ELEN 689 JI, Spring 2007
Advanced Signal Processing for Medial Imaging

This course covers several advanced signal processing topics commonly encountered in medical imaging systems and applications, with a focus on those associated with magnetic resonance imaging (MRI). After taking this course, the students will learn how signals carrying biological information are generated, detected and processed, as well as how images are formed and processed from such signals. The course starts with reviews of some fundamental signal processing topics such as multidimensional signal sampling and reconstruction, signal generation and optimal detection, and multichannel signal detection and reconstruction. This will be followed by discussions on Fourier imaging principles, projection slice theorem, Fourier transform and Radon transform. Some image processing topics such as advanced image reconstruction, fast imaging, image segmentation and image registration will also be discussed.

Prerequisite:
ELEN 444, or permission of the instructor.

Instructor: Jim Ji , 208A Zachry, E-mail: *jimji@tamu.edu*
Office Hours: Tuesday 5-7 PM, Zach 208A or stop by any time when I am in the office. I work most time in Magnetic Resonance System Lab (http://ee.tamu.edu/~mrsl) at USB 109, if I'm not in Zachry 208A. You can also email me or see me after class to make an appointment.

Lectures: TR 03:55PM-05:10PM ZACH 119A

URL: http://ee.tamu.edu/~mrsl. Click courses and follow the links. Grades and notes may be linked to secured webct server. You'll need neo id and password to access it.

Text and References:
Reserved at Evan Library:

1. Prince & Links, Medical Imaging Signals and Systems, Prentice Hall, 2005
2. Liang & Lauterbur, Principles of Magnetic Resonance Imaging, SPIE/IEEE, 1999

On-line eook:
Basics of MRI: http://www.cis.rit.edu/htbooks/mri/ (Lots more on MRI on ISMRM education webcite http://www.ismrm.org/mr_sites.htm)
Hendee and Ritenour Medical Imaging Physics (Search on http://libcat.tamu.edu, click Electronic Resources)

Additional:

1. Webb, Introduction to Biomedical Imaging, IEEE Press, Wiley, 2002
2. Semmlow, Biosignal and biomedical image processing : MATLAB-based applications, Marcel Dekker, 2004

3. Paul Suetens, "Fundamentals of Medical Imaging", Cambridge University Press, Book/CD edition, 2002
4. Shung, K.Kirk Ed. Principles of medical imaging, Academic Press, 1992
5. Cho, Jones, and Singh, Foundations of Medical Imaging, Wiley & Sons, 1993
6. Guy and Ffytche, An Introduction to the Principles of Medical Imaging, Imperial College Press, 2000

Journals:
IEEE Transactions on Medical Imaging
IEEE Engineering in Medicine and Biology Magazine
IEEE Transactions on Image Processing
(Many more on http://ee.tamu.edu/~mrsl/JIMJI_TAMU/links-journalsliteratures.htm, most have online access)

Grading:
The final grade will be determined from the weightings

Mid Exams	= 15 %
Quiz	= 15%
HWs	= 45%
Project	= 25%

Guaranteed: 90-100 A, 80-89 B, 70-79 C, 60-69 D, Below 60 F. Any curve will lower these ranges.

Homework and Projects:
The hw will be assigned approximately every other Thursday, which will typically be due on the next next Thursday and must be handed in at the beginning of the class. The lowest hw score will be dropped. NO LATE HW will be accepted. There will be a 10-minute quiz on each Thursday. You will have an opportunity to present a literature review on medical signal processing to the class (project).

Test:
There will be two closed book exams. You are allowed to bring a two-sided 8.5 by 11-inch handwritten note to the first test and two notes to the final exam.

Midterm: March 3, Wed, 7-9pm (tentative)
Final: May 10, Mon, 8-10am (tentative)

Topics:

- Overview of medical imaging 1
- Review of some basic math and physics 3
- Multidimensional signal processing 5
    a. Sampling and reconstruction in multiple dimension
    b. Applications in medical imaging
- Multichannel and phased-array signal processing 5
    a. Sampling and reconstruction
    b. Parallel imaging in MRI and application in Ultrasound Imaging
- Projection-slice-theorem 3
    a. Principle of tomographic imaging

b. Random transform and back projection
c. X-Ray computer tomography (CT)

- Fourier Imaging and MRI 9
  - Signal generation, sampling and detection
  - Image Reconstruction
- Fast imaging 6
  a. Data acquisition
  b. Image reconstruction
- Medical image analysis 9
  a. Image segmentation and clustering: genomic signal processing
  b. Image registration
  c. Quantitative analysis
- Review and project presentation 4

Total hours: 45

Classroom Behavior: Please be courtesy to your classmates and instructor. Setting your cell phone and beeper to mute mode is required in class.

Students Needing Support Services:
The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities, in Room 126 of the Koldus Building or call 845-1637.

"An Aggie does not lie, cheat, or steal or tolerate those who do."
Honor Council Rules and Procedures on the web http://www.tamu.edu/aggiehonor