MEMS Based Ultrasonic Transducers in Medical Imaging

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Technical Abstract:
Capacitive Micromachined Ultrasonic Transducers (CMUTs) have been developed in the past decade as alternative transducers for generating and detecting ultrasound. Capacitor transducers have been known for over 100 years; however, the advent of silicon micromachining has enabled the realization of the full potential of these transducers. Silicon micromachining allows the manufacture of capacitors with very thin gaps that can withstand electric fields of the order of 109 V/m. These fields enable performance that makes CMUTs competitive and superior to piezoelectric transducers.

In immersion applications, CMUTs are possible with fractional bandwidth of over 100 %, an electromechanical coupling coefficient close to unity; are made in the form of single element or one-dimensional (1D) or two-dimensional (2D) arrays of tens of thousand of elements, as well as annular arrays. They have been operated in the frequency range of 100 kHz to 50 MHz, and included in systems with a dynamic range of the order of 150 dB/V/Hz. Custom electronics have been developed and integrated with arrays of transducers to form compact catheter based medical ultrasound imaging systems.

This presentation will first review the operation of CMUTs, the technology used to make them, transmit/receive RF electronics, and several applications in medical imaging.

Biography:
Butrus (Pierre) T. Khuri-Yakub is a Professor of Electrical Engineering at Stanford University. He received the BS degree from the American University of Beirut, the MS degree from Dartmouth College, and the Ph.D. degree from Stanford University, all in electrical engineering. His current research interests include medical ultrasound imaging and therapy, chemical/biological sensors, micromachined ultrasonic transducers, and ultrasonic fluid ejectors. He has authored over 500 publications and has been principal inventor or co-inventor of 78 US and international issued patents. He was awarded the Medal of the City of Bordeaux in 1983 for his contributions to Nondestructive Evaluation, the Distinguished Advisor Award of the School of Engineering at Stanford University in 1987, the Distinguished Lecturer Award of the IEEE UFFC society in 1999, a Stanford University Outstanding Inventor Award in 2004, and a Distinguished Alumnus Award of the School of Engineering of the American University of Beirut in 2005.