CAP6516: Medical Image Analysis

Prerequisites: CAP5416 or equivalent is desired. Proficiency in Matlab or C/C++ and any image display software that is freely available to you for use in doing the programing assignments and project is a MUST. If you do not have any of the above, you must get the consent of the instructor prior to registering for this class.

Texts and Other Material: There is NO text book for this class. Hoever, there are several references and they are:

1. *Medical Imaging Signals and Systems*, by Jerry Prince & Jonathan Links, Publisher: Prentice Hall.
2. *Digital Image Processing*, by Rosenfeld and Kak (Vol. 1); Publisher: Academic Press.
3. *The Fourier Transform and its Applications*, by Bracewell, McGraw Hill.
4. *Level-set Methods*, by J. A. Sethian, Cambridge University Press.
5. *Geometric Partial Differential Equations*, G. Sapiro, Cambridge University Press.
6. *Mathematical Problems in Image Processing*, G. Aubert and P. Kornprobst, Springer Verlag.
7. *Numerical Solution of PDEs in Science and Engineering* Lapidus and Pinder, McGraw Hill.
8. *Other Material:* Papers from the following journals, *IEEE TPAMI, IEEE TMI, CVGIP, IJCV, JMIV, and IEEE TIP*; Some of these material will be handed out in class.

Instructors: Prof. Baba Vemuri.
Office hours: MW 9th period.
Grading:

1. Hwks. & Programs: 10% – All programing assignments will involve submission of a report with the results in the form of images and matlab code.
2. Midterm : 25%
3. Presentations: 25% – All presentations must use multimedia (laptop-based).
4. Project: 40% – All projects will involve a short (at most 10 pages including figures and refs.) report and a live demo.

Syllabus

Medical image formation, reconstruction mathematics (Fourier slice theorem, Abel, Hankel and Radon transforms), PDE-based denoising, active 2D/3D models and segmentation, segmentation via bayesian estimation, shape priors, Image matching/registration with application to uni- and multi-modal co-registration, diffusion MRI analysis, shape/image classification.

Tentative schedule of lectures

1. Image data acquisition: CT, MR, ultrasound.
2. Fourier, Abel, Hankel transofrms, sampling theorem.
3. CT reconstruction mathematics, backprojection.
4. Discrete and Fast Fourier Transforms.
5. Image restoration via diffusion filtering.

6. Geometric active contours and image segmentation
7. Clustering and Bayesian segmentation methods.
8. Matching and image registration.
9. Diffusion MRI analysis
10. Shape/image classification.