Algorithmic Approaches to Atomic Force Microscopy

Dr. Sean B. Andersson
Boston University - Associate Professor
Department of Mechanical Engineering

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**Abstract:** Atomic force microscopy is a useful and versatile technique for studying structure and, increasingly, dynamics in systems with nanometer-scale features. Efforts over the past decade or so have yielded research instruments with imaging rates on the order of 10 frames per second. While impressive, there are applications for which these speeds are not fast enough. Further, most currently available commercial instruments, as well as the installed base of machines, are far slower than these cutting-edge research devices. In this talk we describe three different approaches to improving the imaging rate of existing machines by an order of magnitude or more. These techniques are algorithmic in nature and achieve the increase in speed through novel sensing approaches. Inspired by ideas in robotics and control, they can be implemented on existing machines with little to no hardware modification. In the first, feedback and path planning are used to ensure measurements are localized to the sample of interest, improving imaging rate by trading off imaging area for time. In the second, estimation is used to allow imaging well beyond the typical bandwidth of the instrument, trading off well-controlled tip-sample interactions for speed. The third applies concepts from compressive sensing and is similar to the first in that gains in imaging rate arise from reduced sampling but now without the restriction of limited imaging area. Experimental and simulation results will be presented.

**Bio:** Sean Andersson received his B.S. in Engineering and Applied Physics from Cornell University (1994), his M.S. in Mechanical Engineering from Stanford University (1995), and his Ph.D. in Electrical and Computer Engineering from the University of Maryland, College Park (2003). He has worked as a Project Engineer for AlliedSignal Aerospace (1995), a Senior Controls Engineer for Aerovironment (1996-1998), and as a Lecturer in Applied Mathematics at Harvard University (2003-2005). He is currently an Associate Professor of Mechanical Engineering and of Systems Engineering at Boston University. His research interests include systems and control theory with applications in scanning probe microscopy, dynamics in molecular systems, robotics, and multi-agent systems. He received the NSF CAREER award in 2009.