University of Southern California

DANIEL J. EPSTEIN DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING

EPSTEIN INSTITUTE SEMINAR • ISE 651 SEMINAR

Prediction of Complex Systems Evolution Using Wireless Multi-Sensor Platforms: An Application to Sleep Apnea Mitigation

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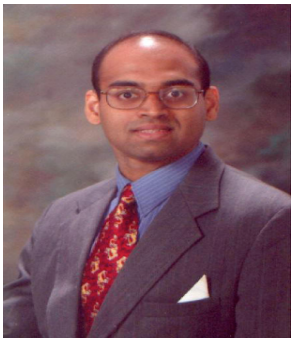
ABSTRACT

Recent advances in wireless communications and sensing technologies are transforming quality and integrity assurance in real-world complex systems—such as ultraprecision manufacturing and human cardiorespiratory processes—from a reactive detect-diagnose, to a proactive predict-prognose paradigm. Since much of the complexity in these real-world processes emerges from the underlying nonlinear nonstationary dynamics, approaches based on capturing this complexity from sensor signals are essential for their effective prediction and prognosis. Development of such approaches has been identified recently to be one of the ten modern scientific challenges.

This talk introduces a nonparametric Dirichlet process-Gaussian Mixture (DPGM) modeling approach to predict the evolution of process states based on tracking the local nonlinear dynamic topological characteristics underlying the measured signals. The approach is applied for real-time monitoring of a common cardiorespiratory disorder known as obstructive sleep apnea (OSA), which is found in 24% of adult males and 9% of adult females, and is considered a major risk factor for stroke and acute cardiorespiratory disorders. The current treatment methods, such as continuous positive airway pressure (CPAP) are not suitable to a majority of OSA patients. We developed a wearable wireless multisensory platform to continuously and noninvasively acquire physiological signals, and predict the nonlinear and nonstationary evolution of the coupled cardiorespiratory dynamics from the measured signal features using the DPGM model. Extensive tests employing recordings from the Physionet database and the wearable multisensory unit suggest that the present approach can predict an OSA episode 1 min ahead with an accuracy of 83%, and 3 min ahead with 77% accuracy. Such early detection can be used to adaptively adjust CPAP device airflow or the torso posture to avert major OSA episodes.

TUESDAY, FEBRUARY 19, 2013
VON KLEINSMID CENTER (VKC) ROOM 100
3:45 – 5:00 PM

SPEAKER BIO



Satish T. S. Bukkapatnam serves as an AT&T Professor of Engineering at Oklahoma State University (OSU). His research addresses the harnessing of high-resolution nonlinear dynamic information, especially from wireless MEMS sensors, to improve the monitoring and prognostics of ultraprecision and nanomanufacturing processes and machines, cardiorespiratory processes, and other complex infrastructure and lifeline systems. His research has led to 122 peer-reviewed publications (70 published/ accepted in journals and 52 in conference proceedings), 5 pending patents, $4.5 million in grants as PI/Co-PI from NSF, DoD and the private sector, and ten best-paper/poster recognitions. He was a recipient of OSU Regents distinguished research award (2011), Halliburton outstanding college of engineering faculty awards (2011 and 2012), IIE Eldin outstanding young industrial engineer award (2012) and SME Dougherty outstanding young manufacturing engineer (2005) award. He received his MS and PhD degrees from the Pennsylvania State University.