BME464/ELE564 Medical Imanging MWF 1:00-1:50 Kelley 216 Fall 2009
BME465/ELE565 Medical Imange Processing Lab R2-4:45, TBA

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week	date	lecture topics	reference
1	9/9	introduction, medical imaging systems	Chap 1
	9/11	physics of x-ray	
2	9/14	*GUI-based programming for image analysis (#1): intro*	
	9/16	x-ray contrast, SNR, dose	Chap 2
	9/18	quantum mottle, unsharpness, beam hardening	
3	9/21	*GUI-based programming for image analysis (#2): filters - tutorial by TA*	
	9/23	four generations of computer-assisted tomography (CAT) systems	Chap 4
	9/25	tomography reconstruction	
4	9/28	convolution, backprojection	
	9/30	Radon transform, inverse Radon Transform,	Chap 5
	10/2	central slice theorem	
5	10/5	**exam #1**	
	10/7	algebraic reconstruction technique	
	10/9	*GUI-based programming for image analysis (#3): area measurement*	
6	10/12	nuclear medicine: physics of radioactive isotopes	Chap 6
	10/14	scintillation gamma camera	
	10/16	single photon emission computed tomography (SPECT)	
7	10/19	no class (Columbus Day)	
	10/21	positron emission tomography (PET)	
	10/23	*GUI-based programming for image analysis (#4): area measurement*	
8	10/26	diagnostic ultrasound, physics and instrumentation	Chap 7
	10/28	2D and color Doppler echocardiography	
	10/30	color Doppler echocardiography	
9	11/2	clinical use of echocardiography	video
	11/4	magnetic resonance imaging (MRI)	Chap 8
	11/6	MRI physics and instrumentation	
10	11/9	**exam #2**	
	11/11	no class (Veterans' Day)	
	11/13	*GUI-based programming for image analysis (#5): final project*	handout
11	11/16	student project presentation - Phase I	
	11/18	student project presentation - Phase I	
	11/20	research topic: automated analysis of mitochondria images	handout
12	11/23	research topic: automated tracking of blood vessels	handout
	11/25	research topic: directional low-pass filter	handout
	11/27	no class (Thanksgiving recess)	
13	11/30	research topic: recursive tracking of vascular trees	handout
	12/2	research topic: 3D reconstruction of blood-vessel imagery	handout
	12/4	research topic: Back-propagation networks for blood vessel detection	handout
14	12/7	research topic: surface integration of velocity vectors	handout
	12/9	student project presentation - Phase II	
	12/11	student project presentation - Phase II	
15	12/18	**final exam** Monday, 9-11 am, K216	

GRADING: exam #1 (25%), exam #2 (25%), final exam (25%), project (25%).

TEXT: "The Physics of Medical Imaging", by S. Webb, New York: Adam Hilger, 1990.

PAPERS: Listed on the reverse side.

BME 464 Medical Imaging: List of reference papers

1. Guo Y, Gong B, Levesque S, Manfredi T, Sun Y. Automated detection and delineation of mitochondria in electron micrographs of human skeletal muscles. *Microscopy Research & Technique* 63: 133-139, 2004.

2. Sun Y. Automated identification of vessel contours in coronary arteriograms by an adaptive tracking algorithm. *IEEE Trans Med Imaging* 8: 78-88, 1989.

3. Sun Y. Spatial frequency characteristics of vessel geometry and densitometry in coronary arteriograms. *Optical Engineering* 29: 1255-1259, 1990.

4. Kottke DP, Sun Y. Segmentation of coronary arteriograms by iterative ternary classification. *IEEE Trans Biomed Eng* 37: 778-785, 1990.

5. Liu I, Sun Y. Fully automated reconstruction of 3-D vascular tree structures using computational algorithms and production rules. *Optical Engineering* 31: 2197-2207, 1992.

6. Liu I, Sun Y. Recursive tracking of vascular networks in angiograms based on the detection-deletion scheme. *IEEE Trans Med Imaging* 12: 334-341, 1993.

7. Sun Y, Liu I, Grady JK. Reconstruction of 3D tree-like structures from three mutually orthogonal projections. *IEEE Trans Pattern Analysis Machine Intelligence* 16: 241-248, 1994.

8. Nekovei R, Sun Y. Back-propagation network and its configuration for blood vessel detection in angiograms. *IEEE Trans Neural Networks* 6: 64-72, 1995.

9. Sun Y, Lucariello RJ, Chiaramida SA. Directional low-pass filtering for improved accuracy and reproducibility of stenosis quantification in coronary arteriograms. *IEEE Trans Med Imaging* 14: 242-248, 1995.

10. Sun Y, Ask P, Janerot-Sjöberg B, Eidenvall L, Loyd D, Wranne B. Estimation of volume flow rate by surface integration of velocity vectors from color Doppler images. *J Am Soc Echocardiography* 8: 904-914, 1995.

11. Sun Y, Nekovei R. Medical Imaging. In: *Image Processing and Pattern Recognition,* Vol. 5 of *Neural Network Systems Techniques and Applications,* edited by Leondes CT, New York: Academic Press, 1998, pp. 89-131.

Course Content:

BME464 Engineering and clinical applications of medical imaging systems including X-ray, computed tomography, radioisotope imaging, ultrasound, magnetic resonance imaging; picture archiving and communications system and medical image processing. (Lec. 3)

BME465 Development of medical image processing algorithms with graphical user interface in C++ under the Windows operating system: smoothing and sharpening filters, morphological filters, area measurement and edge tracer. (Lab. 3)

Objectives:

- To Understand Understand the physics, mathematics, engineering, and clinical applications of medical imaging systems including x-rays, computed assisted tomography, angiography, gamma camera, single photon emission computed tomography, positron emission tomography, ultrasound imaging, and magnetic resonance imaging.

- To Question Think critically about design tradeoffs in medical imaging systems and computer algorithms for medical image processing, alternatives, and verification and validation methods for medical image processing algorithms.
- To Design Design and develop medical image processing algorithms for image enhancement, feature detection, automated analysis, and quantitative measurements by use of modern software development tools.
- To Communicate Improve communication skills through oral presentation and written project reports.

Outcomes:

- Demonstrate an understanding of the physics, mathematics, engineering, and clinical applications of medical imaging systems.
- Apply mathematical analyses to medical image processing problems.
- Demonstrate the proficiency of developing application software using graphical user interface under a modern C++ based software development system.
- Demonstrate the ability to design algorithms for solving specific medical image processing tasks.
- Demonstrate the ability to implement the aforementioned algorithms using the available software development tools.
- Present the completed projects in both oral and written formats.

Any student with a documented disability is welcome to contact me as early in the semester as possible so that we may arrange reasonable accommodations. As part of this process, please be in touch with Disability Services for Students Office in Memorial Union, room 330 or phone 874-2098.

Special Notes about Illness Due to Flu

The H1N1 Flu Pandemic may impact classes this semester. If any of us develop flu-like symptoms, we are being advised to stay home until the fever has subsided for 24 hours. So, if you exhibit such symptoms, please do not come to class. Notify me at 874-2515 or sun@ele.uri.edu of your status, and we will communicate through the medium we have established for the class. We will work together to ensure that course instruction and work is completed for the semester.

The Centers for Disease Control and Prevention have posted simple methods to avoid transmission of illness. These include: covering your mouth and nose with a tissue when coughing or sneezing; frequently washing your hands to protect from germs; avoiding touching your eyes, nose and mouth; and staying home when you are sick. For more information, please view http://www.cdc.gov/flu/protect/habits.htm. URI information on the H1N1 will be posted on the URI website at http://www.uri.edu/news/H1N1, with links to the http://www.cdc.gov site.