Assignment: MRI
Due Friday, 11/15/2019 by 11:59 pm
Complete the deliverables listed below and upload to Canvas.
Please upload each file separately (i.e., don't compress them or make a .zip file)

- Matlab m-file with code to answer the following questions
- A report (saved as a pdf) of answers and figures (if necessary) to support your answer
- Make sure each plot/figure has a title, labeled axes, and is displayed in the correct aspect ratio.

(1) (20 pts) K-space! Using the "kspace" array from the matlab_monday_04.mat explore manipulating the k-space data and comment on these manipulations effects on the imaging data.

(a) Set every other row in kspace equal to zero, then reconstruct the image. Now, set every other column in kspace equal to zero and then reconstruct the image. Describe what is happening in these two images. Can you think of why this is happening?

(b) How would you edit k-space to remove high spatial-frequency information? Demonstrate an example of this by displaying both the k-space image and the reconstructed image.

(c) How would you edit k-space to remove low spatial frequency information? Demonstrate an example of this by displaying both the k-space image and the reconstructed image.

(2) (30 pts) T_1 Mapping. A common technique in MRI is to measure the longitudinal relaxation time T_1 within tissue. There are several different approaches out there, and here we will look at two different approaches variable flip angle (VFA) and variable repetition time (VTR). For a VTR approach, we typically collect several spin echo (SE) images with a known TE and a range of TR values. The signal is described by the equation below:

$$S(TR,T_1) = S_0\left(1-\exp\left(-TR/T_1\right)\right)\overbrace{\exp\left(-TE/T_2\right)}^{\sim 1 \text{ if } TE \ll T_2}$$

(a) For VTR we have two different sequences we want to evaluate. Sequence 1 was collected with TRs defined in TR_s1, while sequence 2 was collected with TRs defined in TR_s2. Use lsqcurvefit to estimate the T1 and S0 values from both datasets (Sequence 1 = VTR_s1 Sequence 2 = VTR_s2). VTR_s1(y,x) refers to the y-th T1 value collected at the x-th TR;

a. For both sequences plot the known T1 (saved as "T1") versus the estimated T1

b. Calculate the error using the equation below for both approaches

$$error = \sum\left(\frac{T_{1,true} - T_{1,meas}}{T_{1,true}}\right)^2$$

c. Comment on the results, Why do you think Sequence 2 has increased error at later time points?