Computational MR imaging
Laboratory 3: Partial Fourier imaging

Report is due on Wednesday the week after the lab session at 23:59. Send your report by email to Bruno Riemenschneider (bruno.riemenschneider@fau.de) and Florian Knoll (florian.knoll@fau.de).

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

2. 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.

3. Write a function that reconstruct partial Fourier MRI data using the Margosian method (see format below, note that this example uses Matlab syntax)

```
function I=pf_margosian(kdata,N,ftype)
% Margosian reconstruction for partial Fourier (PF) MRI
%
% kdata: asymmetric k-space data
% N: target size of the reconstructed PF dimension
% ftype: k-space filter ('ramp' or 'hamming')
%
% I: reconstructed magnitude image
```

4. Write a function that reconstruct partial Fourier MRI data using the POCS method (see format below, note that this example uses Matlab syntax)

```
function I=pf_pocs(kdata,N,Nite)
% POCS reconstruction for partial Fourier (PF) MRI
%
% kdata: asymmetric k-space data
% N: size of the reconstructed PF dimension
% Nite: number of iterations
%
% I: reconstructed magnitude image
```

5. Perform Margosian reconstruction using ramp and Hamming filters on kdata.

6. Perform POCS reconstruction with number of iterations = 2, 4, 6, 8 and 10 on kdata. Choose the minimum number of iterations where the algorithm has converged based on the change in the solution for each iteration and explain your choice. Plot the change in the solution with respect to the number of iterations.

7. For each partial Fourier data set, plot the zero-filled FFT, Margosian and POCS reconstructions. In addition, 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.