Bioengineering 208: Magnetic Resonance Imaging Laboratory
Winter 2007
Lab 1- Week of 1/8

1. **Calculate the excitation RF pulse waveform from a 2D gradient echo image.** Place a thin (but not negligibly thin) phantom so that it runs obliquely through the imaging plane at a shallow angle (roughly 10°). Prescribe a slice thickness that is at least 5x the thickness of the phantom. Record the amplitude of the slice select gradient (CV: a_gzrf1), the thickness of the phantom, and the angle of the phantom relative to the imaging plane. Use a flip angle such that the small tip angle approximation is good. Set CV: rhexecctrl->rhexecctrl+2 (it's a bitmask) to make the scanner save raw (K-space) data. Scan. Obtain the raw data file and reconstruct the image in matlab. From the image, calculate:
    a. **The slice profile.** Report real units on the Z axis of the profile. The amplitude of the profile can be in arbitrary units. Do not neglect the thickness of the phantom. (6 points)
    b. **The RF pulse waveform**. Report real units on the time axis. Amplitude can be in arbitrary units. (2 points)

2. **Calculate a B_1 map from 2D gradient echo image data.** Place a large phantom with some structure (ie not a simple sphere or cylinder) in a volume coil. A piece of fruit or a cluster of test tubes is good. Collect 2D gradient echo images at nominal flip angles of {30°,60°,90°,120°,150°}. Choose a TR that you estimate to be about 1-2 times the T_1 of your phantom. From the images:
    a. **C**alculate a map of the true flip angles in the nominal 90° image. You may assume that the slice profile is a perfect rectangle, and neglect T_1 relaxation for this calculation. (4 points)
    b. From your data, make an estimate of the T_1 of your phantom in any one pixel. You may fit your data to an expression that includes T_1, or pick 2 or more of your data points and hand calculate T_1. (2 points)
    c. Estimate the order of magnitude of the error incurred in your flip angle map by neglecting the imperfect slice profile. (2 points)

3. **Generate and analyze a quadrature artifact.** Take the raw data from the 90° image in Part 2 above. Multiply the imaginary channel by 0.5 and reconstruct the image. This simulates a severe imbalance between the real and imaginary channels in the receive chain of the scanner.
    a. Describe the resultant image using a vector diagram to show the relationship between the correct part of the image and the artifactual part of the image. (3 points)
    b. Write a mathematical expression for the relative amplitudes of the correct and 'ghost' parts of the resultant image in terms of the factor (0.5 in this case) that multiplies the imaginary channel data. (3 points)