**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.

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|  | **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(θ) = 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
   1. 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).
   2. 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
   1. 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.
   1. Question: for TR=1 sec, TE = 5 ms, flip angle = 40°, find the approximate TI which corresponds to:
      1. ‘Nulling’ white matter (i.e. no signal from white matter)
      2. Grey and white matter are of the same intensity (give both TIs where this is true)