Holcombe Department of Electrical and Computer Engineering
Seminar Series

Indoor Locating by Passive Backscattering

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Abstract

Among all of the advances in electronic and information technology in the past one-hundred years, radio-frequency (RF) technology for indoor precision real-time locating system (RTLS) still remains inaccessible for most applications, including 3D human-machine interface (HMI), biomedical monitoring, prosthetic feedback control and indoor navigation. In addition, Internet of Things (IoT) will be heavily constrained if the physical location of the “thing” remains unknown or inaccurately known. Many local area network (LAN) and body area network (BAN) breakthroughs can be enabled if an indoor radar-like technology can be broadly deployed. The detection and ranging principle of indoor RTLS is similar to outdoor radar, but has many unresolved challenges such as unsppecific reflection, path obstruction, and multi-path interference.

The continuous wave (CW) phase-based ranging method for high short-range precision is simple and flexible, but vulnerable to phase offsets and interferences. I will present passive broadband harmonic nonlinear-transmission-line (NLTL) tags to fundamentally rectify previous CW problems. Because phase information is now contained within the second harmonic (SH) rather than the fundamental frequency, interferences and phase errors caused by direct reflections of the interrogating signal are greatly reduced. The tag is now the only radiation source in SH within the indoor ambient, which enables many radar techniques like channel coherence, beamforming and synthetic aperture to improve precision, evaluate measurement quality and reduce spectral cost. Multiple but sparse frequencies are employed to resolve the integer ambiguity and to achieve millimeter-level precision under phase error tolerance towards total of 180°. Human movement causes distinctive magnitude and phase channel fading, and can be equalized for better tag reading or can be exploited for tagless tracking. Furthermore, digital or dumb-antenna beamforming can be used for SNR amplification and multi-path evaluation, while tag movement can be exploited for channel fading and synthetic aperture. I will show realistic indoor experiments to validate our models and algorithms.

Biography of Speaker

Edwin Chihchuan Kan received the B.S. degree from National Taiwan University, Taipei, Taiwan, in 1984, and the M.S. and Ph.D. degrees from the University of Illinois, Urbana, in 1988 and 1992, respectively, all in electrical engineering. In January 1992, he joined Dawn Technologies as a Principal CAD Engineer developing advanced electronic and optical device simulators and technology CAD framework. He was then with Stanford University, as a Research Associate from 1994 to 1997. From 1997, he was an Assistant Professor with the School of Electrical and Computer Engineering, Cornell University, Ithaca, NY, where he is now a Professor. He has spent the summers of 2000 and 2001 at IBM Microelectronics, Yorktown Heights and Fishkill, NY, in the Faculty Partner Program. In 2004 and 2005, he has been a visiting researcher at Intel Research, Santa Clara, CA, and a visiting professor at Stanford University during his sabbatical leave. His main research areas include CMOS technologies, semiconductor device physics, flash memory, CMOS biosensors, ultra-low power radio link, and numerical methods for PDE and ODE.

Dr. Kan received the Presidential Early Career Award for Scientists and Engineer (PECASE) in October 2000 from the White House. He also received several teaching awards from Cornell Engineering College for his CMOS and MEMS courses.