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UNIVERSITY OF CAMBRIDGE

Department of Engineering

Dr Ashwin Seshia – University of Cambridge

Vibration energy harvesting for low-power autonomous sensing

Abstract

Wireless sensors are increasingly being employed for distributed structural health monitoring of civil infrastructure and other engineered systems. The dominant primary energy source for present-day sensor deployments are batteries. Current battery technologies limit operational lifetimes for the monitoring systems being installed and the costs of battery replacement can be very high, especially for sensors in remote, inaccessible or embedded locations. Furthermore, there is a growing requirement for sensor systems installed under operational conditions where batteries are unfeasible, for example in harsh environment conditions.

This talk will describe results from our ongoing research on technologies underpinning autonomous sensing for structural health monitoring, and specifically present research results in the areas of vibration energy harvesting and battery-free Microelectromechanical systems (MEMS) sensors. As opposed to many other sources of energy harvesting, vibration energy harvesting presents unique challenges due to the environment dependent, time-varying or broadband nature of ambient vibration present in real-world monitoring scenarios. This talk will discuss the role of engineered non-linearity in vibration energy harvesting to address improved responsivity to multi-frequency and broadband excitation.

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Abstract (cont.)

Results from the development and initial deployment of a macro-scale parametrically excited vibration energy harvester powered wireless mote on the Forth Road Bridge will be presented. Extensions to the MEMS domain will be discussed where up to 28 orders of parametric resonance have been observed allowing for wideband power harvesting and improved output power characteristics relative to the more conventional (linear) resonant approaches. The power generated from existing MEMS-scale harvesters are sufficient to sustain low-power MEMS sensors that dissipate under 3 micro-Watts in continuous operation. These devices form the basis of autonomous sensor systems that are being developed for a variety of structural health monitoring scenarios in aerospace, automotive and built infrastructure.

Biography

Ashwin A. Seshia received his BTech in Engineering Physics in 1996 from IIT Bombay, MS and PhD degrees in Electrical Engineering and Computer Sciences from the University of California, Berkeley in 1999 and 2002 respectively, and the MA from the University of Cambridge in 2008. During his time at the University of California, Berkeley, he was affiliated with the Berkeley Sensor & Actuator Center. He joined the faculty of the Engineering Department at the University of Cambridge in October 2002 where he is presently a Reader in Microsystems Technology and a Fellow of Queens' College. Dr Seshia serves on the editorial boards of the IEEE/ASME Journal of MicroElectroMechanical Systems and the IEEE Transaction of Ultrasonics, Ferroelectrics and Frequency Control.