EL-715: Sparse Representations in Signal and Image Processing

Introduction: Sparse signal, Signal representations, Sparse representation of signals

Sparse representation: Discrete cosine transforms, Discrete Fourier transform, Discrete wavelet transform, Dictionary learning for sparse representation

Sampling sparse signals: Sparsity, Incoherence, Dictionary, Restricted isometry property

Sparse Solution: Sparse Solution via Linear Programming, Under-determined systems of linear equations ℓ^0, ℓ^1, ℓ^2 and ℓ^p Solutions, Approximate sparse solution, Error correction via linear programming, Signal recovery from random projections.

Recovery Algorithms: Matching Pursuit, OMP, Primal-dual interior point methods, Log barrier method, Gradient projection method, and Fast Algorithms for sparse solutions.

Applications: Image Compression, Denoising, Super-resolution, Face Recognition, MRI, Feature Selection, Sparsity-Based Clustering, Missing, Incomplete, Corrupted Features.

Text Book:
1. M. Elad, Sparse and Redundant Representations: From Theory to Applications in Signal and Image Processing, Springer, 2010.
2. J. L. Starck, F. Murtagh and J. M. Fadili, Sparse Image and Signal Processing: Wavelets, Curvelets, Morphological Diversity, CUP, 2010.
3. S. Boyd and L. Vandenberghe, Convex Optimization, CUP, 2004.

References:
As there is no specific text book for the course, the recommended references for this course may also include:
1. Lustig, Donoho, Santos and Pauly - Compressed Sensing MRI, MRM 2007.
2. Donoho and Elad - Optimally Sparse Representation in General (nonorthogonal) Dictionaries via L1 Minimization, PNAS 2003.
3. G. Strang, Linear Algebra and Its Applications, 4th Ed., Cengage, 2006.
4. Duarte, Davenport, Takhar, Laska, Sun, Kelly, Baraniuk - Single Pixel Imaging via Compressive Sampling, IEEE SPM 2008.
5. Wright, Ma, Saipro, Mairal, Huang, Yan - Sparse Representation for Computer Vision and Pattern Recognition, Signal Processing Magazine 2010.
6. Tropp and Gilbert - Signal Recovery from Random Measurements via Orthogonal Matching Pursuit - IT 2007.
7. Mairal, Elad and Sapiro - Sparse Representation for Color Image Restoration - IEEE IP 2008.
8. Yang, Wright, Huang and Ma - Image Superresolution via Sparse Representation - IEEE IP 2010.