**Understanding Robustness of Battery Supported Cyber-Physical Systems**

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**Abstract:**

We introduce methods to analyze the robustness of battery supported cyber physical systems under co-designed control, scheduling, and battery management algorithms. Robustness refers to the ability to maintain system performance under perturbations. Robustness in controller design has been well defined and understood for a large class of feedback control systems, yet robustness of scheduling and battery management algorithms is relatively less understood. We introduce a novel concept of dynamic schedulability so that robustness of scheduling algorithms is measured through the minimum strength of the perturbations that break the dynamic schedulability. It can be shown that the theoretical model developed for this purpose is able to avoid problems caused by jitters produced by popular simulation methods. Meanwhile, robustness of battery management algorithms is measured by the capability to endure or reject potentially damaging discharge. Utilizing a dynamic nonlinear battery model, we are able to predict the status of the battery under any possible discharge pattern determined by the controller and the scheduling algorithms. This procedure allows any battery management algorithm to make proper decisions when large discharge is expected. The interplay between control, scheduling and battery management algorithms will be demonstrated, which suggests promising future directions for theoretical foundations of CPS.

**Short Bio:**

Dr. Fumin Zhang received the B.S. and M.S. degrees from Tsinghua University, Beijing, China, in1995 and 1998, respectively, and the Ph.D. degree from the Department of Electrical and Computer Engineering, University of Maryland, College Park, in 2004. He has been an Assistant Professor in the School of ECE, Georgia Institute of Technology (Georgia Tech), Atlanta, since 2006. He was a Lecturer and Postdoctoral Research Associate in the Mechanical and Aerospace Engineering Department, Princeton University, Princeton, NJ, from 2004 to 2006. He worked for the Institute for Systems Research, University of Maryland. He founded the research and teaching program in the fields of robotics and control at Georgia Tech Savannah Campus. His major research focus includes design and control of underwater robots and mobile sensor networks, battery modeling and control, and theoretical foundations for cyber-physical systems. He received the NSF CAREER award in September 2009, and the ONR YIP Award in April, 2010.