

Introduction to Wavelet-Subband Image Processing

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Objective:

This course is intended to provide attendees with a functional understanding of wavelet theory and its relationship to digital filter banks. It will enable attendees to:

- identify the benefits and limitations of this algorithm technology;
- analyze and formulate algorithms for image and video compression and transmission;
- develop simple and effective image enhancement tools; and
- extend conventional object detection, classification, and recognition techniques to the subband-wavelet domain.

Description:

Wavelet and subband techniques are receiving tremendous attention now for image processing applications. This course presents the fundamentals of wavelets and subband filter banks. Starting with the basic notion of a signal decomposition, we will show the attractive features of wavelet bases. From this point, the continuous wavelet transform will be developed, followed by the introduction of the discrete wavelet transform. The presentation will then focus on filter banks, which can be used to implement wavelets or to realize systems with properties that go beyond those possible with wavelets.

Included in the theoretical portion of the discussion will be the basic concepts of decimation and interpolation, aliasing and imaging effects, paraunitary and biorthogonal filter banks, two- and M-band filter banks, and multidimensional extensions. In addition, new design techniques will be presented that enable fast and efficient filter banks and wavelets to be constructed in a straightforward manner.

Such filter banks represent a powerful vehicle for solving many image processing problems, often with the benefits of high performance and computational efficiency. In the applied portion of the presentation, specific applications in several important image-processing areas will be discussed, including image and video coding, image enhancement, target detection, and object recognition.

The course is intended for engineers, applied mathematicians, scientists, and technical managers seeking to understand this new technology and its implications in telecommunications and image analysis. Some prior background in Fourier domain concepts is helpful.

Length of course: half day

Instructor:

MARK J. T. SMITH, received the B.S. degree from the Massachusetts Institute of Technology in 1978, and the M.S. and Ph.D. degrees from the Georgia Institute of Technology in 1979 and 1984 respectively, all in Electrical Engineering. He is an electrical engineering professor in the College of Engineering at Georgia Tech, and presently serves as the Executive Assistant to the President of the School.

Dr. Smith is a Fellow of the IEEE and has authored more than 150 papers in the areas of speech and image processing, filter banks and wavelets, and object detection and recognition. He has received two teaching awards at Georgia Tech; received the best paper award from the IEEE Signal Processing Society in 1989 for his journal paper entitled, "Reconstruction Techniques for Tree Structures Subband Coders," received the IEEE SPS Senior Award in 1992 for his journal paper entitled, "Analysis/Synthesis Systems for Subband Image Coding"; and received the best paper award from the IEEE Signal Processing Society in 1995 for his journal paper with Robert Bamberger entitled "Filter Banks for the Directional Decomposition of Images: Theory and Design."

He is the co-author (with R. Mersereau) of two introductory books entitled: "Introduction to Digital Signal Processing" and "Digital Filtering." He is also co-editor (with A. Akansu) of the book entitled "Wavelets and Subband Transforms: Design and Applications," and the co-author (with A. Docef) of a new textbook entitled "A Study Guide for Digital Image Processing."

Dr. Smith is a past Chairman of the IEEE SP Digital Signal Processing Technical Committee and a recent Distinguished Lecturer in the IEEE Signal Processing Society. He has served as an Associate Editor for the IEEE Transactions on Acoustics, Speech, and Signal Processing, as a member of the MIPs Advisory Board of the National Science Foundation, and as a member of the Board of Governors of the IEEE Signal Processing Society. He has been active as a member of the Organizing Committees for the IEEE DSP Workshops since 1988, serving as General Chairman in 1992 and 1994. He has also been active on the organizing committees for the SPIE Visual Communications and Image Processing Conferences (VCIP) since 1990, most recently serving as General Co-Chairman (with R. Ansari) in 1996.

In addition to professional service, teaching, and research, Dr. Smith's past includes athletic training and competition in the sport of fencing. He was National Champion of the United States in 1981 and 1983, and a two-time member of the U.S. Olympic Team in 1980 and 1984. Most recently, Smith was one of the final runners carrying the Olympic Torch to the Opening Ceremonies in the 1996 Summer Olympic Games in Atlanta.