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Image Reconstruction: Filtered Backprojection and Iterative Reconstruction

Computational Physics PHYS-6260-A

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1 Statement of Problem and Progress

Medical physics is the sub-field in which this project topic pertains to. Medical physicists often ensure the safety and efficient of imaging and radiation treatment modalities. This includes but is not limited to CT (Computed Tomography) image reconstruction. Image reconstruction in CT is a mathematical process that generates tomographic images from X-ray projection data acquired at many different angles around the patient. Two major categories of reconstruction methods exist, analytical reconstruction and iterative reconstruction (IR). With the most commonly used analytical reconstruction algorithm being the filtered backprojection (FBP). The goal of this project is to write a python script using the physics behind both the FBP and IR methods to perform image reconstruction similar to CT image reconstruction.

The image I am using is a Shepp-Logan phantom. The Shepp-Logan head phantom is widely used in computed tomography for testing the quality of reconstruction algorithms. I have written code that functions as the radon transform, so I can process the Shepp-Logan phantom and create a sinogram. However, there is a little bit of a problem. I am using a package I am unfamiliar with, which is the Pillow package in python. I can obtain the image of the Shepp-Logan phantom in my code, but the sinogram comes out as a blank image. The issue is somewhere with the indices I am using. I am continuing to work on this problem, however I have obtained sinogram data of an image from a Ph.D student in the Medical Physics Department at Georgia Tech in the worst case that I am unable to get the radon function to work properly and with your permission will be able to use it.

Once the sinogram data is obtained I can reshape it into a matrix of proper size and start running the IR script. Creating a system matrix will then allow me to solve a system of linear equations, where the solutions will be the image.

2 Milestones

Filtered Backprojection (FBP)

- Get familiar with the Pillow package in python and other image commands. (Completion estimate: Pending)
- Construct a Ramp filter. (Completed)
- Complete the code for the fourier transform of the image from the spatial domain to the frequency domain. (Completion estimate: 4/8/2023).
- Implement the Ramp filter along side the fourier transform of the image. (Completion estimate: 4/10/2023)
- Write the code for the inverse fourier transform. (Completion estimate: 4/13/2023)
- Obtain the original image excluding the 1/r blurring effect. (Completion estimate: 4/15/2023)
- Reconstruction of an image other than the Shepp-Logan head phantom. (Completion estimate: 4/15/2023)

Iterative Reconstruction (IR)

- Create system matrix. (Completion estimate: 4/8/2023)
- Implementation of system of linear equation solver and sinogram data. (Completion estimate: Pending)

3 Figures

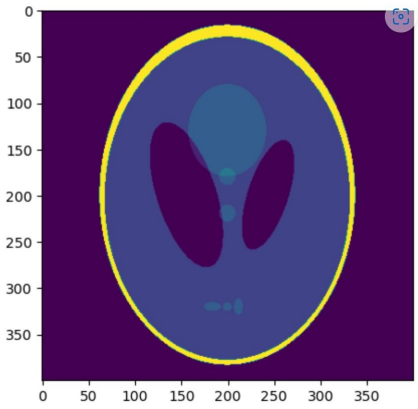

Figure 1: Shepp-Logan Phantom generated in python.