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ELECTRICAL & COMPUTER ENGINEERING
TEXAS A&M UNIVERSITY

S E M I N A R

Room 1003 ETB

September 24, 2013 3:55-5:10 P.M.

Sparity-aware low-power ADC architectures and advanced reconstruction methods

by

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Abstract: Compressive Sensing (CS) is a recent revolutionary theory that enables sub-Nyquist sampling of sparse or compressible signals. According to the CS theorem, a sufficiently sparse signal can be perfectly reconstructed with an overwhelming probability from a much smaller number of incoherent, randomized linear projections relative to the Nyquist sampling systems. This talk first reviews the merits and challenges in conventional CS architectures in literature and then presents the Asynchronous Compressive Sensing (ACS) front-end. The new front-end architecture leverages a continuous-time ternary encoding scheme which modulates amplitude variation to ternary timing information. The power of analog-to-digital conversion is optimized in two aspects. One is to reduce the total data volume at A/D interface by CS technique. The other is to improve the CS hardware power by employing digital-assisted modules in the front-end circuit and reduced duty-cycle of high-power modules. At the digital back-end, an *S*-member Group-based Total Variation (*S*-GTV) algorithm is proposed for the sparse reconstruction of piecewise-constant signals. By including both the inter-group and intra-group total variation, the *S*-GTV scheme outperforms the conventional TV approaches in terms of faster convergence rate and better sparse reconstruction. Analyses and simulations with an ultrasound imaging system confirm that the proposed ACS front-end not only achieves sub-Nyquist sampling for ultrasound signals but also outperforms the conventional CS-based approaches in terms of lower power consumption and higher recovery performance.

Jun Zhou was born in Bengbu, Anhui, China in 1985. He received the B.S. degree in electrical engineering in 2007 from Fudan University, China. He received M.S. degrees in electrical engineering from Fudan University, China and Royal Institute of Technology (KTH), Sweden in 2010. He is currently working toward the Ph.D. degree at Texas A&M University, College Station, TX. He participated as interim technical intern in Qualcomm (Audio-Codec group) in 2013 and as system design intern in Samsung Telecomm America (Smart ultrasound group) in 2012. He had one Student Best Paper in *IEEE International Symposium on Circuits and Systems* (ISCAS) 2010. His research interests include low-power mixed-signal compressive sensing architecture and VLSI design.