ENGG*4660 Medical Imaging

School of Engineering
University of Guelph
Winter 2007

Instructor:

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Teaching Assistant:

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Schedule:

Class times: Tuesday, Thursday 11:30-13:00, MACK 229

Lab times (optional):

Monday 9:30-11:30 Thorn 2336
Wednesday 9:30-11:30 Thorn 2336
Wednesday 11:30-13:30 Thorn 2336
Friday 11:30-13:30 Thorn 2336

Course Description:

Medical imaging is a rapidly developing field within biomedical engineering. There is a demand both within the research community and in clinical support for people with knowledge of the imaging process for the various modalities and the digital image processing techniques for enhancing, restoring and manipulating digital images.

The course material will be divided into two parts. The first part will cover digital image processing techniques from a linear systems perspective. It will be assumed that the students have some background in linear systems theory and signal processing. The second will deal with the various imaging modalities such as x-ray radiography, CT, MRI, ultrasound, etc. The basic physics of image formation will be covered with emphasis on the parameters which affect image quality.

Course Objectives:

By completion of this course, you should be able to:

- Enumerate the factors affecting image quality for each imaging modality.
- Explain the physics of image formation for the various modalities.
- Contrast the uses of the different imaging techniques w.r.t. their advantages and disadvantages.
- Identify the sources of image degradation for the different modalities.
- Relate the point spread function to image resolution both in terms of spatial and spatial-frequency measurements.
- Perform filtering operations in both the spatial and spatial-frequency domains.
- Explain the effects and uses of the various image processing techniques on digital images.
- Given a corrupted image, justify a choice of image processing operators to restore or enhance the image, design and implement the operators, and evaluate both qualitatively and quantitatively the results.

Texts:

Course Text

Prince, Links, *Medical Imaging: Signals and Systems*, Pearson Prentice Hall, 2006

Reference Texts

Gonzalez, Woods, Eddins, *Digital Image Processing using MATLAB*, Pearson Prentice Hall, 2004
Gonzalez, Woods, *Digital Image Processing*, Addison-Wesley, 1992
Castleman, *Digital Image Processing*, Prenice Hall, 1996
Suetens, *Fundamentals of Medical Imaging*, Cambridge, 2002
Liang, Lauterbur, *Principles of Magnetic Resonance Imaging*, IEEE Press, 2000
Bronzino, *The Biomedical Engineering Handbook*, CRC Press, 2000

Evaluation:

Computer Labs/Assignments (4):		40%
Midterm exam	TBA	25%
Final Exam	April 11 19:00-21:00	35%

Tentative Topics:

Image Processing

- Digital imaging fundamentals: spatial resolution; quantization; analog to digital conversion
- Linear systems: point spread functions; convolution; Fourier analysis
- Point operations: contrast enhancement; histogram equalization; H and D curves
- Geometric operations: geometric distortions and corrections; bilinear interpolation
- Linear filtering: low pass filters; high pass filters; high frequency emphasis filters
- Image restoration: inverse, deconvolution; least squares restoration; nonlinear methods

Imaging Modalities

- X-ray radiography
- Computed tomography (CT)
- Magnetic resonance imaging (MRI)
- Nuclear medicine
- Ultrasound
- Positron emission tomography (PET)