RC 154 and 354: Freeware, Shareware, and Open-Source Imaging Tools for Radiology

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Disclosures

- The software described here is not approved for clinical purposes and should not be used for diagnosis or treatment.

Goals

- Address a large variety of image analysis problems.
- Generate "a-ha" moments

Quantitative radiology

- Quantitative radiology is the way of the future
- The limitations of your PACS workstation
- Automation
- Repeatability

Outline

- Introduction
- Exercises

Introduction

- Experience levels
- What kind of problems do you need to solve?
- Why is open source / freeware / shareware interesting?
  - Can be modified?
  - Cheap?
  - Rage against large corporations?

Plan

- Review the four major tasks
- Filtration
  - “improving” an image
- Segmentation
  - isolating what is important in an image, a structure or a feature
- Registration
  - placing objects into a common spatial context
- Display
  - showing results to a human observer

Sample applications

- Why is (fill in my favorite application) not included?
- Windows, Mac, *Nix
- Variety of tools, with different advantages

Application 1: ImageJ

- Multi-format image analysis tool
- Java (runs essentially everywhere)
- Open source
- Sponsor: research services branch, NIMH (Wayne Rasband)
- http://rsb.info.nih.gov/ij/
- Audience: everyone
- Why I like it and use it

ImageJ
Image Processing and Analysis in Java

Application 2: MIPAV

- MIPAV = Medical Imaging Processing, Analysis and Visualization
- Java (runs essentially everywhere)
- Freeware
- Sponsor: Center for Information Technology, NIH (Matthew McAuliffe)
- http://mipav.cit.nih.gov/
- Audience: Biomedical imagers
- Why I like it

MIPAV

Application 3: MRIcron

- 3D Display software
- Lazarus (freepascal): (runs essentially everywhere)
- Open source
- Sponsor: Chris Rorden, University of South Carolina
- http://www.sph.sc.edu/comd/rorden/mricron/
- Audience: Brain researchers
- Why I like it

Communications

- One hand in the air: question
- Two hands crossed in the air: technical problem

Notes

- Memory hogs! Quit one program before opening others

Exercise 1: Load and Display

- Loading and displaying 2D images, singly or in series
  - .dcm
- Loading and displaying volumetric image sets
  - Analyze, nifti
- Windowing and leveling

Exercise 2: DICOM

- Working with DICOM images
  - Viewing header information
  - Why important?

Exercise 3: Ins and Outs of ROIs

- Region-of-interest analysis
  - Creating
  - Saving
  - Measurements

Exercise 4: Programming and macros

- Recording your moves
- Saving what you did
- The power of macros
- Other methods to extend programs

Exercise 5: Filtration

- Simple Filtration
  - Gaussian smoothing
  - Median filtering
  - Edge detection
- Complex Filtration
  - Anisotropic diffusion filtering
- Why filter?

Exercise 6: Thresholding

- A part of segmentation
- Background vs. foreground
  - Many foregrounds!
- Binary images
- Multi-Otsu Thresholding
- Binary operations

Exercise 7: Image Math

- Addition, Subtraction, Multiplication, Division
- Min and Max
- Image calculations

Exercise 7: Putting it together for DWI

- Calculate ADCs.
- $S = S_0 \cdot e^{(-b\ ADC)}$
- $ADC = (\ln(S_0/S))/b$
- Radiology standard, ADC measured in 10^{-3} mm^2/sec
- If $b = 1000\ sec/mm^2$, then

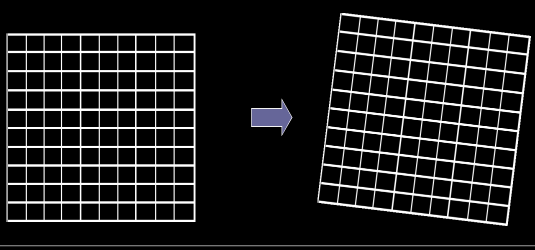
  $ADC_{radiology} = \ln (S_0/S)$.

Exercise 8: level sets

- Level sets used to find brain tumor, to find ventricular outlines.
- Is the intensity the same? Then continue propagating outward. Is it changing? Then slow down.

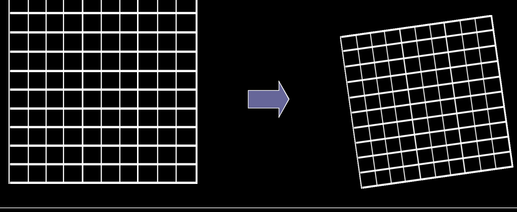
Exercise 9: Image Registration 1

- Rigid body registration



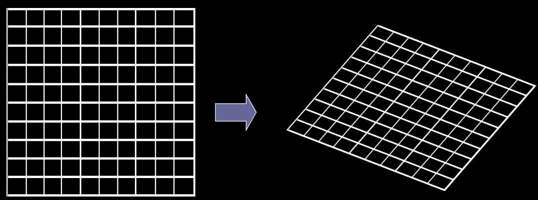
Exercise 9: Registration 2

- Rigid body + scale:



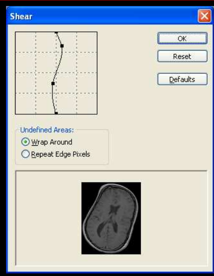
Exercise 9: Registration 2

- Affine registration



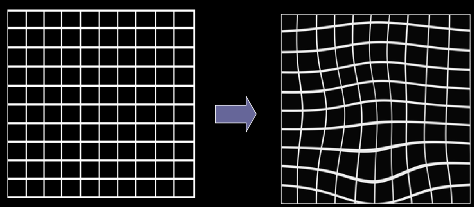
Exercise 10: Registration 2

- Does affine regstration work in a case like this?



Exercise 10: Registration 3

- Non-rigid registration



Exercise 11: Registration to an atlas

- Register to atlas or standard data
- Example of localization

Exercise 12: 3D Imaging

- Reformatting
- MIP
- Surface rendering

Exercise 13: Beyond 3D imaging

- 4D imaging
  - 3D imaging over time
- 5D imaging
  - Time, channel

Making your computer a PACs node

- K-Pacs , Windows (http://www.k-pacs.de/)
- Osirix, Mac (http://www.osirix-viewer.com/)
- ConQuest, Unix (http://www.xs4all.nl/~ingenium/dicom.html)

Discussion

- Differences between freeware, shareware and open source
- Capabilities
- Advantages
- Drawbacks

Resources

- Resources
  - Internet Analysis Tools Registry (IATR) : http://www.cma.mgh.harvard.edu/iatr/
  - Neuroimaging Informatics Tools and Resources Clearinghouse (NITRC) http://www.nitrc.org/
  - Idoimaging (Andrew Crabb): http://www.idoimaging.com/index.shtml
  - Open source http://www.dclunie.com/papers/PACS2006OpenSource.pdf

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