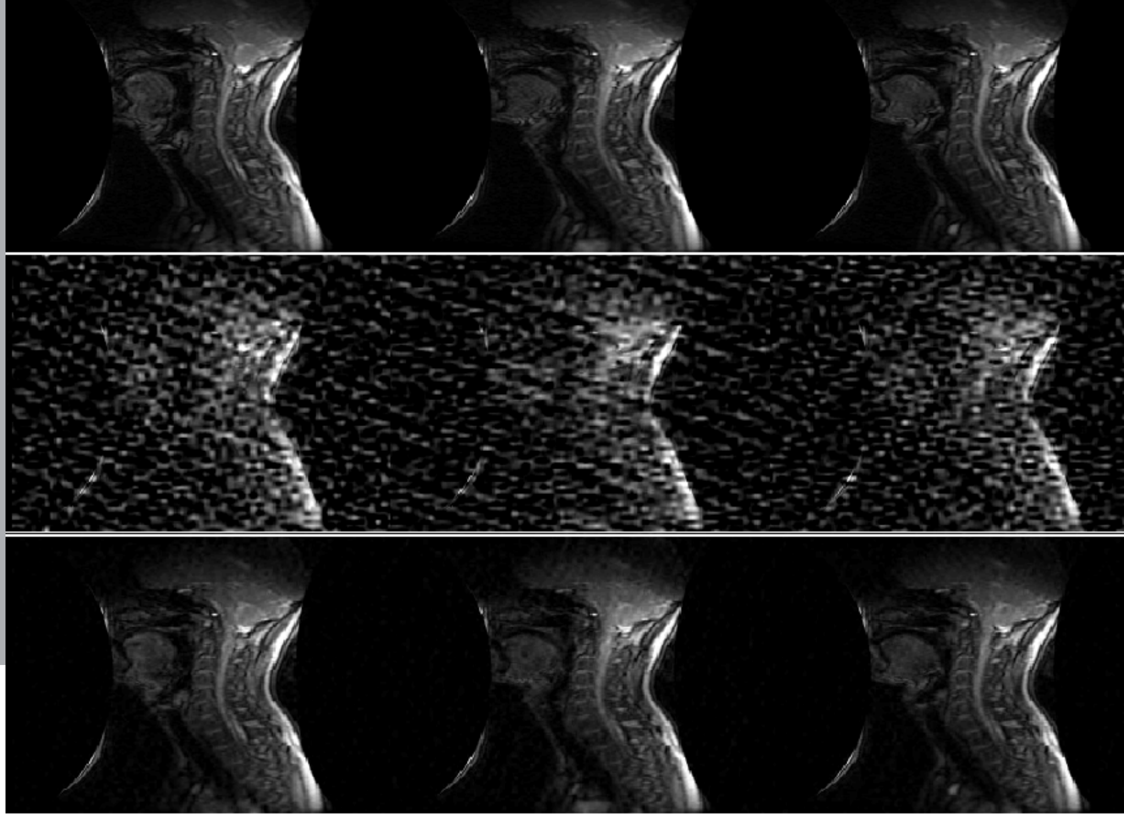

COMPRESSED SENSING

Ziniel exploits structure to improve imaging techniques

Most digital cameras today feature large, multi-megapixel CCD arrays that record incoming light intensity at each pixel location. Typically, as this data is collected, the camera immediately compresses the resultant image into a JPEG file, which reduces time and storage requirements, but in essence "throws away" most of the information that it had collected without a noticeable reduction in quality.

For more than a decade, research on this compressed sensing (CS) has focused on developing more intelligent, more efficient sampling methods. Since compressed sensing does not require hardware with higher and higher sampling rates, the implications are enormous across a wide range of applications, such as radar, medical imaging, remote sensing and hyperspectral imaging.

Justin Ziniel, a doctoral student in electrical and computer engineering (ECE) at The Ohio State University, seeks to extend traditional CS to the scenario in which the underlying signal being recovered has non-trivial structure that can be exploited by observing that, not only does each image have a succinct representation, but each image also is highly similar to its neighbors (in time). Exploiting this structure with compressed sensing allows for more undersampling without a reduction in quality, relative to standard techniques.

"Exploiting structure often comes at the cost of substantially increased computational complexity," explained Ziniel. "We've developed a wide range of message passing algorithms for dramatically speeding up the computation time."

The Ohio Supercomputer Center has been extremely important to Ziniel and his colleagues, Sundeep Rangan, Ph.D., an associate professor of ECE at the Polytechnic Institute of New York, and Philip Schniter, Ph.D., an associate professor of ECE at Ohio State. They must be able to characterize the performance of their algorithms against competing techniques across a wide range of different problems that might be encountered. This typically means averaging the performance on hundreds or thousands of different problems over thousands of realizations.

"This process would take way too long if we had to rely on a single desktop, but by farming out the work to many OSC nodes, we can condense many CPU months' worth of work into just a few hours or days," Ziniel said. "This has allowed us to achieve a much more comprehensive characterization of how our algorithms perform under many different settings than would otherwise be possible."

Three frames of an MRI image sequence of the larynx. The top row consists of fully sampled data that would ordinarily be produced from an MRI machine. The second row is an example of a "traditional" compressed sensing recovery with access to only 16 percent of the complete data. The third row is a recovery on the same 16 percent of data using proposed algorithms that take advantage of the image structure.

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