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Compressive Sensing

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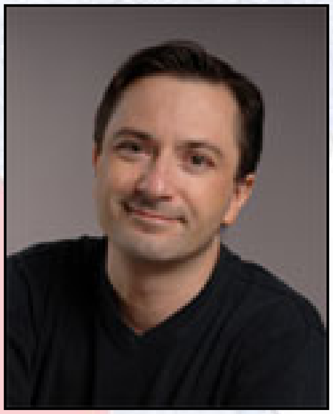

Sensors, cameras, and imaging systems are under increasing pressure to accommodate ever larger and higher-dimensional data sets; ever faster capture, sampling, and processing rates; ever lower power consumption; communication over ever more difficult channels; and radically new sensing modalities. The foundation of today's digital data acquisition systems is the Shannon/Nyquist sampling theorem, which asserts that to avoid losing information when digitizing a signal or image, one must sample at least two times faster than the signal's bandwidth, at the so-called Nyquist rate. Unfortunately, the physical limitations of current sensing systems combined with inherently high Nyquist rates impose a performance brick wall to a large class of important and emerging applications. In digital image and video cameras, for instance, the Nyquist rate is so high that too many samples result, making compression by algorithm like JPEG or MPEG a necessity prior to storage or transmission. In imaging systems (medical scanners and radars) and high-speed analog-to-digital converters, increasing the sampling rate is very expensive or detrimental to a patient's health.

This talk will overview the recent work on compressive sensing, a new approach to data acquisition in which analog signals are digitized for processing not via uniform sampling but via measurements using more general, even random, test functions. In stark contrast with conventional wisdom, the new theory asserts that one can combine "low-rate sampling" with digital computational power for efficient and accurate signal acquisition. Compressive sensing systems directly translate analog data into a compressed digital form; all we need to do is "decompress" the measured data through an optimization on a digital computer. The implications of compressive sensing are promising for many applications and enable the design of new kinds of analog-to-digital converters, cameras, and imaging systems.

Richard G. Baraniuk is the Victor E. Cameron Professor of Electrical and Computer Engineering Department at Rice University. His research interests lie in new theory, algorithms, and hardware for sensing and signal processing. His work on the Rice single-pixel compressive camera has been widely reported in the popular press and was selected by MIT Technology Review as a TR10 Top 10 Emerging Technology for 2007. He is a Fellow of the IEEE and has received national young investigator awards from the National Science Foundation and the Office of Naval Research, the Rosenbaum Fellowship from the Isaac Newton Institute of Cambridge University, the ECE Young Alumni Achievement Award from the University of Illinois, and the Wavelet Pioneer Award from

SPIE. He has received the George R. Brown Award for Superior Teaching at Rice three times and the C. Holmes MacDonald National Outstanding Teaching Award from Eta Kappa Nu, and was selected as one of Edutopia Magazineâ€™s Daring Dozen Education Innovators in 2007. His non-profit open-access educational publishing project Connexions (cnx.org) was a Tech Museum of Innovation Laureate in 2006.