Computational MR imaging
Laboratory 3: Partial Fourier imaging

Report is due on Wednesday before the next lab session at 23:50. Please upload your report on StudOn.

Learning objectives

- Accelerate the acquisition of real-valued images using Hermitian symmetry in k-space
- Estimate the phase for partial Fourier reconstruction
- Apply the Margosian and POCS methods to reconstruct partial Fourier data

1. Zero-filled Fourier reconstruction and Hermitian symmetry reconstruction.
   1.1. Load kdata_phase_error_severe.mat. This dataset has been acquired with a PF=9/16.
   1.2. Compute and plot the zero-filled Fourier reconstruction and the theoretical half-Fourier reconstruction (Hermitian symmetry only, no phase-correction).
   1.3. Discuss artifacts for each case.

2. Phase estimation function
   2.1. Write a function to estimate the phase of an image from a symmetric region at the center of k-space. Hint: use the method shown in class, which includes zero-padding and filtering.
   2.2. Estimate the phase of the zero-filled kdata.
   2.3. Plot estimated phase

3. Margosian partial Fourier reconstruction
   3.1. Write a function that reconstruct partial Fourier MRI data using the Margosian method.
      3.1.1. Define a function returning a window of type either Ramp or Hamming.
      3.1.2. Define a function for Margosian reconstruction.
   3.2. Reconstruct PF kdata using Margosian method with both Ramp and Hamming filters.
   3.3. Discuss results between two filters in terms of SNR and potential artifacts.

4. POCS partial Fourier reconstruction
   4.1. Define a function for POCS reconstruction.
   4.2. Perform POCS reconstruction on the PF kdata with multiple iterations (2, 4, 6, 8, and 10)
   4.3. Choose the minimum number of iterations where the algorithm has converged by comparing reconstructed images to each other. Hint: when comparing reconstructed images, do not forget to normalize images in a range of 0-1. Plot the change in the solution with respect to the number of iterations.

5. Comparison of reconstructions

5.1. Plot the zero-filled FFT, two Margosian reconstructions, and POCS reconstruction.
5.2. Load kdata1.mat from the exercise from the previous week and plot the difference of your reconstructions to the IFFT reconstruction of the fully sampled. Which method provides a better reconstruction? Explain in terms of SNR, spatial resolution, residual artifacts and ringing.