Biomedical Imaging FS 2019

MRI 2

Exercises

The prepared code calculates the MR signal available from three transverse slices of a human head based on a discrete tissue model[1]. The tissue model distinguishes 12 tissue types that differ in proton density, T_1 and T_2. The presence of each tissue across the slices is reflected in maps of relative volume content (see Figs. 1-3 that the script creates).

As prepared, the code calculates available signal assuming the simplest form of contrast, i.e., pure proton-density contrast independent of T_1 and T_2.

The available signal is sampled in k-space, along a Cartesian grid. As prepared, the code assumes full-density sampling at the extent that corresponds to the resolution of the tissue maps. The sampled data is Fourier-transformed to yield resulting images.

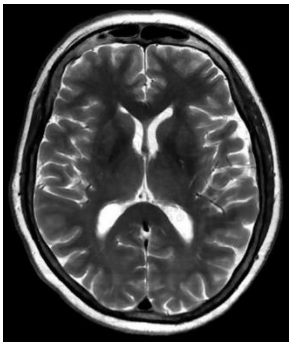
1. Sampling Pattern

- Manipulate the sampling pattern such as to
  - keep only every second horizontal line, setting the others to zero
  - keep only every third horizontal line, setting the others to zero
  - do the same in the vertical direction
  - do both, horizontal and vertical undersampling at the same time
- Explain your observations using the concepts discussed in the lecture on Signals and Systems
- Manipulate the sampling pattern such as to
  - reduce the sampling range to one-half by keeping only the corresponding square in the center of k-space
  - reduce the sampling range to one-fourth in the same fashion
- Again, explain your observations using the concepts discussed in the first lecture

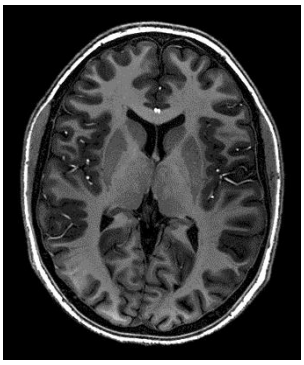
[1] www.bic.**mni**.mcgill.ca/**brain**web

2. Contrast

- Adjust the signal calculation such as to reflect a spin-echo sequence with long T_E and long T_R for T_2 contrast. Find sequence parameters that approximately yield this contrast:



- Adjust the signal calculation to reflect an inversion-recovery sequence for T_1 contrast. Optimise the sequence parameters (T_I, T_E, T_R) to distinguish gray and white matter. Common inversion-recovery T_1 contrast looks like this:



- Adjust the signal calculation such as to reflect a T_1-weighted steady-state gradient-echo sequence with short T_R and short T_E (use the signal equation derived in last week's exercise, again assuming full transverse relaxation). Tune the flip angle to give good differentiation of gray and white matter.