Computational MR imaging
Laboratory 1: MRI pulse sequences and image contrast

Report is due on Wednesday before the next lab session at 23:50. Please upload your report on StudOn.

Learning objectives

- Recall and improve familiarity of the MR contrast generation process.
- Recall and improve familiarity with MR pulse sequences and the k-space concept.
- Simulate image contrasts from generated by pulse sequences using a numerical brain phantom.

1. Inspect the digital brain phantom (Aubert-Broche, Neuroimage 2006)

1.1. Load the file digital_brain_phantom.mat.
1.2. Display the regions Cerebrospinal Fluid (CSF, label=1) Gray Matter (GM, label=2) and White Matter (WM=3).
1.3. Display the predefined T1, T2 and Proton Density (PD) values for these three regions.

2. Simulate MR image contrast from pulse sequences

2.1. Spin Echo Proton density weighted (PDw):
2.1.1. Assume a 90º excitation and a 180º refocusing pulse.
2.1.2. Use the Spin-Echo signal equation from Bernstein eq 14.57.
2.1.3. Choose repetition time (TR) and echo time (TE) accordingly. Hint: Consider the T1 and T2 values of GM and WM.
2.1.4. Spin Echo T1 weighted: Use the same signal equation as for PDw, adjust TR and TE accordingly.
2.1.5. Spin Echo T2 weighted: Use the same signal equation as for PDw, adjust TR and TE accordingly.

3. K-Space trajectories

Consider three popular k-space acquisition trajectories. Cartesian, radial and spiral (see **Figure 1**). Sketch the gradient waveforms that generate these k-space trajectories. Hint: Remember that:

$$k_y = \int_0^t G_y d\tau$$
$$k_x = \int_0^t G_x d\tau .$$

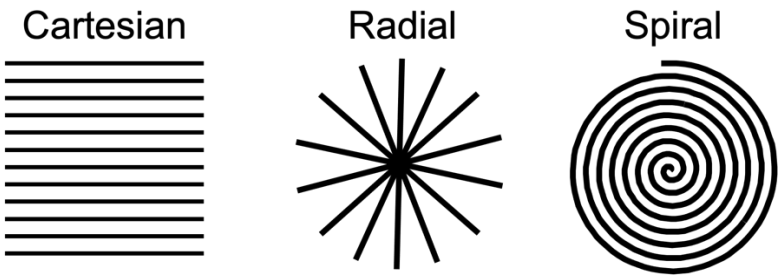

Figure 1: Cartesian, radial and spiral k-space trajectories

Appendix: Equations from Bernstein book:

Spin Echo signal equation (section 2.1.2)

$$S = M_0(1 - 2e^{-(\mathrm{TR}-\mathrm{TE}/2)/T_1} + e^{-\mathrm{TR}/T_1})e^{-\mathrm{TE}/T_2} \qquad (14.57)$$