Computational MR imaging **Name:** *Navaneeth N*
Laboratory 2: k-space sampling and Fourier reconstruction
16/11/2022

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1. **FFT reconstruction of Cartesian MRI data**

   1.1 The plots of the given 512x512 k-space data, magnitude and phase of it's reconstruction are presented in Figure.1.

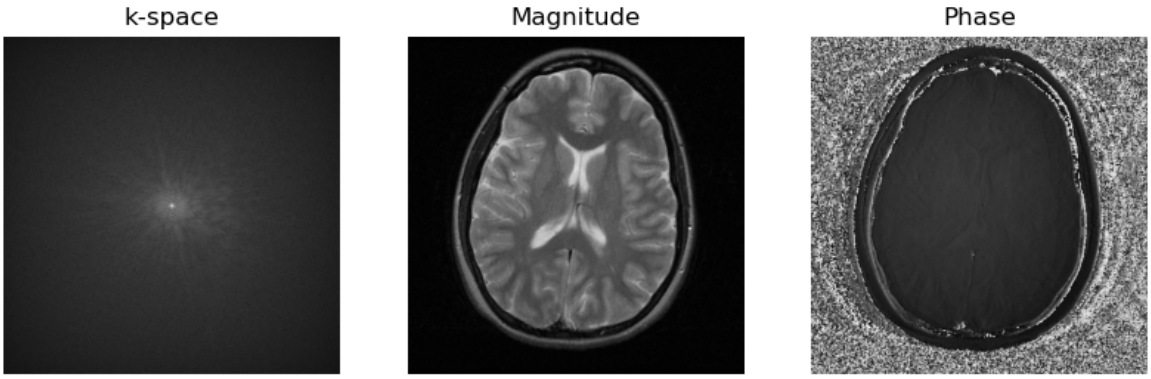

Figure 1: Reconstructed Image.

2. **Effects of k-space zero-padding and zero padding:**

   2.1 The truncated k-space functions their reconstruction images are presented. These results were acquired by using a mask over the original k-space and performing an ifft over the truncated k-spaces:

   2.2 From the above results it the following inferences cn be drawn:

   (a) From figure, it is evident that smaller trucated k-space around the center produces stronger Gibbs ringing effects

3. **Point spread function (PSF)**

   3.1 The plot of boxcar and Hamming window along with their point spread functions (psf) for window sizes 64, 12 and 256 are presented in Figure.3. The psf for each windowing function was obtained by taking the ifft of the respective window.

   3.2 The Full Width Half Maximum (FWHM) values were calculated for both the above window functions and are presented in Table 1.

   3.3 From the above results it the following inferences can be drawn:

   (a) The Hamming window psf exhibits lesser high frequency variation on either side of the main lobe compared to the psf of the boxcar. Hence, the hamming window

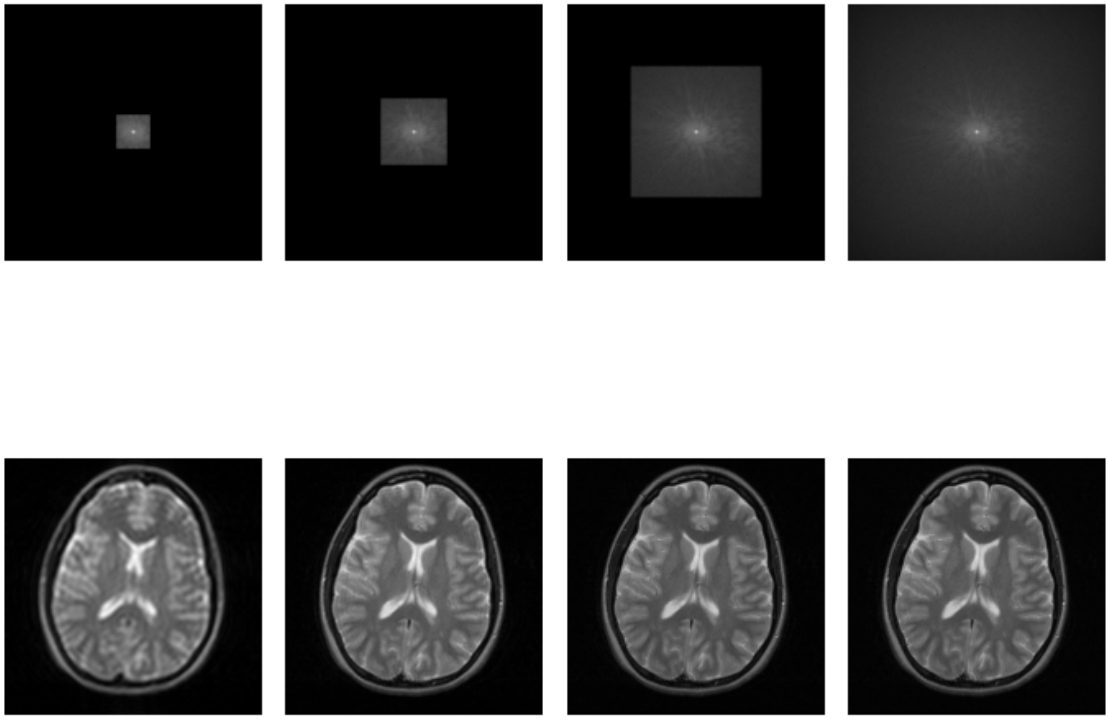

Figure 2: reconstruction images.

Window size	FWHM Boxcar	FWHM Hamming
64	10	14
128	4	8
256	2	4

Table 1: FWHM values

smooths out edges which present themselves as Gibbs rings in the image space.

(b) From the table it can be seen that larger window sizes present smaller FWHM of their psf. Thus, it can be said that smaller psf values would result in a higher spatial resolution.

4. **k-space filtering (windowing):**

4.1 The truncated k-space functions were filtered with a Hamming window and the reconstruction results were compared with a full-space k-space and truncated k-space reconstruction images. These results are presented below :

4.2 From the above results it the following inferences cn be drawn:

(a) From Table 1, it is evident that the FWHM of Hamming window psfs are larger than the boxcar psfs. This indicates that the spatial resolution of the Hamming windowed images may not be as good.

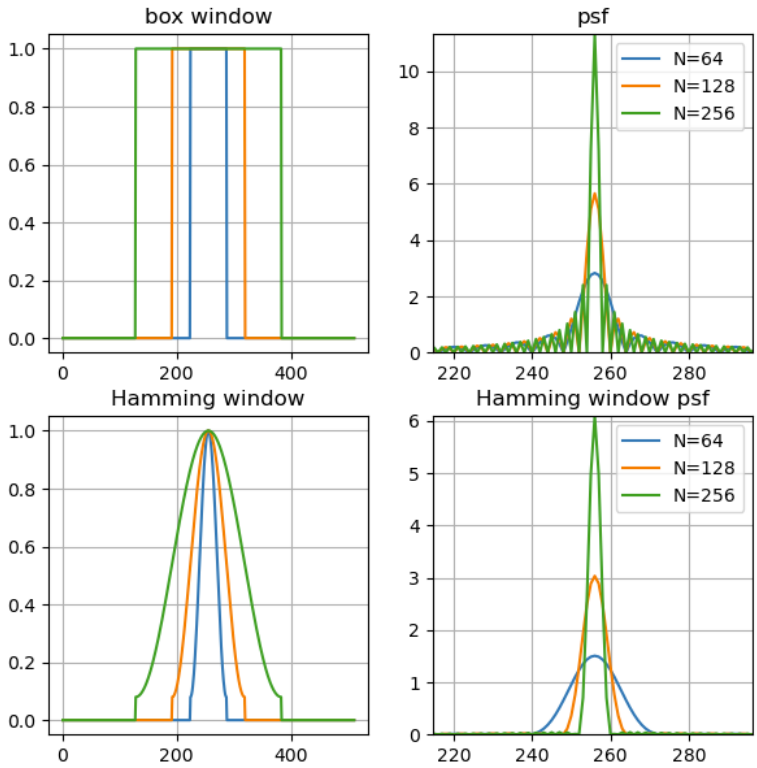

Figure 3: window functions and respective psf.

(b) From the above figure it is clear that while the Hamming window due to it's suppressed side lobes discussed in part 3 helps in removing the Gibbs ringing effect, the image resolution is not as good. Also, at with higher k-space samples, the resolution improves and the Gibbs ringing in the reconstructed images is not as apparent.

5. Oversampling the readout dimension:

5.1 The k-space and their respective image reconstructions are presented in Figure. 5 illustrating (a) Over sampled k-space along Readout direction. (b) Under sampled by factor of 2. (c) Under sampled by factor of 3.

Observations:

(a) The first figure shows a complete image reconstruction when the acquired k-space is oversampled [168,336] in readout direction. The image reconstructed is clear and does not present any wrap-around or ghosting artifacts.

(b) When the acquired k-space is decimated by factor of 2 and 3, it is quite apparent that there are anatomic parts that folded over the area of interest in the reconstructed images. Furthermore, we see the extent of the wrap-around artifact increase with an increase in the extent of under sampling the k-space.

(c) It is quite clear that when the k-space is under sampled, then the reconstructed object exceeds the FOV and presents strong folding artifacts.

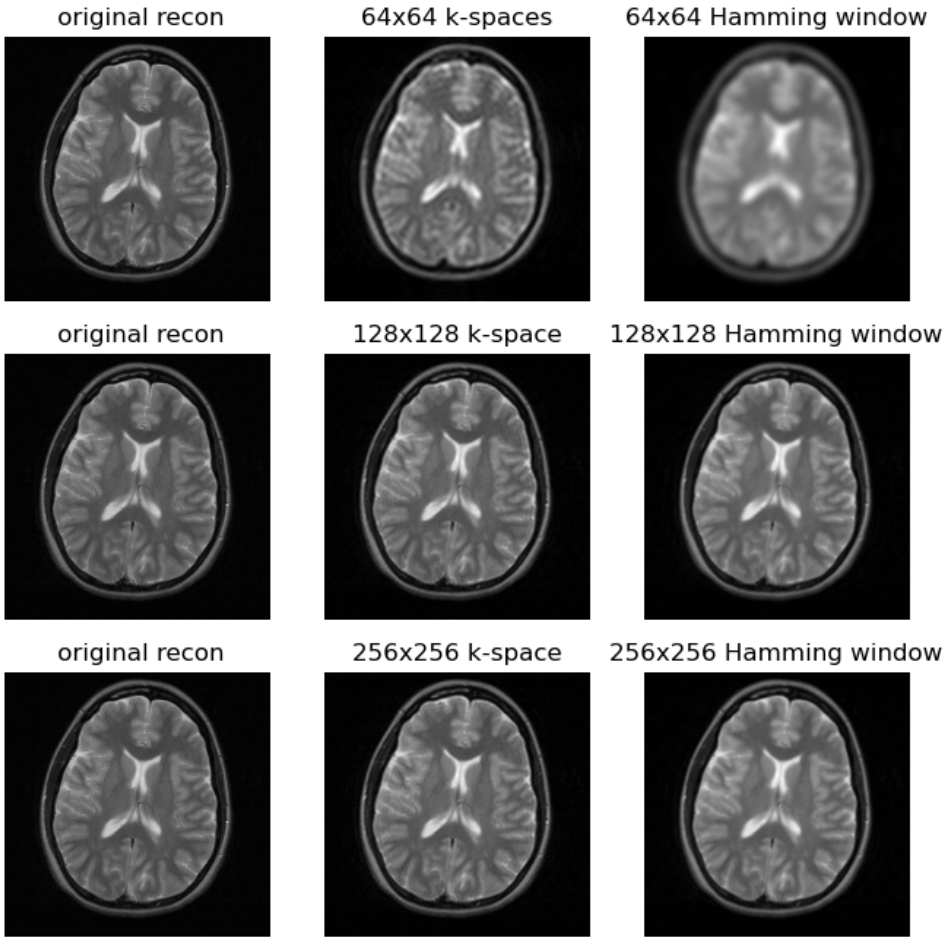

Figure 4: reconstruction images.

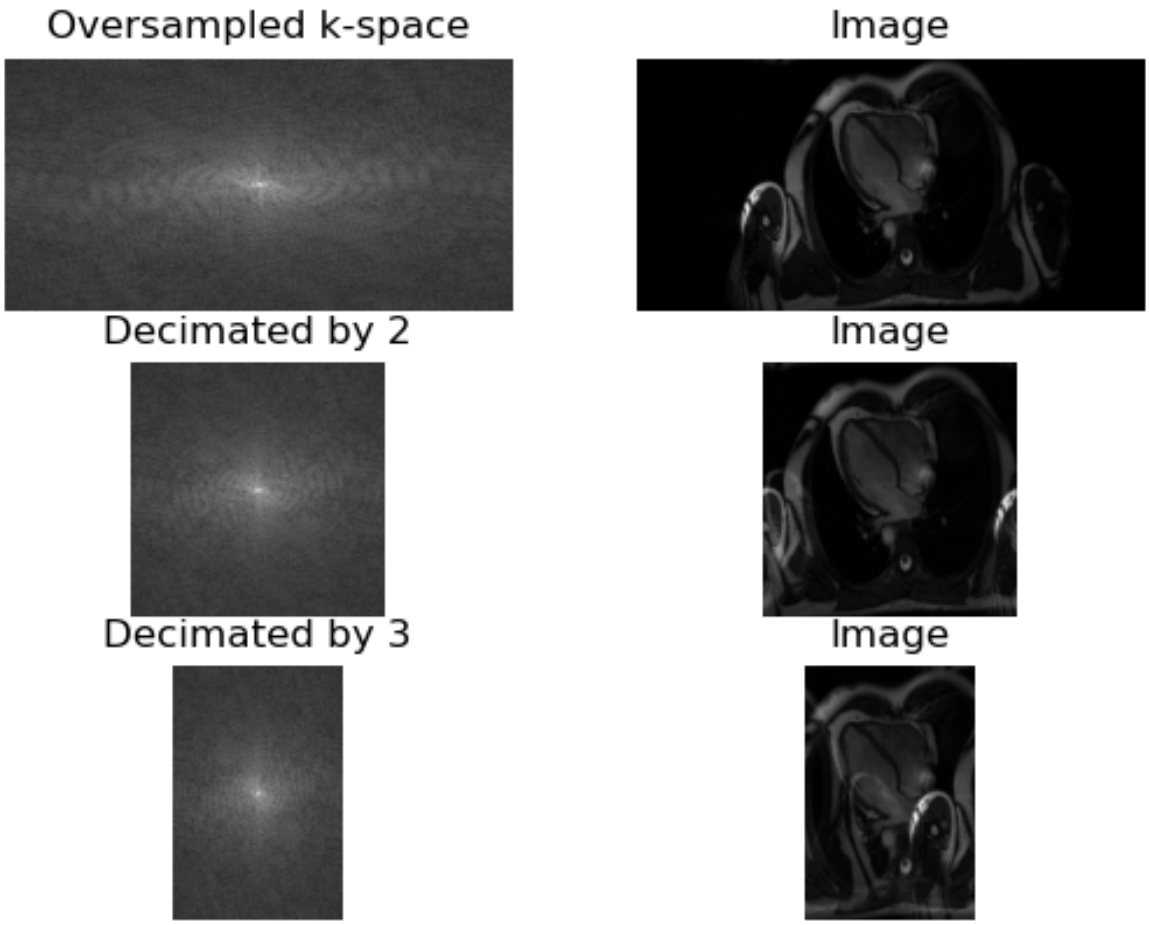

Figure 5: k-space & respective reconstructions.