

<http://www.cs.ucf.edu/~bagci>

[PROGRAMMING ASSIGNMENT] (3)

MEDICAL IMAGE COMPUTING

DR. ULAS BAGCI • (SPRING) 2017 • UNIVERSITY OF CENTRAL FLORIDA (UCF)

Coding Standard and General Requirements

Code for all programming assignments should be **well documented**. A working program with no comments will receive **only partial credit**. Documentation entails writing a description of each function/method, class/structure, as well as comments throughout the code to explain the program flow. Both main code and necessary *cmake* files need to be submitted.

Submit by **14th of April 2017**, 11.59pm.

Deformable Image Registration [10 pts]

Implement a deformable image registration method (use ITK algorithms or your own developed algorithms integrated into ITK path) to register two thoracic CT scans. Accurate registration of thoracic CT is both extremely useful in clinical terms and exceptionally challenging due to the elastic nature of lung tissue deformations. Note that two thoracic CT scans in the download section belongs to the same subject; hence, it is mono-modal image registration you are being asked to implement. You are free to choose the type of registration algorithm from the deformable image registration family (Free Form Deformation (FFD with B-splines), Elastic, Fluid, Diffeomorphic, Demons, etc.).

Your tasks:

- Download fixed and moving image files (chest CTs) in mhd/raw format.
- Download lung masks of fixed and moving imaging files in mhd/raw format.
- Filter fixed and moving images with corresponding lung masks so that resulting images include only lung portions with gray-scale values. Save those new image files to be registered in the next steps.
- Select an appropriate deformable registration type.
- Select an appropriate similarity function (i.e., normalized cross correlation, normalized mutual information, sum of squared difference, etc.)
- Select an appropriate optimization function (i.e., Gauss-Siedel, steepest gradient, etc.)
- Select an appropriate scale parameter (if multi-scale option is willing to be included, scale=2,3,4..).
- You are supposed to "overlay" two images (using ITKSnap, Slicer, FIJI, or some other software) to show qualitatively how registration improves the alignment. You need to show overlays both "before" and "after" registration. Note that overlay images usually better to be shown in different color.
- Visualize deformation field, and calculate Jacobian determinant of the deformation (displacement) fields. Comment about what Jacobian determinant tells us.

- Although overlap measure is not entirely a true metric for measuring image registration's quality, please indicate how overlap measure (i.e., dice) changes before and after. Since lungs are already segmented and given to you, it should be fairly easy to see the changes.
- Submit a report indicating the steps of your algorithm briefly, and show the overlay images as described above. Include Dice and Jacobian Determinant values and comments related to their values.
- Submit registered images and codes (along with executable) via webcourse.

You are allowed to use existing codes in ITK

Some example ITK codes can be found in the following:

<http://www.itk.org/ItkSoftwareGuide>

<http://itk.org/Wiki/ITK/Examples>

Example code for **difference operation on two images**:

<http://itk.org/Wiki/ITK/Examples/ImageProcessing/SquaredDifferenceImageFilter>