchronizationAn application of the cooperative stability analysis via synchronizing region to the distributed output feedback is presented It is shown that the guaranteed synchronizing region for output feedback can be both bounded and unbounded **Event-Triggered Cooperative Control: Analysis and Synthesis** Wenying Xu,Daniel W. C. Ho,Jinde Cao,2022-09-27 The book provides a systematic and in depth introduction to distributed event triggered cooperative control for multi agent systems from a theoretical perspective which will be of particular interest to the readers The included major research topics include a unified design and analysis framework for centralized clustered and distributed event triggered schemes fully distributed design for event self triggered schemes resilient event triggered control under malicious attacks and various methods to aovid Zeno behavior The comprehensive and systematic treatment of event triggered communication and control in multi agent system is one of the major features of the book which is particularly suited for readers who are interested in learning principles and methods to deal with communication constraints in multi agent systems and to design energy saving control protocols The book can benefit researchers engineers and graduate students in the fields of complex networks smart grids applied mathematics electrical and electronic engineering and computer engineering etc

Distributed Cooperative Control and Optimization for Multi-Agent Systems Qing Wang,Bin Xin,Jie Chen,2025-03-02 This book provides a concise and in depth exposition of distributed control and optimization problems of multi agent systems The book integrates various ideas and tools from dynamic systems control theory graph theory and optimization to address the special challenges posed by such complexities in the environment as communication delay topological dynamics and environmental uncertainties In order to deal with the mismatched uncertainties and time delay observer based controller and sliding mode control are developed to achieve consensus control When there is a leader or multiple leaders in the communication topologies containment control is required The book studies both state and output containment for nonlinear multi agent systems with undirected or directed networks Furthermore event triggered schemes are proposed to reduce communication and computation costs Distributed optimization for multi agent systems is an interesting topic that has attracted more and more attention due to its wide range of applications such as smart grids sensor networks and mobile manipulators In distributed optimization the goal is to optimize the global cost function which is the sum of all local cost functions each of which is known only by its own local agent Distributed nonsmooth convex optimization for multi agent systems based on proximal operators is developed to achieve distributed optimal consensus

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