

## 51:185 PAMI I Midterm Examination II

Name: \_\_\_\_\_

On my honor I have neither given nor received aid from any individual other than my instructor on this examination.

Signed: \_\_\_\_\_

This examination is due in class on Monday, April 18, 2005. Hand in calculations, explanations, code, and images used in answering the examination. Carefully explain all approaches, thinking, and techniques. The data files are in the class web site at: ~bme185/P\_185/ExamIIS05. You can access these from the class web page under "Supplemental Material/Image Examples/ExamIIS05".

### Problem A:

On March 29, 2005 we collected the following 6 DICOM files from the Siemens SOMATOM Sensation Cardiac 64 located in Dr. Hoffman's laboratory (complements of Mr. Earl Nixon). These files are:

- b30f050-water.dcm: water phantom with medium b30f recon filter and 50mAs
- b60f050-water.dcm: water phantom with sharp b60f filter and 50mAs
- b30f100-water.dcm: water phantom with medium b30f filter and 100mAs
- b60f100-water.dcm: water phantom with sharp b60f filter and 100mAs
- b30f100-wire.dcm: wire phantom with medium b30f filter and 100mAs
- b30f050-lp.dcm: line pair phantom with medium b30f filter and 50mAs

Based on the data in these files, answer the following questions:

1. Determine the pixel size of the image in b30f050.dcm.
2. Calculate an estimate (mean  $\pm$  sd) of the accuracy of the Siemens machine.
3. Calculate an estimate of noise introduced by the Siemens machine. The noise effects should be calculated using at least two different methods. One of the methods must be an attempt to calculate the information content of the image.
4. What is the effect on noise and accuracy of the two different filters used in the filtered backprojection algorithm? Base your answer on a quantitative analysis.
5. What is the effect on noise and accuracy of X-ray beam intensity (anode current)? Base your answer on a quantitative analysis.
6. Estimate the spatial resolution of the machine. The line pairs are separated by (in cm) 0.5, 0.25, 0.167, 0.125, 0.1, 0.083, 0.071, 0.063, 0.056, 0.05, 0.045, 0.042, 0.038, 0.036, 0.033, 0.031, 0.029, 0.028, 0.026, 0.025, 0.024.

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7. Calculate and display the modulation transfer function of the machine (assuming that the wire in b30f100-wire.dcm is a “point” in space).

### Problem B:

On March 29, 2005 we collected the following two data files from the MicroCAT II machine (complements of Ms. Jacque Thiesse): microCTPhantomSheppLogan.dcm and microCTPhantomHamming.dcm. Also there are two accompanying log files.

1. Determine the pixel size of the microCT machine used to derive the images.
2. What is the effect on image “quality” of using the Shepp-Logan filter and the Hamming smoothing filter in performing the filtered backprojection algorithm?

### Problem C:

Please answer the following questions.

1. The “standard” method for forming a CT image involves the Discrete Fourier Transform (or the FFT implementation). Suppose that you don’t have any Fourier Transform algorithms handy. How can you form a CT image from the measured projections without using the Fourier Transform?
2. Why is it necessary to have the “filtered” part of the standard filtered backprojection algorithm?

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```
[filename, pathname] = uigetfile('*.*dcm', 'Select an image file'); %get file name
if isequal(filename,0)|isequal(pathname,0)
    errordlg('File not found','File error', 'modal');
end
[pathstr,name,ext,versn] = fileparts(filename); %Get file information
if ext=='dcm' %If DICOM
    info = dicominfo(filename); %Read header information from DICOM File
    Image = dicomread(info); %Read DICOM file
    Image=im2double(Image); %If necessary, convert data to double
end

imtool(Image); %Display Image [or imview(Image)]

uid = dicomuid; %Create DICOM Unique Identifier
info.SeriesInstanceUID = uid; %Stuff it into DICOM Header
dicomwrite(Image,outname,info);
```