

Exercises

The prepared code calculates the MR signal available from three transverse slices of a human head based on a discrete tissue model¹. 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

2. Contrast

- Adjust the signal calculation to reflect a steady-state gradient-echo sequence with flip angle θ and repetition time T_R , using the signal equation derived in last week's exercise. Find a combination of θ and T_R that gives good differentiation of gray and white matter in the brain.

¹ www.bic.mni.mcgill.ca/brainweb