Spring 2009 Course

6.342 Wavelets, Approximation, and Compression

Instructor: Vivek Goyal (vgoyal@mit.edu, http://www.rle.mit.edu/stir/)

Lectures MW 11:00-12:30 in 36-153

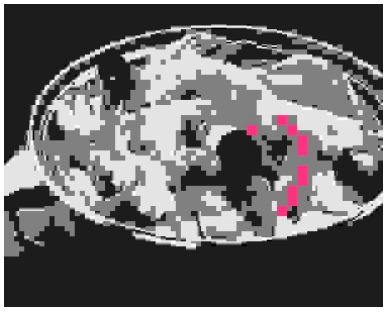
(days and time will not change, but room may change)

Course Units: 12 (3-0-9) (Grad H credit)

Overview: Over the past two decades, wavelet transforms have become an essential complement to Fourier transforms. The associated mathematical developments have led to an appreciation for the connections between sparse approximation, estimation, and compression. Compression efficiency has been improved in many applications, and now many basic assumptions in sensing and data acquisition are being questioned. This course progresses from Hilbert space formulations of basic signal processing concepts to the development of wavelets while maintaining an emphasis efficiently-computed discrete-time signal representations. Applications to approximation and compression are emphasized throughout.

Image compression example: Images from http://www.imagepower.com/technology/jpeg2000/compare/food.html

Original: 844 kbytes



DCT-based compression: 3 kbytes

Wavelet-based compression: 3 kbytes

Prerequisites: 18.06; 6.341 or 6.450. Only 18.06 and 6.011? Inquire with the instructor.

Catalog description: Hilbert space formulation of continuous-time and discrete-time signals. Sampling. Orthogonal and biorthogonal signal expansions. Uncertainty principles and the time-frequency plane. Two-channel filter banks, iterated filter banks, and discrete wavelet transforms. Multiresolution analysis. Wavelet bases, regularity, approximation properties, and nonlinear approximation. Basics of quantization and source coding. Compression, denoising, and other image processing using wavelets. Advanced topics from the current research literature.

Course structure: The course will have a small number of homework assignments (including a few computation problems to be completed with MATLAB), a midterm exam, and a research-oriented final project (no final exam). Projects must use the techniques of the course but may be in any area. The project may be completed individually or in small groups.

Main text: *The World of Fourier and Wavelets: Theory, Algorithms and Applications* by Martin Vetterli, Jelena Kovačević and Vivek K Goyal (manuscript with anticipated publication in 2009). See http://FourierAndWavelets.org for additional information.