Department of Electrical and Computer Engineering
The Johns Hopkins University
520.648 Compressive Sensing and Sparse Recovery – Spring 2017

Homework Assignment VI

Computer Assignment:

You can find the code package on the course webpage which implements a few popular sparse-recovery algorithms. This exercise helps you to investigate and compare their accuracy as well as robustness in the recovery of sparse signals with various sparsity level S using real images. You can choose two: your favorite greedy algorithm and your favorite ell_1-minimization algorithm in the assignment.

The sensing matrices in comparison are: Random Gaussian, Random Subsampling, and Structurally Random Matrices. Consider the following SRM construction – a block-diagonal matrix where each block on the diagonal of size B is a scaled product of 3 matrices: **RFD**, where **D** is either a diagonal matrix of i.i.d Bernoulli random variables or a matrix of uniform random permutation; **F** is either an $B \times B$ Hadamard matrix; and **R** is a random subset of rows of the $B \times B$ identity matrix.

Consider the following three images: Phantom (synthetic), Brain (real) and Boat (real), all available on the course web page in the same code package. This time, devise your own stopping criterion and try to fine-tune other parameter(s) for all of the algorithms. The two sparsifying matrices that you should consider are: DCT and Wavelet. The main.m file in the package helps you to set up the Compressed Sensing problem for these images. For DCT, you would like to use a small patch size, say 8×8. However, for Wavelet, you would like to set the patch size to be as large as the image itself. Compute the distortion based on the peak signal-to-noise ratio, often abbreviated PSNR, defined as follows

$$PSNR = 10 \log_{10} \frac{MAX^2}{MSE} \text{ where } MSE = \frac{1}{N^2} ||\hat{\mathbf{x}} - \mathbf{x}||_2^2.$$

For our three test images, $MAX = 255$ (the maximum dynamic range) and N is the image dimension. Use the psnr.m file in the package to plot the PSNR between the recovered images and the original with respect to the number of measurements M. What are your observations on how to obtain the best recovery performance?

Due date: **Thurs, April 6** in lecture or via email