Biomedical Imaging

Exercise XCT #2 – Sinogram and CT Image Reconstruction

The objective of the exercise is to emulate the process of CT data generation (sinogram) and implement various CT image reconstruction approaches including simple backprojection (BP), filtered backprojection (FBP) and Fourier transform (FT) based reconstruction. Different filter settings in FBP and FT reconstruction and their impact on spatial resolution will be investigated.

To start, please download the Matlab code for XCT_EXERCISE2 from https://moodle-app2.let.ethz.ch and unpack the *.zip file on your computer. Please document and report results of the exercise using Word/PowerPoint.

Task 2.1

- Reconstruct the object whose sinogram taken at angle of 0 to 180 deg. is shown below (*using pencil and paper*, *Figure 1*).

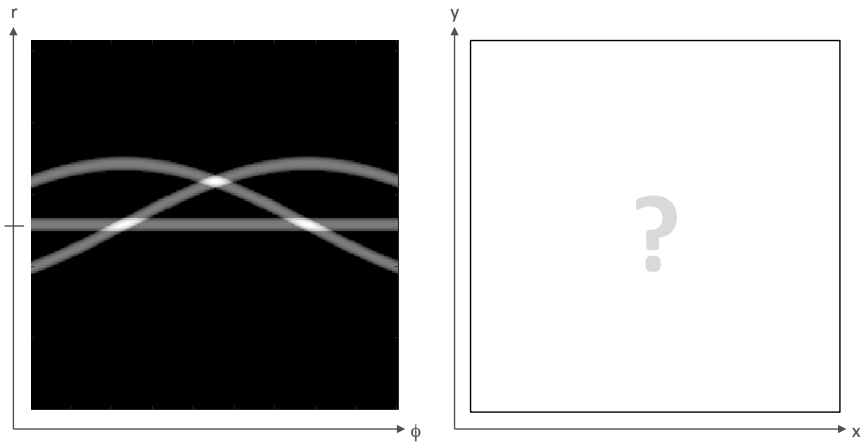

Figure 1: Sinogram (left); sketch the corresponding object (right).

- Start Matlab and enter "XCT_EXERCISE2"; the simple thorax phantom as implemented in Task 1.3 is displayed.
- Open XCT_EXERCISE2.m in the editor and read the code lines and comments carefully.
- Run the code to generate the sinogram of the thorax phantom and interpret the result.

Task 2.2

- Implement image reconstruction using simple backprojection
- Explain why the resulting image is blurred?

Task 2.3

- Copy code from Task 2.2 to implement filtered backprojection.
- Implement an ideal high-pass filter in function *CalcFilter* to correct for image blurring[1].
- Why are "streak" artifacts seen? Correct "streaking" by combing the ideal high-pass with a low-pass filter.
- Plot the Fourier transform pair of the ideal and the modified filter and discuss trade-offs (*see Figure 2*; here *r* refers to position in space while *u* denotes spatial frequency).

[1] You may use functions *R2U()* and *U2R()* to transform between image and spatial frequency space (forward/inverse Fourier Transform (FT)).

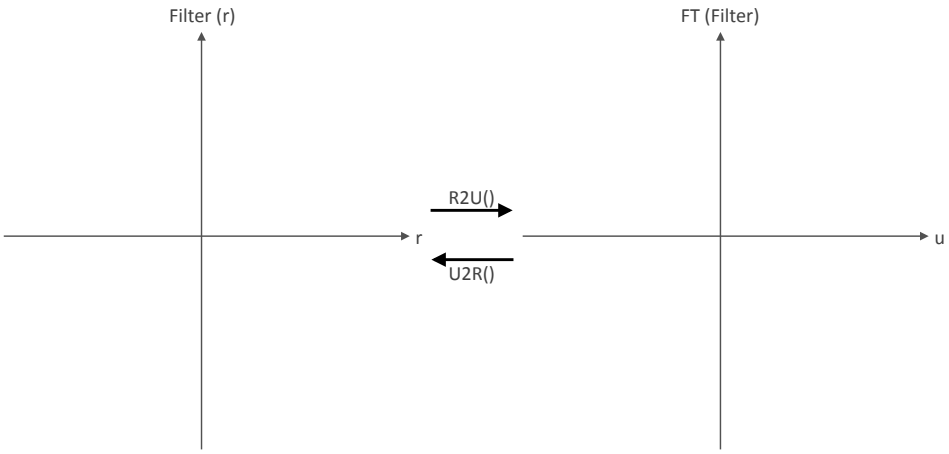

Figure 2: Filter in spatial domain (left) and corresponding depiction in spatial frequency domain (right).

Task 2.4

- State the Fourier-Slice theorem. Derive the relation between a projection and its Fourier transform.
- Implement image reconstruction from projections using the two-dimensional (2D) Fourier transform.
- Compare reconstruction result with result obtained in Task 2.2.
- Why are there image artifacts? (hint: inspect the Fourier space of your data)
- Implement data gridding[2] in the Fourier space to correct for image artifacts.

Questions?

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[2] See: griddata() in Matlab