

1. (a) Please elaborate in MRI what is the contrast source and what factors determine the time resolution and spatial resolution in x, y, and z, respectively, and their relationship with the gradient echo pulse sequence.

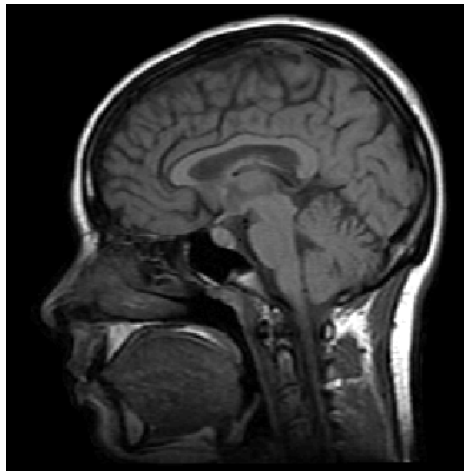
(b) Since I never mentioned during our MRI lectures and I have no idea, either :Q, please help me to find out the VALUES of the pulse duration and bandwidth of the B1 magnetic pulse, magnetic gradients (including x, y, and z gradients), and the other required physical quantities commonly used in clinical MRI and use these values to estimate the resolutions mentioned in (a). Note that please include the citation links where you find the values in your report.

2. Given are 2 MRI raw data files obtained: 256x256 data points each, corresponding to the real (hw2_r.dat) and imaginary (hw2_i.dat) components in k-space. The data files are provided with binary format and all data points contain 4-byte integers. Ideally, you can reconstruct the MRI image by 2D inverse Fourier transforming the provided k-space data.

(a) Show the real and imaginary components, respectively (by Matlab instruction: `imagesc()`), and check the data range (by Matlab instructions: `colorbar`, `max()` and `min()`, and `mean2()`). By checking the data range, supposedly, you should be able to find out that the data suffer a constant DC offset, which arises from the electronics.

(b) Discuss the effects on the image when the receiver channel has a constant DC offset arising from the electronics. You can apply 2D inverse Fourier transform to the provided k-space data, and see the effects directly from the reconstructed image. Justify your findings.

(c) Follow (b). How could you retrospectively correct it? Could you test your proposed method successfully on it? Discuss how you make it or why you are unsuccessful. If you were successful, you will see a sagittal-slice image similar to the following image.



(d) Use the same set of data to verify the effects of sampling interval in k-space on the image. Make sure to include DC offset correction in your reconstruction program. Reconstruct the image by using only the even samples along the k_y direction (i.e., column direction or consider the gradient echo pulse sequence used in our lecture slide). Justify your findings.

(e) Use the same set of data to implement half Fourier imaging which saves you about half of the scan time. Make sure to include DC offset correction in your reconstruction program. Does it work well? Why or why not? Note that almost all the commercial MRI systems in the world have the half Fourier imaging function in their standard package. So there must be some way to make it work. (halfFourier imaging: acquire half of k-space data, then use the conjugate-symmetry property of Fourier transform for a real signal to build the full k-space and reconstruct the MRI image).

(f) Use the same set of data to verify the effects on the image if the amplification gain of the receiver I channel (real part) is larger than that of the receiver Q channel (imaginary part). Make sure to include DC offset correction in your reconstruction program. Describe how you made it, and justify your findings on the reconstructed image.

Notice:

1. Please hand in your solution files to the LMS elearning system, including your word file of the detailed solutions, the associated Matlab codes, and all the related materials. It would be nice that you can put your codes with comments side by side along with your answer in the word file.
2. Name your solution files “BioMedImg_HW2_StudentID.doc” and

“BioMedImg_HW2_StudentID.m”, and archive them as a single zip file:
BioMedImg_HW2_StudentID.zip.

3. The first line of your word or Matlab file should contain your name and some brief description, e.g., % EE 441000 王小明 u9612345 HW2 12/20/2016