ECE DISTINGUISHED SPEAKER SERIES

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Colorado School of Mines

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Implementing a Wireless Geophysical Sensor Network

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Sponsored by the Department of Electrical and Computer Engineering

Implementing a Wireless Geophysical Sensor Network

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Designing an efficient wireless sensor network capable of real-time, continuous (e.g., 500 Hz sampling rate), geophysical monitoring requires a more intelligent approach than a naive "sense, store, send" method. As we know, the radio on a wireless mote platform consumes significant amounts of power; thus, we apply compressive sampling techniques to reduce radio transmissions (and save energy) in our development of a wireless geophysical sensor network. In addition to energy savings from reduced radio transmissions, compressive sampling techniques can also save energy in many applications (e.g., avalanche monitoring) from reduced sensing requirements.

In this presentation, I will show that compressive sampling is a viable option for reducing the amount of data that is both collected and transmitted in a wireless seismic sensor. Specifically, I will summarize experimentation and results from three ongoing research projects. First, we simulated CS on real-world seismic data containing avalanches to find the "best" combination of sparsity domain and recovery algorithm; the seismic data was collected during the winter of 2010-2011, when seven wired geophone sensors were buried in a snow slope close to an active avalanche region near Davos, Switzerland. We tested a number of compressive sampling percentages, from 10% to 90% of the original (full) signal, and then used a pattern recognition workflow to automatically identify avalanche events in the real-world seismic data. With only 30% of the original seismic data, we were able to reconstruct the signal and classify 90.7% of the avalanche events; as a comparison, with 100% full sampling, we were able to classify only 1.7% more (92.4% total) of the avalanche events. Second, we compared CS to five other compression algorithms designed specifically for resource constrained wireless devices; we found that CS, a non-adaptive technique, offers several benefits over other lossy and lossless algorithms tested. Third, our successful results led us to develop a novel on-mote compressive sampling method called the Randomized Timing Vector algorithm (RTV). In addition to describing our new lightweight algorithm, I will show results from our experiments that indicate our RTV algorithm outperforms other existing algorithms in at least two ways: RTV does not falter at moderate to high sampling rates (e.g., 500 Hz or above) and RTV showed the greatest power savings since it eliminates costly floating point calculations and reduces ADC conversions.

Tracy Camp is a Full Professor of Computer Science in the Department of Electrical Engineering and Computer Science at the Colorado School of Mines. She is the Founder and Director of the Toilers (http://toilers.mines.edu), an active ad hoc networks research group. Her current research interests include the credibility of ad hoc network simulation studies and the use of wireless sensor networks in geosystems. Dr. Camp has received over 20 grants from the National Science Foundation, including a prestigious NSF CAREER award. In total, her projects have received over $20 million dollars in external funding. This funding has produced 12 software packages that have been requested from (and shared with) more than 3000 researchers in 86 countries (as of October 2012). Dr. Camp has published over 80 refereed articles and 12 invited articles, and these articles have been cited almost 4,000 times (per Microsoft Academic Search) and over 7,000 times (per Google Scholar) as of December 2012. Dr. Camp is an ACM Fellow, an ACM Distinguished Lecturer, and an IEEE Senior Member.

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