

Contrast Manipulation Toolbox – 10/12/2024

The purpose of this toolbox (*Dan Gallichan, danielg@fmrib.ox.ac.uk*) tutorial is to attempt to provide a basic understanding of what influence some of the different pulse-sequence parameters - primarily TR, TE and flip angle - have on the images.

To start off you need to unzip the **contrastManipulationTutorial.zip** file to a temporary location. Then launch Matlab and change the working directory to the location of the unzipped files.

	T1 (ms)	T2 (ms)
WM	600	80
GM	900	100
CSF	3500	2000

Approximate relaxation times at 1.5 T

T1-Contrast

1. Open *SimContrast* on MATLAB. Input TR = 8000 ms, flipAngle = 90°, TE = 5ms and run the code.
2. Set TR = 1 s (→ nearly 7h of acq. time) and run the code.
3. Set TR = 20 ms (→ 8 min of acq. time) and run the code.
4. Set the flip angle to be equal to the WM Ernst angle. (Ernst angle: $\cos(\theta) = \exp(-TR/T1)$; For T1=600 ms and TR=20 ms it turns out to be 14.7°). Run the code.
5. Increase the flip angle to 20°. Run the code.
6. Set T1=900 ms (GM) and run `simSignalvFlip`. Set T1=600 ms (WM) and run `simSignalvFlip`. Type `T1pair = [600 900]` then `simContrastvFlip`
 - a. Question: To the nearest degree, what is the flip angle that maximises the contrast between tissues with T1 values of 600 ms and 900 ms when a TR of 20 ms is being used? (Use the zoom tool in the plot to find this).
 - b. Set the flip angle to this value and run *simContrast* again. Now you should have a reasonable T1-weighted image in a reasonable scan time.

T2-weighting

1. Type close all to get rid of all the open figures. Open *SimContrast* on MATLAB, set TR = 200 ms and run the code. Reduce now the flip angle and run the code: the T1-weighting should decrease.
2. Find a flip angle small enough to provide little visible contrast without making the image look too noisy (CNR ~ 1). Now increase TE
 - a. Question: Increasing the TE will increase the T2-weighting but will also make the image look noisier - the noise is the same level but the signal is reduced. Approximately what is the TE which maximises the T2-weighted CNR? (only an approximate answer is required as there is a large range of TE values with similar CNR)

Inversion Recovery

1. Type close all to close all figures. Set the TR = 1 s, TE = 5 ms and flip angle = 90°. If you type `useInversion=1` and TI = 500 ms then you can re-run *simContrast* and look at the effect of using an inversion recovery sequence. Set flip angle = 40° and re-run.
 - a. Question: for TR=1 sec, TE = 5 ms, flip angle = 40°, find the approximate TI which corresponds to:
 - i. 'Nulling' white matter (i.e. no signal from white matter)
 - ii. Grey and white matter are of the same intensity (give both TIs where this is true)