

ECE 513: Vector Space Signal Processing

Spring 2020

Final Projects

The final projects in ECE 513 provide you an opportunity to independently study a research topic of your choice that is related to the course materials. The final projects contribute 30% to the total grade.

In the end you find a list of suggested papers for the projects. **These are only the starting points.** In many cases, further consultation of key papers in the references are required.

A project can align with your current research. In that case, it is important that **what you present for evaluation in ECE 513 is what you do during the course and specifically for the course.** In addition, you need to clarify the scope of and the connection between your ECE 513 project and your current research.

All projects should contain novel work. For example, it could be applying ECE 513 theoretical tools to analyze the studied method (or a simplified version of it), implementing two related methods and providing comparison, applying the studied technique to a new problem, providing new illustrative examples or test cases to gain more insight of the studied method, or running simulation on different test data. **Final projects will be evaluated based on the level of understanding, the originality, connection to and application of ECE 513 class materials, and amount of the presented work.**

Your first step in working toward a project is to submit one page proposal that summarize the research problem and define the scope of the project. Following are the deadlines for the final projects.

One page proposal (3% grade): March 11.

Oral presentation (7% grade): May 4-6.

Project report (20% grade): May 15.

References

- [1] C. Couvreur and Y. Bresler, "On the optimality of the Backward Greedy Algorithm for the subset selection problem," *SIAM Journal on Matrix Analysis and Its Applications*, Vol. 21 No. 3, pp. 797-808, 1999.
- [2] M.C. Vanderveen, A. J. Van Der Veen, and A. Paulraj, "Estimation of multipath parameters in wireless communications," *IEEE Trans. Signal Processing*, vol. 46, pp. 682-690, Mar. 1998.
- [3] L. Tong and S. Perreau, "Multichannel blind identification: From subspace to maximum likelihood methods," *Proc. IEEE*, vol. 86, pp. 1951-1968, Oct. 1998.
- [4] G. B. Giannakis and C. Tependeleniglu, "Basis expansion models and diversity techniques for blind identification and equalization of time-varying channels," *Proc. IEEE*, vol. 86, pp. 1969-1986, Oct. 1998.

- [5] A.J. van der Veen, “Algebraic methods for deterministic blind beamforming,” *Proc. IEEE*, vol. 86, pp. 1987–2008, Oct. 1998.
- [6] G. Harikumar and Y. Bresler, “Exact image deconvolution from multiple FIR blurs,” *IEEE Trans. Image Processing*, June 1999.
- [7] M. Unser, A. Aldroubi, M. Eden, “B-Spline Signal Processing: Part I–Theory,” *IEEE Transactions on Signal Processing*, vol. 41, no. 2, pp. 821–833, February 1993.
- [8] M. Unser, A. Aldroubi, M. Eden, “B-Spline Signal Processing: Part II–Efficient Design and Applications,” *IEEE Transactions on Signal Processing*, vol. 41, no. 2, pp. 834–848, February 1993.
- [9] H. Bolcskei, Hlawatsch, and Feichtinger, “Frame-theoretic analysis of oversampled filter banks,” *IEEE Trans. Signal Processing*, vol. 46, pp. 3256–3268, 1998.
- [10] S. Mallat and Z. Zhang, “Matching pursuits with time-frequency dictionaries,” *IEEE Trans. Signal Processing*, vol. 41, pp. 3397–3415, Dec. 1993.
- [11] M. Elad and A.M. Bruckstein, “A Generalized Uncertainty Principle and Sparse Representation in Pairs of Bases,” *IEEE Trans. On Information Theory*, Vol. 48, pp. 2558–2567, September 2002.
- [12] R. Venkataramani and Y. Bresler, “Optimal sub-Nyquist nonuniform sampling and reconstruction of multiband signals,” *IEEE Trans. Signal Processing*, vol. 49, no. 10, pp. 2301–2313, Oct. 2001.
- [13] A. Aldroubi and K. Gröchenig. Nonuniform sampling and reconstruction in shift-invariant spaces. *SIAM Review*, 43(4):585–620, 2001.
- [14] M. Vetterli, P. Marziliano, and T. Blu. Sampling signals with finite rate of innovation. *IEEE Trans. Signal Proc.*, 50(6):1417–1428, Jun. 2002.
- [15] R. J. Barton and H. V. Poor, “An RKHS approach to robust l_2 estimation and signal detection,” *IEEE Trans. Image Processing*, pp. 485–501, May 1990.
- [16] J. A. Tropp, “Greed is good: algorithmic results for sparse approximation,” *IEEE Trans. Inform. Theory*, 2004.
- [17] D. L. Donoho and M. Elad, “Maximal Sparsity Representation via l_1 Minimization,” *Proc. Nat. Aca. Sci.*, Vol. 100, pp. 2197–2202, March 2003.
- [18] S. Farsiu, M. D. Robinson, M. Elad and P. Milanfar, “Fast and robust multiframe super resolution,” in *IEEE Transactions on Image Processing*, vol. 13, no. 10, pp. 1327–1344, Oct. 2004.
- [19] F. Perez-Cruz and O. Bousquet, “Kernel methods and their potential use in signal processing,” *IEEE Signal Processing Magazine*, Vol. 21, pp. 57 - 65, May 2004.
- [20] J. Wright, A. Y. Yang, A. Ganesh, S. S. Sastry and Y. Ma, “Robust Face Recognition via Sparse Representation,” in *IEEE Transactions on Pattern Analysis and Machine Intelligence*, vol. 31, no. 2, pp. 210–227, Feb. 2009.

- [21] EJ Cands, X Li, Y Ma, J Wright, “Robust principal component analysis?,” *Journal of the ACM (JACM)* 58 (3), 1-37.
- [22] S. Ravishankar, J. C. Ye and J. A. Fessler, “Image Reconstruction: From Sparsity to Data-Adaptive Methods and Machine Learning,” in *Proceedings of the IEEE*, vol. 108, no. 1, pp. 86-109, Jan. 2020.
- [23] Jong Chul Ye, Yoseob Han, and Eunju Cha, “Deep Convolutional Framelets: A General Deep Learning Framework for Inverse Problems,” *SIAM Journal on Imaging Sciences* 2018 11:2, 991-1048.
- [24] Ali Rahimi and Benjamin Recht, “Weighted Sums of Random Kitchen Sinks: Replacing minimization with randomization in Learning.” In *Advances in Neural Information Processing Systems*, 2008.
- [25] Simon S. Du, Xiyu Zhai, Barnabs Pczos, Aarti Singh, “Gradient Descent Provably Optimizes Over-parameterized Neural Networks,” *International Conference on Learning Representations (ICLR)* 2019