

Quantum Cybernetics: Control and Communication in the Quantum Domain

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Time: 10:30am, Wed., Oct. 26, 2016

Place: ECEC 202, NJIT

In this talk, I will first provide a brief introduction to quantum cybernetics. Then I will focus on our recent results on quantum state estimation, quantum Hamiltonian identification, fault-tolerant quantum filtering and quantum robust control with my collaborators. An efficient method of linear regression estimation (LRE) is presented for quantum state estimation. Based on LRE, we present a recursively adaptive quantum state estimation protocol and experimentally implement the adaptive estimation protocol on two-qubit systems. The computational capability of full quantum state estimation is pushed forward to reconstruct a 14-qubit state with a run time of only 3.35 hours using the LRE algorithm. Also, we present a two-step optimization quantum Hamiltonian identification algorithm, characterize its computational complexity and establish an error upper bound. We analyse how to determine the fault tolerant quantum filter and fault detection equation for a class of open quantum systems coupled to a laser field that is subject to stochastic faults. Lastly, we present several results on sampling-based learning control (SLC) of quantum ensembles, sliding mode control of quantum systems, and consensus and synchronization of quantum networks.

Bio-sketch: Daoyi Dong received a B.E. degree in automatic control and a Ph.D. degree in engineering from the University of Science and Technology of China, Hefei, China, in 2001 and 2006, respectively. Currently, he is a Senior Lecturer at the University of New South Wales, Canberra, Australia, and a visiting scholar at Princeton University, USA. He was with the Institute of Systems Science, Chinese Academy of Sciences and with the Institute of Cyber-Systems and Control, Zhejiang University. He had visiting positions at RIKEN, Wako-Shi, Japan and The University of Hong Kong, Hong Kong. His research interests include quantum control, multiagent systems and intelligent control. Dr. Dong is a recipient of an International Collaboration Award and an Australian Post-Doctoral Fellowship from the Australian Research Council. He is also a co-recipient of Guan Zhao-Zhi Award at The 34th Chinese Control Conference and the Best Theory Paper Award at The 11th World Congress on Intelligent Control and Automation (WCICA). He serves as an Associate Editor of IEEE Transactions on Neural Networks and Learning Systems.