EECE 586 Wavelets, Principles and Applications in Signal (Jan. 2014 – Apr. 2014)

Course website:
http://www.ece.ubc.ca/~elec586

Course Duration: Jan. 2014 – Apr. 2014

Instructor:
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Grading:
Textbook assignments (20%);
Exam (45%)
Student lecture presentation (5%)
Take-home Matlab projects (30%)

Summary:

In this course we will focus on the concepts, methodologies and tools of signal processing using wavelets. We will discuss the basics of wavelets, and aim at the appropriate balance of theory and applications. Topics of interest include multi-resolution analysis, wavelet packets, and selected applications to data compression, denoising, and signal and image processing. The course has no specific prerequisites, although a basic knowledge of digital signal processing (e.g. Fourier transforms) transforms is recommended.

The course will consist of lectures and student presentations. Students will explore the basics of wavelet and gain the hands-on experience with MATLAB® Wavelet Toolbox by doing homework assignments and a project on a topic related to the student's area of interest.

Course Outline:

• Introduction and Background
  o Overview and notation: filter bank, scaling function and wavelets
  o Analysis and synthesis of signals
  o Orthogonal basis of functions: Fourier analysis, Local cosine bases
  o Time, frequency, and scale
  o Discrete-time filters: Convolution; Fourier Transform; Lowpass and Highpass Filters
  o Sampling rate change operations
• Filter Banks and Multiresolution Analysis
  o Filter Banks
  o The Discrete Wavelet Transform
  o Multiresolution
  o MATLAB® Wavelet Toolbox
• Wavelet Theory (Time-Scale Analysis)
  o The Continuous Wavelet Transform
  o Analysis and Synthesis with Wavelets
• Properties of the filters, and the scaling functions and wavelets
  • Variations over a Theme
    o Wavelet packets
    o Multifilters and Multiwavelets.
  • Extensions:
    o Design of filter banks
    o Lifting scheme
    o Second Generation Wavelet Transform (SGWT)
    o Ridgelets, Curvelets
    o edge-avoiding wavelets
  • Selected applications
    o Data compression, signal denosing, feature extraction/detection
    o Signal and image processing basics
    o Data hiding
    o Multiscale methods for partial differential equations and integral equations
    o Compressed sensing (e.g. wavelet-domain compressive signal reconstruction), fMRI application
    o Wavelet applications in data mining

• Student lecture/project presentations

Useful links:

1. Some wavelet books:

   http://bigwww.epfl.ch/horbelt/wavelets/wavebooks.html

2. A selection of some on-line Wavelet course websites:

   o Slides and handouts from the MIT course "Wavelets, Filter Banks and Applications".
   o A selection of notes entitled "TUTORIAL: Multiscale Methods and Applications"
     http://jstarck.free.fr/cours.htm
   o Lecture notes from the University of Texas for "Wavelets and Signal Processing"
     http://www.ma.utexas.edu/users/gilbert/
   o Course notes from Dalhouse University for "Wavelets and Filter Banks".
     http://www.engmath.dal.ca/courses/engm6610/
   o Lecture notes and background material from the University of Minnesota for "Introduction to the Mathematics of Wavelets"
     http://www.ima.umn.edu/~miller/Math5467S06.html