Medical Imaging Systems (Spring 2021)
Assignment 1

Back-projection reconstruction of Computed Tomography

During the CT lectures, we introduced back-projection as an image reconstruction method frequently used in Computed Tomography. In this assignment, you are requested to implement this image reconstruction method. In addition, you will play with imaging parameters to gain more understanding of this image reconstruction method.

1. In Matlab, there are two related functions to be used: radon and iradon. Please read Matlab help documents for instructions and do the following.

1.1 Take one of your real life photo, resize and crop it to be 512x512, and convert it to be gray scale.

1.2 Use Matlab functions to generate 1D projections of the photo (called sinogram).

1.3 Use Matlab functions to do back-projection reconstruction.

1.4 Use Matlab functions to do filtered back-projection reconstruction. Use the default the Ram-Lak filter (or called ramp filter).

[Simulation parameters]

1. Projections: 0 degree to 180 degrees with 3 degree of increment.
2. Projections: 0 degree to 180 degrees with 0.3 degrees of increment.

2. Now, you are asked to redo 1 from scratch. You may not use Matlab functions radon and iradon.

2.1 Write a code to generate 1D projections of the image.

2.2 Write a code to perform back-projection using 1D projections from 2.1.

2.3 Write a code to perform back-projection as in 2.2 but with ramp filtering in frequency domain.

2.4 Write a code to perform back-projection as in 2.2 but with ramp filtering in spatial domain.

(hint: Please read the attached slides from a MIT course slides for explanation of how to implement a Ram-Lak filter.)

[Simulation parameters]

1. Projections: 0 degree to 180 degrees with 3 degree of increment.
2. Projections: 0 degree to 180 degrees with 0.3 degrees of increment.

3. Comparison of reconstruction results. (Please compare your results both qualitatively and quantitatively.)

3.1 Compare and discuss two sets of simulation parameters.

3.2 Compare and discuss back-projection and filtered back-projection results.

3.3 Compare and discuss Matlab functions and your implementation regarding image quality and efficiency.