上海交通大学自动化系
Department of Automation
Shanghai Jiao Tong University

系统控制与信息处理教育部重点实验室
Key Laboratory of System Control and Information Processing Ministry of Education

Frank L. Lewis 客座教授聘任仪式暨系列学术报告会

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学术报告一：Cooperative Control Synchronization: Optimal Design and Games on Comunication Graphs

报告时间：5 月 18 日（周四） 10：00-11：30
报告地点：电信学院 2-410

学术报告二：Cooperative Control for Multi-Agent Systems in AC Microgrid Distributed Generation

报告时间：5 月 19 日（周五） 10：00-11：30
报告地点：电信学院 2-410

Biosketch F.L. Lewis: Member, National Academy of Inventors. Fellow IEEE, Fellow IFAC, Fellow AAAS, Fellow U.K. Institute of Measurement & Control, PE Texas, U.K. Chartered Engineer. UTA Distinguished Scholar Professor, UTA Distinguished Teaching Professor, and Moncrief-O'Donnell Chair at The University of Texas at Arlington Research Institute. Qian Ren Thousand Talents Consulting Professor, Northeastern University, Shenyang, China. Foreign Expert Scholar, Huazhong University of Science and Technology. IEEE Control Systems Society *Distinguished Lecturer*. Bachelor's Degree in Physics/EE and MSEE at Rice University, MS in Aeronautical Engineering at Univ. W. Florida, Ph.D. at Ga. Tech. He works in feedback control, reinforcement learning, intelligent systems, and distributed control systems. He is author of 7 U.S. patents, 340 journal papers, 414 conference papers, 20 books, 48 chapters, and 12 journal special issues. He received the Fulbright Research Award, NSF Research Initiation Grant, ASEE *Terman Award*, Int. Neural Network Soc. *Gabor Award* 2009, U.K. Inst. Measurement & Control *Honeywell Field Engineering Medal* 2009. Received IEEE Computational Intelligence Society *Neural Networks Pioneer Award* 2012 and AIAA *Intelligent Systems Award* 2016. Distinguished Foreign Scholar at Nanjing Univ. Science & Technology. Project 111 Professor at Northeastern University, China. Distinguished Foreign Scholar at Chongqing Univ. China. Received Outstanding Service Award from Dallas IEEE Section, selected as Engineer of the Year by Ft. Worth IEEE Section. Listed in Ft. Worth Business Press Top 200 Leaders in Manufacturing. Received the 2010 IEEE Region 5 Outstanding Engineering Educator Award and the 2010 UTA Graduate Dean's Excellence in Doctoral Mentoring Award. Elected to UTA Academy of Distinguished Teachers 2012. Texas Regents Outstanding Teaching Award 2013. He served on the NAE Committee on Space Station in 1995.

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学术报告一

Cooperative Control Synchronization: Optimal Design and Games on Comunication Graphs

Abstract:

Distributed systems of agents linked by communication networks only have access to information from their neighboring agents, yet must achieve global agreement on team activities to be performed cooperatively. Examples include networked manufacturing systems, wireless sensor networks, networked feedback control systems, and the internet. Sociobiological groups such as flocks, swarms, and herds have built-in mechanisms for cooperative control wherein each individual is influenced only by its nearest neighbors, yet the group achieves consensus behaviors such as heading alignment, leader following, exploration of the environment, and evasion of predators. It was shown by Charles Darwin that local interactions between population groups over long time scales lead to global results such as the evolution of species.

In this talk we present design methods for cooperative controllers for distributed systems. The developments are for general directed graph communication structures, for both continuous-time and discrete-time agent dynamics. Cooperative control design is complicated by the fact that the graph topology properties limit what can be achieved by the local controller design. Thus, local controller designs may work properly on some communication graph topologies yet fail on other topologies. Our objective is to provide local agent feedback design methods that are independent of the graph topology and so function on a wide range of graph structures.

An optimal design method for local feedback controllers is given that decouples the control design from the graph structural properties. In the case of continuous-time systems, the optimal design method guarantees synchronization on any graph with suitable connectedness properties. In the case of discrete-time systems, a condition for synchronization is that the Mahler measure of unstable eigenvalues of the local systems be restricted by the condition number of the graph. Thus, graphs with better topologies can tolerate a higher degree of inherent instability in the individual node dynamics. A theory of duality between controllers and observers on communication graphs is given, including methods for cooperative output feedback control based on cooperative regulator designs.

In Part 2 of the talk, we discuss graphical games. Standard differential multi-agent game theory has a centralized dynamics affected by the control policies of multiple agent players. We give a new formulation for games on communication graphs. Standard definitions of Nash equilibrium are not useful for graphical games since, though in Nash equilibrium, all agents may not achieve synchronization. A strengthened definition of Interactive Nash equilibrium is given that guarantees that all agents are participants in the same game, and that all agents achieve synchronization while optimizing their own value functions.

学术报告二

Cooperative Control for Multi-Agent Systems in AC Microgrid Distributed Generation

Abstract:

With aging power distribution systems and new opportunities for renewable energy generation, the smart grid and microgrid are becoming increasingly important. Microgrid allows the addition of local loads and local distributed generation (DG) including wind power, solar, hydroelectric, fuel cells, and micro-turbines. Microgrid holds out the hope of scalable growth in power distribution systems by distributed coordination of local loads and local DG so as not to overload existing power grid generation and transmission capabilities. Sample microgrids are smart buildings, isolated rural systems, and offshore drilling systems. Microgrid takes power from the main power grid when needed, and is able to provide power back to the main power system when there is local generation excess.

When connected to the main distribution grid, microgrid receives a frequency reference from grid synchronous generators. Standard operating procedures call for disconnecting microgrid from the main power grid when disturbances occur. On disconnection, or in islanded mode, the absence of rotating synchronous generation leads to a loss of frequency references. After islanding, it is necessary to return Microgrid DG frequencies to synchronization, provide voltage support, and ensure power quality.

In this talk we develop a new method of synchronization for cooperative systems linked by a communication graph topology that is based on a novel distributed feedback linearization technique. This cooperative feedback linearization approach allows for different dynamics of agents such as occur in the DGs of a microgrid. It is shown the new cooperative protocol design method allows for frequency synchronization, voltage synchronization, and distributed power balancing in a microgrid after a grid disconnection islanding event. The distributed nature of the cooperative feedback linearization method is shown to lead to sparse communication topologies that are more suited to microgrid control, more reliable, and more economical than standard centralized secondary power control methods.