Lab 2: CT image reconstruction with parallel x-ray beam

Student name: **Total mark:** / 5

Student number: **TA signature:**

The Matlab Image Processing Toolbox contains functions that perform both the Radon and inverse Radon transforms ('radon' and 'iradon') for CT image reconstruction with parallel x-ray beam geometry. Learn how they work at the MathWorks website: shttp://www.mathworks.com/help/images/examples/reconstructing-an-image-from-projection-data.html . Also read documentations of 'radon' and 'iradon' by typing 'help radon' and 'help iradon' on the command line.

Instructions

- Complete all three parts of the lab below following the instructions.
- Answer all questions using complete sentences in the boxes provided. Answers may be typed or hand-written **legibly**. You may exceed the box size if necessary.
- Before leaving the lab, give the completed lab sheet to the TA.
- If a printer is unavailable, please inform the TA.
- If you have any questions, please do not hesitate to ask.

Part I [1 mark]: _____ / 1

(1) Download an abdomen phantom image from: http://www.imp.uni-erlangen.de/phantoms/abdomen/abdomen.html. Show the image.
(2) Convert the image data into double-precision data using 'im2double'. Show the converted image using 'imshow' with a colorbar.
(3) Apply the Radon transform to the phantom so as to have the projections with angles θ from 0 to 179 degrees with 1 degree step. Show the sinogram of the projections using "imagesc" with a colorbar.
(4) Apply the inverse Radon transform to the projections to reconstruct the object. Show the reconstructed image with a colorbar.
(5) Is the reconstructed phantom image identical with the original one in (2)? Justify your answer.

Part II [1 mark]: _____ / 3

(1) Using the phantom image in Part 1, set the projection step angle 5-degree. Show the sinogram with a colorbar.
(2) Reconstruct the image. Show the reconstructed image with a colorbar.

(3) Compare the reconstructed images with the original one in Part I (2). Are they identical? If not, explain what the cause(s) of the difference is (are).

(4) Try different frequency domain filters in inverse Radon transform. The default filter is Ram-Lak (ramp filter). See 'iradon' documentation. Discuss the effect of the filter type on reconstructed image quality. *Hint: Consider each filter's responses' shape*

(5) Repeat (1)-(4) with an angle step bigger than 5-degree. Describe the effect this has on the results. For an actual CT, why might one not want to use a very small angle step size?

Part III [1 mark]: _____ / 1

(1) Download an actual CT image of human body parts from the internet. Show the image.
(2) Perform the tasks (2)-(5) in Part I on this image.
(3) Perform the tasks in Part II on this image.
(4) What are the advantages and disadvantages of using a phantom image?