A Dynamic Network Perspective on Resilient Control

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Abstract:

Many important systems can be modeled as a collection of integrating agents that exchange material, energy, or information with each other according to some protocol and interconnection topology. When that exchange is governed by differential equations we refer to such a system as a dynamic network. Of particular interest is the situation that arises when there is a tight integration of physical system dynamics, sensors and actuators, and computing infrastructure, resulting in what has come to be called a cyberphysical system. Such systems can be viewed as a dynamic network not only at the level of the physical process but also at the level of the sensing, communication, and control system, giving rise to the interpretation of complex systems as being networks controlled by networks. In this talk we consider how this interpretation can be applied to the analysis and design of system resilience – the ability for a system to return to normal operation as soon as possible after a disruption. Our approach is to model the resilient control problem as the problem of disturbance or noise attenuation in consensus networks. To motivate our approach we first note that a number of physically-relevant systems exist (e.g., the power grid) that can be modeled as a dynamic network. For such processes, we show how controller networks can be designed to reject two kinds of disturbances or attacks: sudden, time-limited disruptions and continuous-time disruptions. We also discuss how network topology can impact the ability to reject disturbances. We conclude by considering the extension of these ideas to more general problems related to sustainability.
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Bio:

Kevin L. Moore is the Dean of the College of Engineering and Computational Sciences at the Colorado School of Mines. He received the B.S. and M.S. degrees in electrical engineering from Louisiana State University and the University of Southern California, respectively. He received the Ph.D. in electrical engineering, with an emphasis in control theory, from Texas A&M University in 1989. He has been an Assistant and Associate Professor at Idaho State University (1989-1998); an Associate and Full Professor of Electrical and Computer Engineering at Utah State University, where he was the Director of the Center for Self-Organizing and Intelligent Systems, directing multi-disciplinary research teams of students and professionals developing a variety of autonomous robots for government and commercial applications (1998-2004); a senior scientist at Johns Hopkins University's Applied Physics Laboratory during a one-year research stay, where he worked in the area of unattended air vehicles, cooperative control, and autonomous systems (2004-2005); and a Full Professor of Engineering at the Colorado School of Mines (2005-present), where he was Director of the Center for Robotics, Automation, and Distributed Intelligence and the G.A. Dobelman Distinguished Professor (2005-2011). He also worked in industry for three years pre-Ph.D as a member of the technical staff at Hughes Aircraft Company. His research interests include iterative learning control, autonomous systems and robotics, and applications of control to industrial and mechatronic systems, including the cooperative control of networked systems. He is the author of the research monograph Iterative Learning Control for Deterministic Systems, co-author of the book Sensing, Modeling, and Control of Gas Metal Arc Welding, and co-author of the research monograph Iterative Learning Control: Robustness and Monotonic Convergence for Interval Systems. He is a licensed professional engineer, involved in several professional societies and editorial activities, and is interested in engineering education pedagogy, particularly capstone senior design. He is an ABET Program Evaluator, a senior member of IEEE, a member of the IEEE Control System Society Technical Committee on Intelligent Control, and has served on several editorial boards.