# ECE 497 - MD: Wavelets in Signal Processing

## Projects

The projects in ECE 497 - MD provide you an opportunity to independently research a topic of your choice, as well as try out your original ideas, in the wavelets and related fields. The ideal projects should come from your own interests, either from your thesis work or an area that you want to explore. In that case, it is important that **what you present for evaluation in ECE 497 - MD is what you do during the course and specifically for the course**. In other cases, you could consult the following list of suggested projects. Each of these projects would investigate a promising new direction in the wavelet field, which has plenty of room for novel improvements and applications.

### Suggested Projects

- **Ridgelets and curvelets**

  1. E. J. Cands and D. L. Donoho (1999). Ridgelets: a key to higher-dimensional intermittency? Phil. Trans. R. Soc. Lond. A., 357, 2495-2509.
  2. E. J. Cands and D. L. Donoho (1999). Curvelets - A Surprisingly Effective Nonadaptive Representation for Objects with Edges, Curves and Surfaces, L. L. Schumaker et al. (eds), Vanderbilt University Press, Nashville, TN.

  These and related papers are available on-line at:
  `http://www.acm.caltech.edu/~emmanuel/publications.html`

- **Complex wavelets and applications**

  1. N. G. Kingsbury. Image processing with complex wavelets. Phil. Trans. Royal Society London A, September 1999.
  2. N. G. Kingsbury. Complex wavelets for shift invariant analysis and filtering of signals. Applied and Computational Harmonic Analysis, 10(3):234-253, May 2001.

  These and related papers are available on-line at:
  `http://www-sigproc.eng.cam.ac.uk/~ngk/`

- **Random cascades of Gaussian scale mixtures for natural images**

  1. M J Wainwright, E P Simoncelli and A S Willsky, Random cascades on wavelet trees and their use in modeling and analyzing natural images. Applied Computational and Harmonic Analysis, 11(1):89-123, July 2001.

  This and related papers are available on-line at:
  `http://www.cns.nyu.edu/~eero/publications.html`

- **Lapped transform via time-domain pre- and post-filtering**

  1. T. D. Tran, "Lapped transform via time-domain pre- and post-filtering. Part I: general framework," submitted to IEEE Trans. on Signal Processing, Oct. 2001.
  2. J. Liang, C. Tu, and T. D. Tran, "Lapped transform via time-domain pre- and post-filtering. Part II: fast algorithms," submitted to IEEE Trans. on Signal Processing, Oct. 2001.

3. W. Dai and T. D. Tran, "Regularity-constrained pre- and post-filtering for block DCT based systems," submitted to IEEE Trans. on Signal Processing, Dec. 2001.

These papers are available on-line at:
`http://thanglong.ece.jhu.edu/`

- **Filter banks for communications**

1. A. Scaglione, G. B. Giannakis, and S. Barbarossa, Redundant Filterbank Precoders and Equalizers, Parts I and II", IEEE Trans. on Signal Processing, vol. 47, pp. 1988-2022, July 1999. (received IEEE-SP Soc. Best Paper Award, 2000).

- **Beamlets and multiscale image analysis**

1. X. Huo and D. Donoho, "Beamlets and multiscale image analysis," with D. Donoho, Springer, Lecture Notes in Computational Science and Engineering: Multiscale and Multiresolution Methods.

This and related papers are available on-line at:
`http://www.isye.gatech.edu/~xiaoming/publication/`

- **The Double-Density Discrete Wavelet Transform**

1. I.W. Selesnick. The Double Density DWT. In A. Petrosian and F. G. Meyer, editors, Wavelets in Signal and Image Analysis: From Theory to Practice. Kluwer, 2001.
   `http://taco.poly.edu/selesi/double/`

- **Bandelets and vertex-based shape coding for image compression**

1. E. Le Pennec and S. Mallat. Image compression with geometric wavelets. In *Proc. IEEE Int. Conf. on Image Proc.*, Vancouver, Canada, Sep. 2000.
2. G. Schuster and G. Melnikov and A. Katsaggelos, "Operationally Optimal Vertex-Based Shape Coding", IEEE Signal Processing Magazine, pp.91-108, Nov. 1998.

- **Anisotropic adaptive 2-D wavelets**. Isotropic wavelet packets bases in 2-D, whose elements having the same scale along each dimension are well understood. If we allow the scales in two dimensions differ by simply letting the 2-D separable filter banks to have arbitrary orders of rows and column decompositions, then this would lead to a much richer set of bases. What are the properties of this family of bases and what are their potentials in applications?

- **Wavelet-Based Digital Watermarking**.

1. W. Zhu, Z. Xiong and Y.-Q. Zhang, "Multiresolution Watermarking for Images and Video," *IEEE Trans. CSVT*, Vol. 9, No. 4, pp. 545—550, June 1999.
2. P. Moulin and M. K. Mıhçak, "A Framework for Evaluating The Data-Hiding Capacity of Image Sources," to appear in *IEEE Trans. on Image Processing*, Sep. 2002.
3. M. K. Mıhçak and P. Moulin, "Information-Embedding Codes Matched to Local Gaussian Image Models," to appear in *IEEE Int. Conf. on Image Processing*, Rochester, NY, Sep. 2002.

- **Motion Estimation in the Wavelet Domain**. Can we estimate the motion of video sequences in the wavelet domain? What are the advantages and disadvantages? Can the multiresolution characteristics help in speeding up the estimation?

- **Signal Detection. Target Recognition**. Can we recognize a particular shape or object from the wavelet coefficients of the data?