Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2010
Lab 4

1. **EPI.** In this exercise, you will observe and correct the effects of time shifts and resonance offset in EPI. Place a phantom in the birdcage head coil and insert into scanner. Use the UCSD generated pulse sequence called spepgj, which supports both EPI and spiral image acquisition. Prescribe a single axial slice with 64x64 resolution and set CV: gtype=1 (EPI). Record the value of the CVs: skip; pw_xcyc. Autoprescan and then scan. In manual prescan, misset the X shim by 10 units and rescan. Return the X shim to the original value, and scan with the Y shim misset by 10 units. In this pulse sequence, EPI data is collected using a single readout that covers all 64 echoes. The data appears in raw time order. In order to reconstruct the data, you will need to extract the individual echoes from the echo train, discarding the (skip) data points between echoes that are collected on the gradient ramps. Even numbered echoes should be reversed in time, and 2D FT performed. The resulting image will likely have significant Nyquist Ghosts that are dominated by time shifts between even and odd echoes.
    a. **Correction of Nyquist Ghosts.** The Fourier shift theorem states that a shift in K-space can be simulated (or corrected) by applying a phase ramp in image space (after row FT). Apply a linear phase ramp to the even echoes by multiplying your data after row FT by exp(j(A*x)) where x is the x location in pixels (centered at pixel 33), and apply the column transform. Adjust A until the Nyquist Ghost is minimized. Calculate from the optimal value of A what the time shift was, in units of the sampling period. (6 points)
    b. **Off resonance effects in EPI.** In addition to the time shift correction above, you will also need to correct the data for spatially dependent phase shifts when reconstructing the data with misset shims. Use the coefficients of the required corrections to estimate the gain of the shim system (gradient per unit shim offset) and compare with Lab 3. For this calculation, you will need to use pw_xcyc, which is the time in microseconds from echo to echo in the EPI train. (7 points)
2. **Spiral.** In this exercise, you will be using the blurring in a spiral image to estimate the average resonance offset in a phantom. Place the BIRN phantom in the birdcage coil, and prescribe a single shot spin echo spiral scan using spepgj. Use a FOV that is approximately twice the dimensions of the phantom. Auto-prescan and scan. Your TA will then secretly change the center frequency of the scanner. Perform another scan and use the blurring in the scan to estimate the resonance offset. The easiest way to do this is to start with the on-resonance scan, and simulate the effects of resonance offset for a range of assumed offsets. The simulation that looks the most like the blurred image indicates the true resonance offset. Use $K_r \propto t^n$ as a model for the dependence of K on t, and use the oscilloscope to estimate the exponent n. (7 points)