ENSC 477 / 895 Medical Image Acquisition

Lab #1, Assigned Friday, Sept 27, 2019. Due on Oct 10, 2019 at 11:59pm. (NOTE: this material will be testable on the midterm). Meet in room ASB 10878. The TA for this lab is Nic Zilinski. You can reach him by email at nzilinsk@sfu.ca.

Part I: Simulation of X-ray CT acquisition

A brief demonstration of a simulated Computed Tomography (CT) measurement will presented in the laboratory. The goal of this measurement is to acquire data similar to computed tomography, but using an optical system and total absorbers. A photograph of the mock-up is included in Figure 1. The purpose is to expose you to the concepts and principles of CT, without exposing you to X-ray radiation.

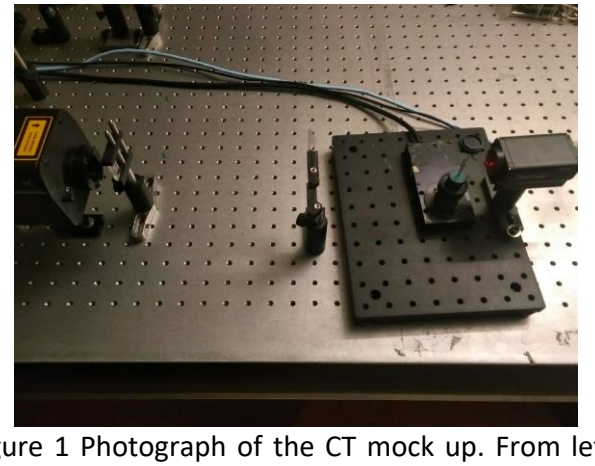

Figure 1 Photograph of the CT mock up. From left to right: Laser; cylindrical lenses ("collimator"); rotation stage; detector.

Your objective is to acquire projection data over multiple rotations, and to graph the results as a sinogram. Then process the data to make an image using the back-projection algorithm discussed in class. Compare the results from your implementations of unfiltered and filtered back-projection. **Do not just use the built in Radon transform function** (but you can use it to compare your results).

What to submit:

1) Draw a sketch (top down view) of the object that you will attempt to image.

2) Print an image of the sinogram you acquired. Label your axes. Also label the traces that correspond to objects nearest and furthest from the rotational axis. Explain your rationale for the degrees of rotation and the number of acquisitions.

3) Document how you did the back-projection processing. (submit your code)

4) Document how you added the filtered back-projection processing. (submit your code)

5) Print out the reconstructed image and compare to the hand sketch.

Part II: Effects of noise and filtering in X-ray CT

Next refer to the file sino1.bmp. Load this file and perform the CT reconstruction. Compare back projection results with and without filtering. The original sinogram in sino1.bmp has high intensity and very low zero noise. This is an unrealistic case for medical imaging. Consider the effects of noise on your sinogram. In MatLab, you can use the function 'imnoise' to simulate adding noise to your system. Next, consider the effects of using a lower dose (this can be done by dividing the original data by a constant, (for example 2x, 5x, 10x, etc) in the presence of noise. This will affect your SNR.

What to submit:

6) Image of reconstructed image, no noise, with and without filtering.

7) Comparison of reconstructed images in the presence of varying amounts of noise, with and without filtering.

8) A discussion of your results in the context of the course concepts.

Part III: CT visualization

The last part of this laboratory will be to gain introductory experience with medical image visualization software. There are several variations of very powerful but free software on the internet. One suggestion is to use MIPAV, which can be downloaded here: http://mipav.cit.nih.gov/. Another suggestion is FIJI, which can read the file format. Fiji is a very powerful and freely available tool for image processing and visualization: http://fiji.sc/Downloads. You may use the 3D visualization software of your choice.

For your lab report, obtain a volumetric CT data set. Generate and display a volumetric rendering, an axial slice, coronal slice, and a sagittal slice (using the definitions in the text).

Publically accessible medical image databases are available. There are multiple sources of public medical image databases. Here is an example of a database funded by the National Institutes of Health (NIH), a government research funding agency in the USA:

https://imaging.nci.nih.gov/ncia/login.jsf

And another one from The Cancer Imaging Archive:

http://www.cancerimagingarchive.net/

There is also some Xray CT reconstructions from a thoracic dataset on this webpage:

http://www.via.cornell.edu/crpf.html

Lab Reports

Lab reports are to be completed in groups. Submit a single report per group. Expected length is ~5 pages, using the standard laboratory report sections (Intro, Methods, Results, Discussion). Labs will be graded for presentation quality as well as content.