Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2012
Lab 1

1. **Reconstruct an image from raw (Fourier Domain) data.** This exercise is simply 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_12
   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 will be on the server after the lab. Read in the data, combine real and imaginary data into complex data, reshape it into a 2D array, perform a 2D FT (using the fft function), and display an image. Remember to submit all matlab code. (2 points)

2. **Calculate a B_1+ map from 2D image data.** The flip angle (the angle through which spins are rotated away from the Z axis), is an important parameter in most pulse sequences. While the scanner hardware tries to apply the RF pulses spatially uniformly, spatial inhomogeneity of the B1 field is always present, and for some pulse sequences significantly degrades the performance of the method. It is sometimes useful to measure (map) the local B1 field and either try to correct for B1 inhomogeneity or at least know how much inhomogeneity is present. In this exercise, we will take 2D images of a phantom. The pulse sequence consists of a slice selective excitation RF pulse followed by spatially encoded data acquisition that fills 2D Fourier space. For now the 2D image acquisition part will be considered a black box. 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 B1+, expressed in units of the actual flip angle in degrees for an image acquired at a nominal 90° flip angle. Be aware that there is also inhomogeneity in the sensitivity of the experiment (the receive field B1-), such that an unknown scaling of the signal exists at each point in the image (10 points)

3. **Calculate a B_1- map from 2D image data.** On the receive side of the scanner, RF antenna(s) pick up the signal, which is digitized by the receiver. The final image is proportional to sin(αB1+) x B1-. From the data from Part 2, calculate a map of B1- (4 points). Repeat the experiment using an 8 channel receive coil. For each coil, map B1+ and B1-. For B1-, map both magnitude and phase. (4 points)