ENU 5658: Image Analysis with Medical Physics Applications

Fall 2004

Time/place Tues. period 5,6 (11:45 -1:40), Thurs. period 6 (12:50 – 1:40), 225 NSC

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Open office hours: 2-5 T,Th (or by appointment)

Text *Radiological Imaging*, H.H. Barrett and W. Swindell

Additional reading will be assigned from technical journal articles and the following texts:

1. *The Essential Physics of Medical Imaging*, J.T. Bushberg
2. *Digital Image Processing*, K.R. Castleman
3. *The Fourier Transform and Its Applications*, R.N. Bracewell
4. *Foundations of Image Science*, H.H. Barrett and K.J. Myers

Grading

55% Homework and projects	A = 90 -- 100
10% Midterm I	B+ = 87 – 89, B = 80 – 86
15% Midterm II	C+ = 77 – 79, C = 70 – 76
20% Final	D = 60 – 69

Description The focus of this course is the study of imaging science within a radiographic context. The course covers the essential analytical tools of linear systems theory and the theory of stochastic processes and their application to radiographic imaging systems. Other topics covered in this course include the following: linear filtering of noisy images, sampling theory, image reconstruction from projections, image quality evaluation (model observers and ROC analysis).

Objectives Development of an in depth understanding of the essential analytical tools of imaging science applied to radiographic systems.

Prerequisites Calculus 1 and 2 and advanced linear or matrix algebra. Solid computer programming skills.

Attendance Policy On time class attendance is mandatory. Chronic tardiness or absence will negatively impact the final grade. There is zero tolerance for cell phone disruptions.

Make-up/Late Policy There will be no make-up of exams. Unless otherwise specified, homework is due at the beginning of class on the due date. Late homework will be penalized commensurate with the degree of lateness.

Students with Disabilities Students requesting classroom accommodation must first register with the Dean of Students Office. The Dean of Students Office will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodation.

Academic Honesty All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is a reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others.

Course Schedule

Subject	Topics	Period(s)
Imaging Intro	Clinical imaging modalities	1
	Digital image display	2
	Formats of computer image files	3
Linear Systems Theory and Application	Linear systems theory overview	4
	Non-local behavior, shift invariance	5
	Convolution	6
	Point spread function	7
	Sinusoidal input	8
	Fourier Transform overview, interpretation	9,10
	Fourier Transform properties	11
	Discrete FT implementation	12
	System/modulation transfer function	13
	Linear filters	14
	MIDTERM I	15
	Sampling theory	16
	Aliasing	17
	General radiological imaging model	18,19
	Transmission imaging model	20,21
Stochastic Theory In Imaging	Random variables, image noise	22,23
	Noise power spectrum, filtering noisy images	24,25
Computed Tomography	Radon Transform	26
	Sinogram, 2D Fourier Transform	27
	MIDTERM II	28
	Central Slice Theorem	29
	Filtered Backprojection	30
	Iterative/statistical reconstruction methods	31,32
Image Quality Evaluation	Overview of methods	33-34
	Receiver operating characteristic (ROC) analysis	35-38
	Model observers	39, 40
	FINAL	41

Reading Assignments

Topic	Reading
Clinical imaging modalites	Bush: Ch. 1
Digital image display	Bush: 4.1, 4.6
Linear systems theory, convolution, point spread function	B&S: 2.1-2.2, A.1 Cast: 9.1, 9.3
Sinusoidal input, Fourier Transform	B&S: 2.3, B.1-B.3 Cast: 9.2, 10.1-10.3 Brace: Ch. 2, Ch. 6
Linear filters	B&S: 2.4 Cast: 11.1-4
Sampling theory, aliasing	B&S: 2.5 Cast: Ch. 12 Brace: pp. 189-198
General radiological imaging model, transmission imaging model	B&S: 4.1,4.3
Stochastic theory in imaging	Bush: 10.3 Cast: 11.5.1-11.5.4
CT, Central slice theorem, filtered backprojection	B&S: 7.1-7.3.3
Iterative/statistical reconstruction	B&S: 7.3.5
Image quality evaluation overview	B&M: 13.1, 14.1 Bush: Ch. 10
ROC analysis	B&M: 13.2.1-13.2.5 Metz (1978)
Model observers	B&M: 13.2.6, 14.3.1