Electrical Engineering and Computer Science Technical Seminar Series

Friday, November 8, 2019
12:00 PM in COB 263

Modeling and Optimization for Irrigation Control Using Internet of Things

Prof. Alberto Cerpa

Abstract

Lawns, also known as turf, cover an estimated 128,000 square kilometers in North America and consume approximately 7 billion gallons of fresh water each day. Despite recent developments in irrigation control and sprinkler technology, state-of-the-art irrigation systems are unable to consider localized water requirements across the irrigation system and deliver localized control, preventing efficient irrigation. Inspired by preliminary results in simulation, we introduce the wireless sensor/actuator irrigation node, allowing us to retrieve soil moisture data at a high granularity across the irrigated space for control decisions and system monitoring, as well as actuate each sprinkler independently allowing us to tailor irrigation efficiently in response to spatially heterogeneous water requirements, something no other system is capable of. We then introduce modeling techniques that allow us to predict future water movement through the space caused by runoff, leaching, and other effects, as well as predict future weather conditions that will affect the moisture in the system. These models are then used to find optimal scheduling for the distributed valves, minimizing system water consumption subject to the quality of service constraints to maintain high plant health. Finally, we show through extensive deployment side by side with state-of-the-art control strategies that our proposed systems are capable of providing significant water savings while providing a higher quality of service to the turf compared to the baselines. Furthermore, we find that through clever system design we can achieve a robust wireless system that will run perpetually, virtually eliminating manual system configuration requirements, allowing us to bridge the technology gap to the end-user to vastly improve system adoptability. In this way, we demonstrate the feasibility of wireless sensor use in turf irrigation systems.

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Biography

Alberto Cerpa is an Associate Professor and was one of the three founding faculties of the Electrical Engineering and Computer Science program in the School of Engineering at UC Merced when he joined in 2005. He received a Ph.D. degree in Computer Science from UCLA (2005), working under the supervision of Deborah Estrin. He also received an M.Sc. in Computer Science from USC (2000) under the guidance of Deborah Estrin, and an M.Sc. in Electrical Engineering from USC (1998) under the guidance of Victor O. K. Li. Alberto received his undergraduate degree (Engineer) in Electrical Engineering from Buenos Aires Institute of Technology, in Buenos Aires, Argentina (1995), working under the supervision of Osvaldo Micheloud. While in graduate school, he worked as a protocol design consultant (together with Jeremy Elson) for Akamai and NetApp (Peter Danzig), as well as Sun Research Labs (Charles Perkins) and Xerox (Cheryl Bhence). Back in Buenos Aires, he worked for Startel S.A., the company that deployed the first Internet nodes in Argentina (1995-1996), and the telecommunication company Alcatel-France (1994-1995). His interests lie broadly in the computer networking and distributed systems areas, with a recent focus in systems research in wireless sensor networks, internet of things and cyber-physical systems. Alberto is a recipient of the NSF CAREER Award (2013). Several of his papers are some of the top-cited papers in top journals, including ACM TMC (2nd out of 1535), ACM SIGCOMM CCR (32 out of 2472), and JPDC (59 out of 2867). He is a member of the ACM and IEEE.