HW #3
BME 599: Advanced Topics in MRI
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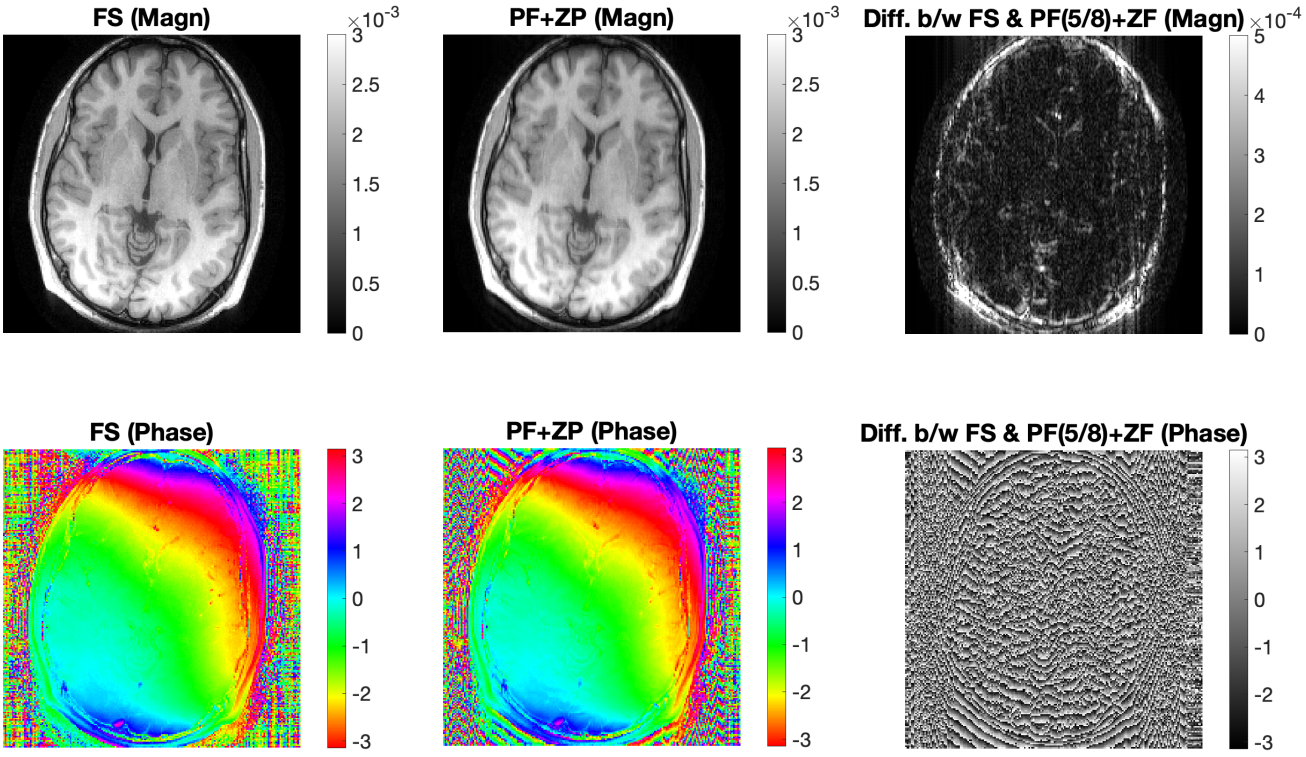
Problem 1: Partial Fourier Imaging

a.) Zero-Filled Reconstruction

- Perform a zero-filled reconstruction, and display both the magnitude and phase of the image. Compute the difference between this image and the fully-sampled image, and display the magnitude and phase of the difference image.



Left: The direct FT reconstruction of the fully-sampled (FS) data, showing magnitude (top) and phase (bottom) images.
Middle: The zero-filled reconstruction (falsely named “ZP”/“zero-padded” in the figures…) of the PF=⅝ k-space data, showing magnitude (top) and phase (bottom) images.
Right: The magnitude (top) and phase (bottom) of the difference image between the FS and PF+ZP reconstructed images.

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.

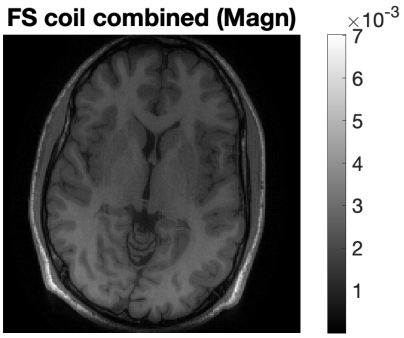
- Compute the difference between the POCS reconstruction and the fully-sampled image, and display the magnitude and phase of the difference image.

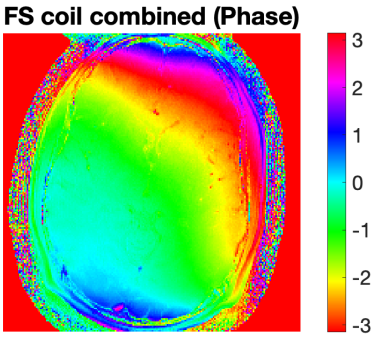
Problem 2: SENSE

a.) Fully-Sampled Image

- Using the fully-sampled data and sensitivity maps, compute the coil-combined image. Display the magnitude of this image.

Below are the magnitude (top) and phase (bottom) images from the coil-combined fully-sampled k-space data and coil sensitivity maps.



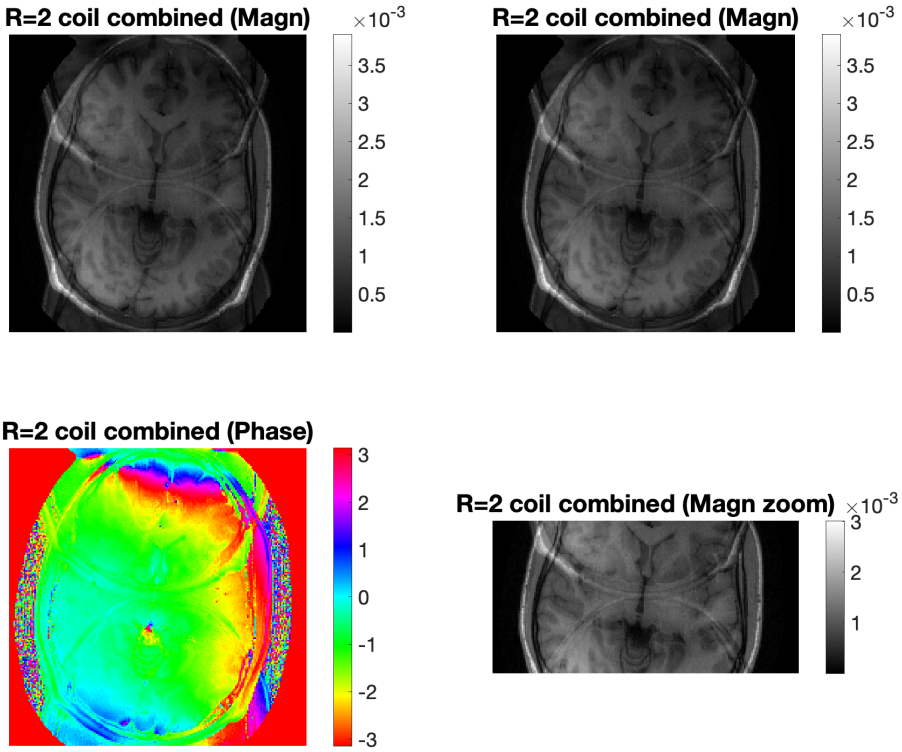


b.) Aliased R=2 Image

- 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.

Left: The magnitude (top) and phase (bottom) images from zero-filling reconstruction following retrospective undersampling by a factor of R=2 in the PE (vertical) direction.

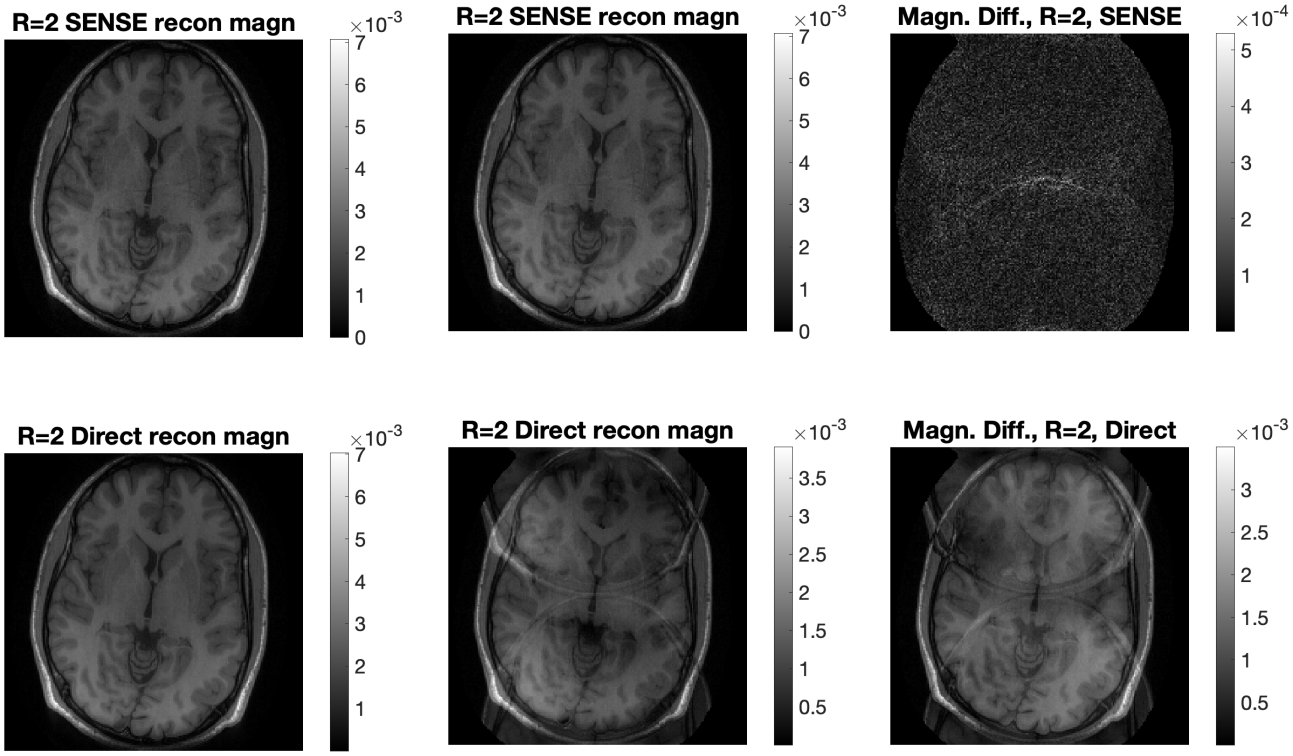
Right: The “full FOV” magnitude image (top) and the “undersampled FOV” (bottom), where the “full FOV” has the same matrix size as the fully sampled data. The “undersampled FOV” is obtained by cropping the “full FOV” image to half the number of PE (vertical) lines, centered at the DC/middle (line 101); this it shows just the center 100 lines from the “full FOV” image.



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.

The *left column* shows the magnitude images reconstructed from R=2 undersampled k-space data using SENSE (top) and from fully-sampled k-space data using coil-combination (bottom).
The *middle column* shows the magnitude images reconstructed from R=2 undersampled k-space data using SENSE (top) and direct zero-filling (bottom).
The *right column* shows the magnitude of the difference images, between the fully-sampled coil-combined reconstruction and the SENSE (top) and direct zero-filled (bottom) reconstructions.



d.) SENSE R=4 Reconstruction

- Repeat the SENSE reconstruction for R=4. Display the reconstructed image
- Display the difference compared to the fully-sampled image, like before.

The *left column* shows the magnitude images reconstructed from R=4 undersampled k-space data using SENSE (top) and from fully-sampled k-space data using coil-combination (bottom).
The *middle column* shows the magnitude images reconstructed from R=4 undersampled k-space data using SENSE (top) and direct zero-filling (bottom).
The *right column* shows the magnitude of the difference images between the fully-sampled coil-combined reconstruction and the SENSE (top) and direct zero-filled (bottom) reconstructions of R=4 undersampled k-space data. Note the difference in colorbar values between SENSE and direct zero-filled reconstructions.