Bioengineering 278: Magnetic Resonance Imaging Laboratory
Winter 2012
Lab 3

1. **Phase Encoding (Wednesday)**
   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. 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 beat. Calculate the subject's heart rate from the image. (12 points)

2. **SNR in MRI (Friday)**
   SNR in MRI is proportional to
   $$SNR \propto M_{xy}(\rho, B_1^+, \alpha, TE, TR, \ldots) B_1^- V \sqrt{T_{ADC}}.$$
   M_{xy} is the transverse magnetization at the time of data acquisition, and is dependent on the local proton density ρ as well as a bunch of pulse sequence related parameters. The B_1^- term is the RF coil sensitivity, and the final terms are the voxel volume V and the square root of the total ADC time. The square root comes from the fact that when you take N samples of a signal and add them up, you get a signal that is N times bigger, but when you add N samples of uncorrelated Gaussian white noise, the RMS value increases by sqrt(N). In this exercise, you will fix the first two terms in the expression above, and test the validity of the last two terms.

   Place any phantom in the birdcage coil. A simple measure of SNR in an MR image is the mean value of the signal in a ROI of the phantom divided by the RMS value of a patch of background outside the phantom.
   <u>Dependence on bandwidth</u>. Collect 256x256 images at two bandwidths. Collect the lower bandwidth image first, with TE set to minimum full, and use the same TE for all scans. The higher bandwidth scan is your 'reference scan'. Predict the relative SNR and compare with your measurement. (2 points)
   <u>Dependence on FOV</u>. Increase the FOV by about 20%, predict the relative SNR, and compare with your measurement. (2 points)
   <u>Dependence on matrix size</u>. At the original FOV, reduce the resolution in the phase encode direction to 128 and rescan. Leaving the phase encode resolution at 128, increase the frequency encode resolution to 512 and rescan. Predict the relative SNR and compare with your measurements. (2 points each)