CSE/BioE 320/420: Biomedical Image Computing and Modeling

Short Programming Assignment 1

Due on Friday September 18, by midnight

In this assignment, you are given several medical image datasets, and a microscopic neuron image dataset. You can find these images in the "Sample_Images" folder on Course Site. Your task is to read and display these images, and perform some image processing/analysis tasks.

You can choose to use Matlab, C/C++, or Java. Some software libraries that can assist you in completing your homework are listed in the document "Computing_resources.pdf", which is posted on Course Site.

Requirements

1. Brain or Heart image (in DICOM format), or some other DICOM image of your own choice (e.g. an image that you intend to use for your course project)

   - Write a program to read the DICOM image stack, and display the image slices in a window. For instance, you can show the image slice by slice in a loop, with a short pause in-between slices. Or you may develop a simple user interface with controls such as *next slice, previous slice*, *go to first slice*, *go to last slice*, etc. (**Note:** you may need to use the "InstanceNumber" property in dicom header to sort the image slices properly.)
   - Read the Dicom header information of the stack, and output some key parameters such as slice thickness and pixel spacing.
   - The slices in the image are axial slices. Use image processing, e.g. image interpolation, techniques to generate the corresponding coronal slices. Write the coronal slices out in a new DICOM image.
   - Use thresholding and morphological operations to segment the head (or the heart) from the background. The segmentation result can be saved as a stack of 2D binary masks, one per image slice.
   - Implement the Region Growing algorithm, or use Connected Component Analysis to segment a region of interest (e.g. white matter in the brain, left ventricle in the heart, dark Cerebrospinal fluid region in the brain). The user is allowed to interactively input one or more seed points inside the region of interest to either start region growing, or select the connected region that is to be segmented.

2. Time-lapse actin filament movie (in multi-image TIFF format, 24 images in total)

   - Apply two smoothing methods on the image and display their outputs. For instance, you can try Gaussian smoothing, median or mean filtering.

- Enhance the contrast of the image, if necessary. You can try and compare the results from several different contrast enhancement methods, such as histogram equalization and linear stretching.
- Use thresholding, edge detection, or ridge point detection algorithms to detect, segment, and even track the filaments in the image. (**Note:** detection and segmentation of the filaments on one image are required; tracking is optional.)

What to hand in

1. A brief summary of your image processing steps and key results from these steps.
2. Your code implementing all the required (and optional) image analysis tasks.
3. A README file describing how to test your code and view the outputs.

Your completed work should be submitted via Course Site.

Acknowledgements

The brain image dataset is obtained from the Surgical Planning Laboratory, Department of Radiology, Brigham and Women's Hospital, Harvard Medical School. The actin filament image is obtained from Dr. Ikuko Fujiwara (NHLBI/NIH) and Dr. Thomas Pollard (Yale University). The Neuron image dataset is obtained from Dr. Michael Burger (Lehigh) and his collaborators.