DTI preprocessing using imagen_diffsl V.5

Objective:
The imagen_diffsl script preprocesses all dti data from the eight IMAGEN centers (http://www.imagen-europe.com).

Configuration:
Imagen_diffsl needs FSL>=5.09 to be installed on your system and properly set up (http://fsl.fmrib.ox.ac.uk/fsl/fslwiki/FslInstallation). If the option RESTORE is set to yes, you need the restore.py script, and python>=2.7 and dipy>=0.8 installed.

Preprocessing steps:
The pipeline consists in the following steps:
- Linear registration with eddy current correction and bvec rotation using the first volume of the dti data as reference.
- B0 mapping correction if possible using magnitude and phase images from the fieldmap acquisition. The correction direction is defined automatically (default is y).
- Brain extraction
- Tensor computation with weighted least squares and RESTORE (optional, http://www.ncbi.nlm.nih.gov/pubmed/15844157).

The script takes into account the own characteristics of each imaging center considering the scanner type, the diffusion-weigthed and the B0 fieldmap sequences.

Input:
The general use is:
imagen_diffsl <mag> <phase> <dti> <center> <restore> <pdir>
- o mag, the raw magnitude image from the fieldmap.
- o phase, the raw phase image from the fieldmap.
- o dti,the 4D image including the diffusion weighted images.
- o center, the center id between 1 and 8.
- o restore=yes or no for the optional RESTORE
- o pdir, output directory for preprocessed data

All images must be in ANALYZE, NIFTI or NIFTI.GZ.

For centers concatenating fieldmaps (magnitude and phase images in a 4D image) like Nottingham and Dublin, you may replace the magnitude with NA and the phase with the 4D image:
imagen_diffsl   NA   000038429243s601a1006   000038429243s901a1009 2 yes /tmp/

For Berlin with three dti sets and without fieldmap from the GE scanner, you need to specify only the three dti images (no correction distortion is applied):
Imagen_diffsl   000021053574s006a1001   000021053574s007a1001   000021053574s008a1001   4 yes /tmp/

For Berlin with one dti set and with fieldmaps from the Siemens scanner, you need to specify 41 instead of 4 for the center id:
imagen_diffsl   000014178831s006a1001   000014178831s007a2001   0000014178831s016a1001   41 yes /tmp/

Output:

The script creates one folder per subject with inside:

subject_mag	the raw magnitude image
subject_phase	the raw phase image
subject_phase_w	the wrapped phase image
subject_phase_uw	the unwrapped phase image
subject_phase_rads	the rad/sec phase image
subject_dti_ecc.unwarp/	folder for the distortion correction
subject_dti	the raw dti data
subject_dti.bval	the b values
subject_dti.bvec	the gradient directions
subject_dti_ecc	the eddy current corrected dti data
subject_dti_ecc.bvec	the bvec table corrected for rotation
subject_dti_ecc_mask	the brain mask after eddy current correction
subject_dti_ecc_brain	the brain extracted and eddy current corrected dti data
subject_dti_ecc_brain_*	the diffusion measures from the tensor estimation with wls
subject_dti_ecc_brain_restore_*	and RESTORE
subject_dti_ecc_dc	the eddy current and distortion corrected dti data
subject_dti_ecc_dc_mask	the mask after eddy current and distortion correction
subject_dti_ecc_dc_brain	the brain extracted and distortion corrected dti data
subject_dti_ecc_dc_brain_*	the diffusion measures from the tensor estimation after distortion correction with wls
subject_dti_ecc_dc_brain_restore*	and RESTORE
subject_dtit.slices	mean value per axial slices and diffusion-weighted volumes
subject_dti_ecc.log	transformation matrix during the affine registration
subject_dti_ecc.rotation	total angle rotation in radians and flag for 2 and 5 degrees
subject_dti_ecc_dc.log	cost values after distortion correction (smaller is better)
subject_dti_ecc_brain_tf.log	summary of the wls tensor fitting after eddy current correction
subject_dti_ecc_brain_restore_tf.log	summary of the restore tensor fitting after eddy current correction
subject_dti_ecc_dc_brain_tf.log	summary of the wls tensor fitting after distortion correction
subject_dti_ecc_dc_brain_restore_tf.log	summary of the restore tensor fitting after distortion correction

*:
_V1 - 1st eigenvector
_V2 - 2nd eigenvector
_V3 - 3rd eigenvector
_L1 - 1st eigenvalue
_L2 - 2nd eigenvalue
_L3 - 3rd eigenvalue
_RD – radial diffusivity
_MD - mean diffusivity
_FA - fractional anisotropy
_MO - mode of the anisotropy (oblate ~ -1; isotropic ~ 0; prolate ~ 1)
_S0 - raw T2 signal with no diffusion weighting

Data availability:
The preprocessed data can be found in the Imagen database (https://imagen2.cea.fr) under "Processed Data".

Authorship:
Herve Lemaitre[1], Pauline Frère[1], have participated sufficiently in the processing to take authorship responsibility when these data are used.

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