Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2015
Lab 1

1. **Reconstruct an image from raw (Fourier Domain) data.** This exercise is to go through the steps to read and reconstruct image data from the scanner. While we are scanning, we will put the data onto a UCSD accessible server: cfmri.ucsd.edu/home/guest/data/BENG278_15 user: guest pass: (ask). The data file consists of a header, followed by raw data in the time order in which it was collected. Complex data is stored in 16 bit signed integers, with the real part followed by the imaginary part for each data point. A simple matlab script to read data is on the server. Put something in the scanner that will produce a signal, use the single channel head RF coil. Setting the control variable (CV) rhexecctrl to 11 will make the scanner save raw (k-space data) to /usr/g/mrraw. Collect image data. Read in the data, combine real and imaginary data into complex data, reshape it into a 2D array. Make an image of the magnitude of the k-space data (**2 points**). Reconstruct the data into an image by writing code to explicitly multiply each complex data point by it's corresponding Fourier basis function and summing the results (ie a slow ft) (**4 points**). Re-reconstruct the image using the fft function to verify your reconstruction (**2 points**).

2. **EPI.** In this lab, you will observe Nyquist ghosts and resonance offset effects in EPI. Prescribe a spin echo EPI sequence and parameters: FOV=24cm x 5mm, matrix 64x64, BW=62.5KHz, TE=min_full, TR=1s, rhexecctrl=11. Under the 'Advanced' tab, set ramp_samp to 0. Autoprescan and then scan under the following conditions:
    1. Default
    2. X shim misset by 20 units
    3. Y shim misset by 20 units

   Carefully measure using the oscilloscope the timing parameters you will need to do the calculations below. In the resulting raw data the even numbered lines have already been reversed. Reconstruct the image by 2D FT. Unless you are super lucky, there should be Nyquist ghosts resulting from phase inconsistency between even and odd lines. Assume the odd lines are perfect, and that the even lines can be corrected using a time shift of A microseconds, and an additional constant phase offset of B radians that is the same for all even lines. Find and report A and B by guess-and-check, and reconstruct a ghost free image from data set 1 (**6 points**). Reconstruct data sets 2 and 3 assuming the same values of A and B, and calculate from the distortions in these images the gain of the X and Y shim systems (the shim gradient in G/cm per unit shim offset). (**6 points**).