HOMEWORK #3

BME 599: Advanced Topics in MRI

Due: Tuesday 11/21/23 at 11:59 pm

Problem 1: Partial Fourier Imaging

a. Zero-Filled Reconstruction: Load *Data_Assignment3_Problem1.mat* into MATLAB. This contains fully-sampled k-space data from a T_1-weighted brain scan. The data only has a single receiver coil (to keep things simple for now!). Retrospectively undersample this data using a partial Fourier factor of 5/8. This is a bit larger than what is often used in practice – however, this will make it easier to see the artifacts. Assume that the phase encoding direction is oriented vertically. *Perform a zero-filled reconstruction, and display both the magnitude and phase of the image.* Next, compute the difference between this image and the fully-sampled image, and *display the magnitude and phase of the difference image.* Note that you may need to adjust the windowing level to better visualize the difference image.

b. Conjugate Phase Reconstruction: Implement a POCS conjugate phase reconstruction following the steps described in the lecture slides. *Display the magnitude and phase of the reconstructed image.* In addition, compute the difference between the POCS reconstruction and the fully-sampled image, and *display the magnitude and phase of the difference image*.

Problem 2: SENSE

a. Fully-Sampled Image: Load *Data_Assignment3_Problem2.mat* into MATLAB. This contains fully-sampled 8-channel k-space data from the same brain scan, along with the measured coil sensitivity maps. *Using the fully-sampled data and sensitivity maps, compute the coil-combined image. Display the magnitude of this image.*
b. Aliased R=2 Image: Retrospectively undersampled the k-space data using an acceleration factor of R=2 by setting every other phase encoding line equal to zero. Assume that the phase encoding direction is oriented vertically. *Display the resulting magnitude image*. You should see aliasing along the phase encoding direction.
c. SENSE R=2 Reconstruction: Using only the undersampled k-space data from Part b and the coil sensitivity maps, *implement your own SENSE reconstruction and display the reconstructed magnitude image*. In addition, compute the difference between the SENSE reconstruction and the fully-sampled image, and *display the magnitude of the difference image*.
d. SENSE R=4 Reconstruction: Repeat the SENSE reconstruction for R=4. *Display the reconstructed image and the difference compared to the fully-sampled image*, like before.

Bonus (completely optional ☺): Use the data in problem 2 to implement your own GRAPPA reconstruction. Use a kernel size of 3 (readout) x 2 (phase encoding) and 24 autocalibration lines to calculate the GRAPPA weights.