Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2012
Lab 2

1. **Frequency Encoding (Wednesday)**
   Place a large phantom in a birdcage coil and position in scanner. Scan the phantom using a spin echo pulse sequence with xres=256, yres=128, rhexecctrl=11 to save raw data, and bandwidth 16KHz. Record the values of CVs: a_gxw, pw_gxw, pw_gxwa, and pw_gxwd. These are the amplitude and pulse widths of the frequency encoding gradient pulse, with the a and d suffixes denoting the attack and decay of the trapezoidal gradient. a_g* is in G/cm, and pw_* is in μs. In addition, record the values of: a_gx1, pw_gx1, pw_gx1a, and pw_gx1d, which is a gradient pulse that precedes the frequency encoding pulse. Repeat the scan with the value of a_gx1 reduced by a factor of 2, again with a_gx1=0, and again with a_gx1 inverted from the original value. Sketch the appearance of the pulses from the oscilloscope. Generate images of the magnitude of the raw data before FT for all four data sets. Generate images of both the magnitude and phase of the images after FT.
   i. Why are the phases of the images different? Write a mathematical expression that describes the relative phases of the images as a function of the position x along the frequency encode direction and the changes in the area of gx1 (time integral of the trapezoidal gradient pulse). State what the units of your expression are (ie if there is a phase slope, is it in rad/cm, or rotations per pixel, or ???). Plot your function, and indicate the four collected data points (images) on the plot. Does your data match your expression? (8 points)
   ii. Set a_gx1 to 'u'. This 'unlocks' the parameter and allows the software to recalculate the default value. Prescribe a new scan with identical parameters by copying and pasting the prescription but set bandwidth=64KHz and repeat the scan. Record the values of *gxw*. Write a mathematical expression that relates the FOV and the bandwidth to the amplitude of the readout gradient (a_gxw). Also, how does the bandwidth relate to the duration of the readout gradient and the matrix size? The parameters from parts 1i and 1ii should both fit these expressions. (4 points)
2. **Chemical Shift (Friday)**
   Find the difference in γ between water and oil using MR imaging (8 points). It may help to look up the Fourier shift theorem and/or view the first 12 minutes of: http://academicearth.org/lectures/effect-on-fourier-transform-of-shifting-signal before the lab.