M219, Winter 2018 - Laboratory #1

A k-space odyssey...

Due Thursday, March 1st by 10pm via E-mail (10-points)

Your laboratory report must be typed and submitted via e-mail as a PDF document. Include sections entitled: Introduction, Methods, Results, Discussion, and Conclusion. Maximum report length is two pages (12-point font, 1-inch margins, no exceptions). The data is shared, but the data analysis and reports are written individually. Late assignments will be discounted by $e^{-t/\tau}$, where $\tau = 72$ hours.

1 Background

In class we have discussed the relationship between frequency and spatial domains and how you can move from one domain to the other using the Fourier Transform. Recall,

$$S(\vec{k}) = \int M_{xy}(\vec{r}, 0) e^{-i2\pi\vec{k}\cdot\vec{r}} d\vec{r} \tag{1.1}$$

In lab you will acquire images using a phantom filled with water and observe the respective k-space.

2 Pre-Lab

Please print the screening form and sign it before coming to the lab. Personal information should not be provided. We simply need adequate information to keep you safe during the lab. Review k-space related lecture material. Review this document.

3 Directions

Images will be acquired with a fast spoiled gradient echo sequence. Keep track of your acquisition parameters! For the following setup, predict the resulting k-space and write your answer in your notes before you acquire any images. Make a prediction for each experiment you perform. You'll need both your prediction and the outcome for your lab write-up. The pulse sequence has been modified to show you the magnitude k-space data on the scanner.

- We will use a 10cmx10cm cross-shaped phantom filled with water to analyze the following:

  1. Acquire images and k-space for each phantom configuration. Begin with the phantom oriented with the gradient hardware and a field of view a bit larger than the object itself. Knowing the shape of the phantom make a sketch of what you think k-space will look like.

2. Repeat the experiment, but rotate the FOV on the scanner. Do this again, but rotate the phantom instead of the FOV. Make a sketch of what you think k-space will look like for both conditions.
3. Using the original FOV compare results for low and high resolution. Make a sketch of what you think k-space will look like for both conditions.
4. With a fixed matrix size, compare results for a small and a large FOV. Make a sketch of what you think k-space will look like for both conditions.
5. Shift the FOV relative to the object, then shift the object in the scanner using the original FOV. Make a sketch of what you think k-space will look like for both conditions.

- Once you have finished with these experiments, it is your turn to design your own! Change the phantom orientation in the scanner or change the scanning parameters. Make a prediction about what you will see k-space.

4 Analysis

Using Matlab, simulate four different objects/conditions from the lab and compare the simulated and acquired results. Is your acquired k-space similar to the simulated one? What differences are apparent? Why?

MAGNETIC RESONANCE (MR) ENVIRONMENT SCREENING FORM FOR INDIVIDUALS*

The MR system has a very strong magnetic field that may be hazardous to individuals entering the MR environment or MR system room if they have certain metallic, electronic, magnetic, or mechanical implants, devices, or objects. Therefore, all individuals are required to fill out this form BEFORE entering the MR environment or MR system room. Be advised, the MR system magnet is ALWAYS on.

***NOTE: If you are a patient preparing to undergo an MR examination, you are required to fill out a different form.**

Date _____/_____/_____ (month day year) Name ______________________________ (Last Name, First Name, Middle Initial) Age _______

Address ____________________________________ Telephone (home) (_____) _____-________

City ____________________________________ Telephone (work) (_____) _____-________

State ____________________ Zip Code ___________

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1. Have you had prior surgery or an operation (e.g., arthroscopy, endoscopy, etc.) of any kind? ❐ No ❐ Yes
   If yes, please indicate date and type of surgery: Date ____/____/____ Type of surgery________________
2. Have you had an injury to the eye involving a metallic object (e.g., metallic slivers, foreign body)? ❐ No ❐ Yes
   If yes, please describe: ____________________________________
3. Have you ever been injured by a metallic object or foreign body (e.g., BB, bullet, shrapnel, etc.)? ❐ No ❐ Yes
   If yes, please describe: ____________________________________
4. Are you pregnant or suspect that you are pregnant? ❐ No ❐ Yes

WARNING: Certain implants, devices, or objects may be hazardous to you in the MR environment or MR system room. Do not enter the MR environment or MR system room if you have any question or concern regarding an implant, device, or object.

Please indicate if you have any of the following:

❐ Yes ❐ No Aneurysm clip(s)
❐ Yes ❐ No Cardiac pacemaker
❐ Yes ❐ No Implanted cardioverter defibrillator (ICD)
❐ Yes ❐ No Electronic implant or device
❐ Yes ❐ No Magnetically-activated implant or device
❐ Yes ❐ No Neurostimulation system
❐ Yes ❐ No Spinal cord stimulator
❐ Yes ❐ No Cochlear implant or implanted hearing aid
❐ Yes ❐ No Insulin or infusion pump
❐ Yes ❐ No Implanted drug infusion device
❐ Yes ❐ No Any type of prosthesis or implant
❐ Yes ❐ No Artificial or prosthetic limb
❐ Yes ❐ No Any metallic fragment or foreign body
❐ Yes ❐ No Any external or internal metallic object
❐ Yes ❐ No Hearing aid
❐ Yes ❐ No Other implant______________________
❐ Yes ❐ No Other device______________________

IMPORTANT INSTRUCTIONS

Remove all metallic objects before entering the MR environment or MR system room including hearing aids, beeper, cell phone, keys, eyeglasses, hair pins, barrettes, jewelry (including body piercing jewelry), watch, safety pins, paperclips, money clip, credit cards, bank cards, magnetic strip cards, coins, pens, pocket knife, nail clipper, steel-toed boots/shoes, and tools. Loose metallic objects are especially prohibited in the MR system room and MR environment.

Please consult the MRI Technologist or Radiologist if you have any question or concern BEFORE you enter the MR system room.

I attest that the above information is correct to the best of my knowledge. I have read and understand the entire contents of this form and have had the opportunity to ask questions regarding the information on this form.

Signature of Person Completing Form: ______________________________ (Signature) Date _____/_____/_____

Form Information Reviewed By: ______________________________ (Print name) ______________________________ (Signature)

❐ MRI Technologist ❐ Radiologist ❐ Other ______________________________