EE523: Data Compression

Prof. Mark Fowler
Phone: 777-6973 **E-Mail**: mfowler@binghamton.edu
Fowler's Web Page: http://ww.ws.binghamton.edu/fowler
Blackboard Website: http://blackboard.cc.binghamton.edu/

Office: Q14, 3rd floor of Engineering Building
Office Hours: To Be Determined

Description

Discusses the theory and methods of data compression of signals, images, and video. Techniques covered include: Quantization, Vector Quantization, Differential Schemes, Filterbanks and Subband Coding, Wavelet Transform, JPEG 2000, and MPEG. Coverage of selected topics of recent research issues in data compression.

Prerequisites

Students are expected to have a working knowledge (at the undergraduate level) of the topics listed below. Of course, we will **briefly** review these ideas as we encounter them, but they are the tools that we will use to describe and analyze compression techniques.

- **Digital Signal Processing** at the level that is covered in EECE402/520 (your EE523 book reviews some of this in Sections 11.4 – 11.9; see me if you need a pointer for more review). You should be familiar with things like:
  - Frequency Response of a Digital Filter
  - Transfer Function of a Digital Filter
  - Block Diagram of a Digital Filter
  - FIR Filters – not design, but how they work and how to analyze them
  - Discrete Fourier Transform (DFT) – what it is and what it means
- **Probability and Random Processes** at the level that is covered in ISE261 & EECE377 (your EE523 book reviews most of this in Appendix A; see me if you need a pointer for more review). What you mostly need is an understanding of the CONCEPTS rather than a complete "problem working" ability. You should be familiar with things like:
  - Probability – what it is and what it means
  - Random Variables (RV) – what they are (e.g., the number rolled on dice, the voltage representing a speech signal, etc.)
  - Probability Density Function (PDF) – especially the Gaussian PDF (you know, the "bell-shaped curve"); you should understand what a PDF tells you about how the RV is distributed.
  - Expected Value of an RV – nothing more than the average value or another way to view it: the point at which the PDF would balance on your finger
  - Correlation Between RVs – understand what it means (that the outcome of one RV is statistically linked to the outcome of another RV; e.g., consider the RVs height and weight of humans – there is a positive correlation between these two in the sense that if you are tall you are more likely to be heavy)
  - Stochastic or Random Process (RP) – just need to know that in the discrete-time case this is just viewed as a sequence of random variables

- Correlation Function – for a discrete-time random process this is nothing more than looking at the correlation between pairs of RVs taken from the sequence that makes up the random process; you should be familiar with the idea that a narrow correlation function indicates that the random process will fluctuate rapidly (in other words there is little correlation between fairly closely spaced samples in the random process) whereas a wide correlation function indicates that the random process will fluctuate slowly (in other words, there is much correlation between fairly closely spaced samples in the random process)
- Power Spectral Density (PSD) – shows how the power of an RP is spread out over frequency; PSD is the Fourier transform of the correlation function. Thus, a narrow correlation function (RP fluctuates rapidly) has a wide PSD and a wide correlation function (RP fluctuates slowly) has a narrow PSD.

Reading Materials

- **Text Book**: *Introduction to Data Compression*, ***3rd Edition***, by Kahlid Sayood (you can probably get away with using the 2nd edition if you had to)
- **Reference Material**: To Be Posted on "Blackboard" Website As Needed

Topics

Our focus will be primarily on so-called lossy compression methods. However, because many lossy methods use some aspects of Lossless methods (mainly Huffman and Arithmetic Coding) we will briefly cover those topics.

See Schedule for details on exactly what we will cover in each Topic

Ch. 1 Introduction
Ch. 2 Math Preliminaries for Lossless Compression
Ch. 3 Huffman Coding
Ch. 4 Arithmetic Coding
Ch. 8 Mathematical Preliminaries for Lossy Coding
Ch. 9 Scalar Quantization
Ch. 10 Vector Quantization
Ch. 12 Math for Transforms, Subbands, and Wavelets
Ch. 13 Transform Coding
Ch. 14 Subband Coding
Ch. 15 Wavelet Methods
Applications & Current Topics (TBD as time allows)

Course Grade

Homework/Quizzes	= 15%
Take Home Exam #1	= 28%
Take Home Exam #2	= 28%
Project	= 29%

Academic Honesty Policy

All students must adhere to the Student Academic Honesty Code of the University and the Watson School. The Department of Electrical and Computer Engineering has adopted a standard policy to enforce these codes for violations involving course work. There are two categories of violations defined in the links below. **Category I violations result in a grade of 0 for the graded work plus a one letter course grade reduction.** A *Report of Category I Academic Dishonesty* form is filed with the Provost's Office; if a prior report is already on file, the offense is automatically elevated to Category II. **Category II violations result in at least a failing grade for the course plus any additional penalties determined by the Watson Academic Integrity Committee.**

All students are expected to be aware of the details of the policies and definitions given on the following web links:

University Academic Honesty Code:
http://bulletin.binghamton.edu/program.asp?program_id=826
Watson School Academic Honesty Code:
http://www.binghamton.edu/watson/Watson_Academic_Honesty_Policy.pdf
ECE Department Academic Honesty Code Enforcement Policy
http://www.ece.binghamton.edu/documents/Academic_Honesty_Policy.pdf