Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2013
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_13
   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, and collect image data. Setting the control variable (CV) rhexecctrl to 11 will make the scanner save raw (k-space data) to /usr/g/mrraw. Read in the data, combine real and imaginary data into complex data, reshape it into a 2D array, perform a 2D FT (using the ft function, supplied on the server), and display an image. Remember to submit all matlab code. (2 points). Apply 2 different filters of your choice to the K-space data and re-FT the data into image space. For each, describe why the image looks like it does. (2 points each).

2. **Calculate a B_1^+ map from 2D image data.** The flip angle is an important parameter in most pulse sequences. While the scanner hardware tries to apply the RF pulses spatially uniformly, spatial inhomogeneity of the B_1 fields are always present, and for some pulse sequences significantly degrade the performance of the method. It is sometimes useful to measure (map) the local B_1 fields and either try to correct for B_1 inhomogeneity or at least know how much inhomogeneity is present. In this exercise, we will take 2D images of a phantom. Assume that the phantom is uniform. The pulse sequence consists of a slice selective excitation RF pulse followed by spatially encoded data acquisition that fills 2D Fourier space. The scanner software allows you to specify a nominal flip angle for a scan, but it is only approximate, and does not correct for spatial inhomogeneity (it simply sets a power level for the pulse). Your only free parameter for this experiment is the nominal flip angle, which can be set between 0-180°. Using this parameter, design and carry out a set of measurements that will allow you to produce a map of B_1^+, expressed in units of the actual flip angle in degrees for an image acquired at a nominal 90° flip angle. (8 points)

3. **Calculate a B_1^- map from 2D image data.** From the data from Part 2, calculate a map of B_1^- (3 points). This map can be in arbitrary units, as we have no way to produce an absolute scaling of B_1^-. Repeat the experiment using the body coil for B_1^+ an 8 channel receive coil for B_1^-. For each of the 8 coils, map B_1^+ and B_1^-. For the B_1^-, map both magnitude and phase. (3 points)