

**The George W. Woodruff School of Mechanical Engineering
Georgia Institute of Technology**

Mechanical Engineering Seminar

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The Woodruff School of Mechanical Engineering

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ABSTRACT

Advanced Micro-Mechanical Systems for Audio, Ultrasound, and Nanoscale Science and Technology

Microscale mechanical systems can be key enablers for significant scientific and technological advances when used with proper insight into the field of application. In this talk, we summarize some of our efforts along these lines in acoustics, medical ultrasound imaging, and atomic force microscopy (AFM). We first describe an optical sensing technique, when combined with a novel biomimetic mechanical structure, leads to directional microphones achieving 36 dB(A) noise level with a 2mmx1mm diaphragm, a significant performance improvement over the state of the art for hearing aid microphones. We then describe capacitive micromachined ultrasonic transducers (CMUTs) as an enabling technology for medical imaging in cardiology. At the level of fundamental transducer design, we demonstrate that CMUTs can achieve both high bandwidth and high electromechanical coupling coefficient, $k^2 > 0.8$ with good dynamic range. This figure exceeds that of single crystal piezoelectrics, while retaining the advantages of microscale integration. As an example of higher level system integration, we describe CMUT based imaging arrays to guide interventions in coronary arteries. These 1.2mm diameter arrays operating around 10MHz are monolithically integrated with CMOS electronics on the same silicon chip. We present volumetric images obtained with CMUT arrays as ultimate results of this interdisciplinary team effort. As an example of our work in interfacing micro-mechanical systems with nanoscale and biological systems, we describe the FIRAT probe for AFM. By removing the undesired dynamic characteristics of the AFM cantilevers, the FIRAT probe provides over 100x improvement in imaging speed resulting in video-rate AFM imaging. In single molecular mechanics measurements, FIRAT probes reduce the hydrodynamic drag forces by an order of magnitude, enabling faster pulling experiments on biomolecules. In the final part of the talk, we discuss future research opportunities based on these advances and our target applications from material science to nanotechnology enabled medical imaging.

BIOSKETCH

F. Levent Degertekin is a Professor and Woodruff Faculty Fellow in the G.W. Woodruff School of Mechanical Engineering with joint appointment in the School of Electrical and Computer Engineering at Georgia Institute of Technology. He received the B.S. degree in 1989 from the Middle East Technical University, Turkey; the M.S. degree in 1991 from Bilkent University, Turkey; and the Ph.D. degree in 1997 from Stanford University, CA, all in Electrical Engineering. He worked at the E.L. Ginzton Laboratory of Stanford University as an Engineering Research Associate from 1997 until he joined Georgia Tech as an Assistant Professor in 2000. His research interests are in micromachined transducers, opto-acoustic devices, medical ultrasound imaging, MEMS metrology, bioanalytical and biomedical instrumentation, and atomic force microscopy.

Dr. Degertekin is an associate editor for the IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control. He has served on the editorial board of the IEEE Sensors Journal, and on the technical program committees of several international conferences on ultrasonics, sensors, and micro-opto-mechanical systems (MOEMS). Dr. Degertekin has received an NSF CAREER award for his work on atomic force microscopy in 2004, and with his students, the IEEE Ultrasonics, Ferroelectrics, and Frequency Control Society 2004 Outstanding Paper award for work on capacitive micromachined ultrasonic transducers. He has authored over 70 journal publications and holds 27 U.S. patents.

For more information, please contact the host, Dr. Ari Glezer at 404-894-3266.