
Electrical & Computer Engineering
S E M I N A R
Louisiana State University

**Interdependency of Control and Communications
in Cyber Physical Systems: An Entropy Framework**

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Abstract—In order to understand how to operate the physical dynamics of cyber physical systems (CPSs), we study the control of entropy (or equivalently uncertainty) via communications in CPSs. We consider the controller as the Maxwell’s demon that decimates the system entropy. Due to the second law of thermodynamics, the system entropy cannot be spontaneously decreased. Therefore, to reduce the system entropy, the controller needs external information communicated from sensors. The following aspects of the proposed framework will be introduced: (a) For a finite state physical system in CPS, we derive upper and lower bounds for the communication requirements. The optimal designs of message mechanism and control policy are proposed. (b) For networked physical dynamics nodes (such as generators in a power grid), the entropy propagation is described using ordinary differential equations, in which the communication requirement due to quantization error is taken into account. (c) Networked CPS is condensed to the continuous space and the corresponding entropy evolution is described using partial differential equations (PDEs), for two special types of CPS dynamics. Solutions are obtained for the PDEs to characterize the propagation, decimation and generation of entropy in the field.

Bio—Husheng Li received the BS and MS degrees in electronic engineering from Tsinghua University, Beijing, China, in 1998 and 2000, respectively, and the Ph.D. degree in electrical engineering from Princeton University, Princeton, NJ, in 2005. From 2005 to 2007, he worked as a senior engineer at Qualcomm Inc., San Diego, CA. In 2007, he joined the EECS department of the University of Tennessee, Knoxville, TN, as an assistant professor. He is promoted to associate professor in 2013. His research is mainly focused on statistical signal processing, wireless communications, networking, smart grid and game theory. Dr. Li is the recipient of the Best Paper Awards of EURASIP Journal of Wireless Communications and Networks, 2005, EURASIP Journal of Advances in Signal Processing, 2015, IEEE ICC, 2011 and IEEE SmartGridComm 2012, and the Best Demo Award of IEEE Globecom, 2010.

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