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
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Sliding Mode Techniques for Complex Systems

Prof. Sarah Spurgeon OBE
University of Kent, UK

Abstract:

In the real world, there are a number of systems such as power networks, ecological systems, biological systems and energy systems which can be modelled as dynamical equations composed of interconnections between a collection of lower-dimensional subsystems. Such classes of systems are called large-scale interconnected systems and they are often widely distributed in space. A fundamental property of an interconnected system is that a perturbation of one subsystem can affect the other subsystems as well as the overall performance of the entire network. The purpose of control and monitoring paradigms from the domain of engineering within a large scale interconnected systems architecture is thus to minimise the effect of any perturbation or uncertainty on the overall system behaviour. For interconnected systems, the presupposition of centrality may fail to hold due to either the lack of centralised information or the lack of centralised computing capability. When the number of subsystems is large, the computation time also increases significantly if centralised control is employed. In the extreme case when information transfer among the subsystems is blocked, centralised control schemes simply cannot be applied. Even with engineered systems, issues such as the economic cost and reliability of communication links, particularly when systems are characterised by geographical separation, may limit the appetite to develop centralised systems. From the perspective of economics and reliability, decentralised strategies are pertinent for large scale interconnected systems. Sliding mode control is a practically realisable nonlinear control strategy which yields robust performance in the presence of uncertainty. Interesting properties result from allowing the control signal to switch; for example, total invariance of the system response to a substantial class of parameter variations and external disturbance signals is possible. Dynamic performance requirements are met by prescribing a dynamic system which exhibits the ideal performance required from the plant. An appropriate discontinuous control signal is then selected to ensure the trajectories of the system of interest find this ideal dynamic attractive. This lecture will first provide a brief introduction to the basic properties of sliding modes and then explore how the properties of sliding mode observers and controllers can be applied to complex systems, with a particular emphasis on decentralised interconnected systems paradigms.

Biography:

Sarah Spurgeon OBE, FREng, FInstMC, FIET, FIMA is Professor of Control Engineering at the University of Kent and President of the Institute of Measurement and Control in the UK. Sarah Spurgeon's research interests are in the area of systems modelling and analysis, robust control and estimation in which areas she has published over 270 refereed research papers. She was awarded the Honeywell International Medal for 'distinguished contribution as a control and measurement technologist to developing the theory of control' in 2010 and an IEEE Millenium Medal in 2000. She is currently a member of the Council of the International Federation of Automatic Control (IFAC) and a member of the General Assembly of the European Control Association. Within the UK she is an independent member of the Defence Scientific Advisory Council (DSAC) which provides independent advice to the Secretary of State for Defence on science, technology, engineering, analysis and mathematics matters and is also a Board Member of EngineeringUK.