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SPECIAL ISSUE ON NONLINEAR AND MULTI-AGENT SYSTEMS: MODELING, CONTROL AND OPTIMIZATION

Nonlinear and multi-agent systems have been widely used in modeling, control, and optimization of complex systems. Despite the remarkable progress made thus far, there remain many insufficiently unexplored topics that are important within the fields. It is with great enthusiasm that we present this special issue, dedicated to gathering high-quality papers on nonlinear control and distributed optimization. This special issue compiles a selection of eight papers that delve into various aspects of nonlinear control and distributed optimization. Among these papers, two papers specifically address the challenges of fixed-time and data-driven control of nonlinear systems with state constraints and unknown system information, respectively. The remaining six papers consider distributed control and optimization for multi-agent systems with complex networks and nonlinear dynamics. The key contributions of each manuscript included in this special issue are summarized as follows:

1) Fixed-time safe tracking control of uncertain high-order nonlinear pure-feedback systems via unified transformation functions by Chaoqun Guo, Jiangping Hu, Jiasheng Hao, Sergej Čelikovský and Xiaoming Hu. This paper considers fixed-time control of an uncertain nonlinear pure-feedback system with state constraints. A new nonlinear transformation function is proposed to handle both the constrained and unconstrained cases in a unified way. Then a fixed-time dynamic surface control (FDSC) technique is developed to facilitate the fixed-time control design for the pure-feedback system together with a radial basis function neural network. Finally, an adaptive fixed-time control strategy is proposed to guarantee safe tracking with the actual possible constraints, either present or missing.

2) Event-triggered optimal control of completely unknown nonlinear systems via identifier-critic learning by Zhinan Peng, Zhiquan Zhang, Rui Luo, Yiqun Kuang, Jiangping Hu, Hong Cheng and Bijoy Kumar Ghosh. Unlike classical adaptive dynamic programming (ADP) methods with actor-critic neural networks (NNs), this paper proposes a filter-regression-based approach to reconstruct the unknown system dynamics. Adaptive laws are designed for the identifier-critic NN by using only the measured system state and input data. Furthermore, in order to reduce state sampling frequency, static and dynamic event triggers are embedded into the proposed optimal control design.

3) A penalty ADMM with quantized communication for distributed optimization over

multi-agent systems by Chenyang Liu, Xiaohua Dou, Yuan Fan, and Songsong Cheng. This paper considers a distributed convex optimization problem by assuming that the agents obeyed a quantized communication mechanism. To this end, a quantized penalty ADMM algorithm is designed to obtain the suboptimal solution. At the same time, the O(1/k) convergence rate for is analyzed for general convex objective functions, and an R-linear rate is also analyzed for strongly convex objective functions.

4) Distributed accelerated Nash equilibrium learning for two-subnetwork zero-sum game with bilinear coupling by Xianlin Zeng, Lihua Dou and Jinqiang Cui. First-order methods are frequently used in distributed/parallel algorithms for solving large-scale and big-data problems due to their simple structures. In contrast to existing time-invariant first-order methods, this paper designs a distributed accelerated algorithm by combining saddle-point dynamics and time-varying derivative feedback techniques. If the parameters of the proposed algorithm are suitable, the algorithm owns $O(\frac{1}{t^2})$ convergence in terms of the duality gap function without any uniform or strong convexity requirement.

5) Generalized synchronization in the networks with directed acyclic structure by Sergej Čelikovský, Volodymyr Lynnyk, Anna Lynnyk and Branislav Rehák. Generalized synchronization is considered in the direct acyclic networks. Nodes of the network consist of copies of the so-called generalized Lorenz system with possibly different parameters, yet mutually structurally equivalent. As the class of generalized Lorenz systems includes the well-known particular classes such as (classical) Lorenz system, all these classes can be synchronized using the presented approach.

6) Consensus of multi-agent systems and stabilization of large-scale systems with time delays and nonlinearities - a comparison of both problems by Branislav Rehák, Volodymyr Lynnyk. Although stabilization of large-scale systems and consensus problem of multi-agent systems show similar features, one can also observe important differences. A comparison of both problems is presented in this paper. This paper finds that when the time delays are heterogeneous, full synchronization of the multi-agent systems cannot be achieved; however, stabilization of the large-scale network is reachable. In the case of nonlinear systems, the stabilization of a large-scale nonlinear system is possible under more restrictive assumptions compared to the synchronization of a nonlinear multi-agent system.

7) Fully distributed consensus for high-order strict-feedback nonlinear multiagent systems with switched topologies by Yifei Wu, Sunyu Zheng, Rui Xu, Ronghao Wang and Zhengrong Xiang. This paper studies a distributed consensus problem of high-order strict-feedback nonlinear multiagent systems. By employing the adaptive backstepping technique and switched system theory, a novel fully distributed protocol is proposed for MASs with switched topologies. Based on the Lyapunov function method, this paper analyzes the consensus of multiagent systems without restricting the dwell time of the switched signal under the proposed adaptive protocol.

8) Generalized synchronization-based partial topology identification of complex networks by Xueqin Zhang, Yunru Zhu, Yuanshi Zheng. Partial topology identification of complex networks is investigated in this paper. The authors construct the response networks consisting of nodes with simpler dynamics than that in the drive networks. Sufficient conditions are derived to guarantee partial topology identification by designing

suitable controllers and parameters update laws.

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editors of the special issue

Jiangping Hu, School of Automation Engineering, University of Electronic Science and Technology of China, Chengdu 611731, Sichuan, P. R. China; Yangtze Delta Region Institute (Huzhou), University of Electronic Science and Technology of China, Huzhou 313001. P. R. China.
e-mail: hujp@uestc.edu.cn

Bijoy Kumar Ghosh, Department of Mathematics and Statistics, Texas Tech University, Lubbock, TX, 79409-1042, USA; School of Automation Engineering, University of Electronic Science and Technology of China, Chengdu 611731. P. R. China.
e-mail: bijoy.ghosh@ttu.edu

Xiaoming Hu, Optimization and Systems Theory, Royal Institute of Technology, SE-100 44 Stockholm, Sweden.
e-mail: hu@math.kth.se

Volodymyr Lynnyk, The Czech Academy of Sciences, Institute of Information Theory and Automation, Pod Vodárenskou věží 4, 182 08 Praha 8. Czech Republic.
e-mail: volodymyr@utia.cas.cz

Štěpán Papáček, The Czech Academy of Sciences, Institute of Information Theory and Automation, Pod Vodárenskou věží 4, 182 08 Praha 8. Czech Republic.
e-mail: papacek@utia.cas.cz

Branislav Rehák, The Czech Academy of Sciences, Institute of Information Theory and Automation, Pod Vodárenskou věží 4, 182 08 Praha 8. Czech Republic.
e-mail: rehakb@utia.cas.cz