Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2014
Lab 1

1. **Record pulse sequences using an oscilloscope.** Prescribe a 2D single slice gradient echo imaging pulse sequence and scan a phantom. Repeat for a spin echo pulse sequence. For each pulse sequence:
    a. Draw the RF, Gx, Gy, and Gz waveforms, and label the transition points (beginning and end of each pulse), using letters (A, B, C…) (**2 points**).
    b. Draw the corresponding K-space trajectory in the Kx-Ky plane, and label the corresponding transition points from the pulse sequence **(4 points**).

2. **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_14 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 (**1 points**).

3. **Fourier shift theorem**
   Place a live human in the scanner.
   Set up a body coil scan with a landmark on the abdomen.
   Acquire an axial gradient echo image of the abdomen.
   Adjust TR and the choice of frequency encoding direction and rescan until you have a single image from which you can calculate the subject's heart rate from the artifacts in the image. You may have to repeat the scan to get clean data. It may help to ask the subject to hold his/her breath for the duration of the scan. It will help to have a subject with a steady heart rate. Calculate the subject's heart rate from the image. (**7 points**)