TORTOISE Tolerably Obsessive Registration and Tensor Optimization Indolent Software Ensemble

Carlo Pierpaoli, Lin-Ching Chang, Gustavo Rohde, M. Okan Irfanoglu, Lindsay Walker
Alan Barnett, Peter Basser, Guan Koay, Sinisia Pajevic, Joelle Sarlls, Minjie Wu
NIH, Bethesda, MD, USA

Origin

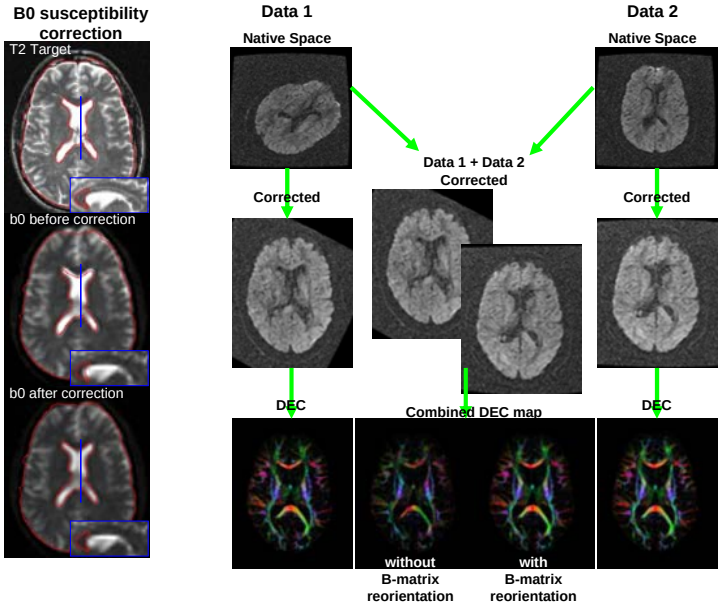
Why TORTOISE? Our software is not for rabbit type people; if you need to process diffusion data at the scanner console you do not want to use our software.

Why obsessive? We have realized that DTI is a wonderful quantitative technique which is unfortunately susceptible to all sorts of artifacts and confounds. We spent a lot of time trying to obtain reliable DTI measurements, which has made ourselves and our software a little obsessive. Why indolent? Our emphasis has been on developing conceptually rigorous routines more than optimizing the speed and user-friendliness of the software.

DIFF_PREP

DIFF_PREP is a module of TORTOISE for pre-processing of the diffusion weighted images. It includes:

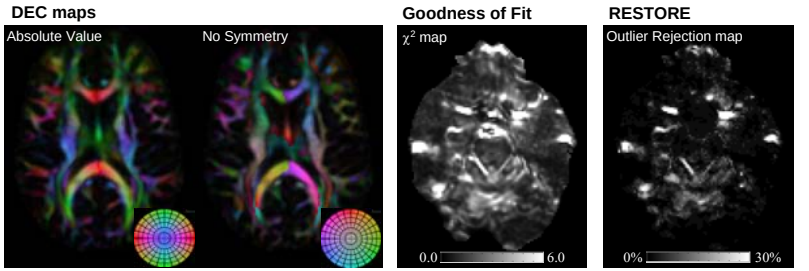
- Image import and computation of B-matrix from gradient table
- Motion and eddy current distortion correction with B-matrix reorientation[1]
- B0 susceptibility induced EPI distortion correction using b-spline deformation[2]
- Reorientation of the DWIs into a target space with B-matrix reorientation[1]



DIFF_CALC

DIFF_CALC is a software package for the estimation of the diffusion tensor in each voxel and for the computation of tensor-derived quantities. Functions include:

- Automated[3] and manual (ROI based) image noise estimation
- Tensor computation approaches including weighted and unweighted linear, non-linear[4], robust fitting including GMM[5] and RESTORE[6], dual compartment[7], Newton constrained fitting[8]
- Proper weighting in the tensor fitting to account for changes in the statistical properties of the image due to interpolation from image registration[9]
- Goodness of fit analysis with display of the residuals of the fitting
- Tensor derived quantities in analyze format including Trace(D), eignevalues, eigenvectors, fractional anisotropy, relative anisotropy, volume ratio[10], lattice index[11], all originally proposed directionally encoded color (DEC) maps[12], χ^2 map, Westin measures[13], linefield
- ROI analysis
- Export modules for diffusion weighted images and/or diffusion tensor to: FSL[14], Camino[15], TrackVis[16], Slicer[17], DTI-TK[18], NRRD[19], VTK[20]



Conclusions

We plan to release this software package on June 1, 2009. But, remember it is a tortoise. Details of the software are available on our wiki website:

http://science.nichd.nih.gov/confluence/display/nihpd/TORTOISE

References

[1] Rohde, G.K., et al., MRM, 2004. 51(1): p. 103-14, [2] Wu, M., et al., MICCAI 2008. 11(Pt 2): p. 321-9. [3] Koay CG., et al., JMR, 2009 (in press), [4] Basser, P.J., et al., JMR B, 1994. 103(3): p. 247-54, [5] Mangin, J.F., et al., Med Image Anal, 2002. 6(3): p. 191-8. [6] Chang, L.C.,et al., MRM, 2005. 53(5): p. 1088-95. [7] Kim, S., et al., 13th ISMRM, 2005, #1285 [8] Koay, C.G., et al., JMR, 2006. 182(1): p. 115-25. [9] Rohde, G.K., et al., Neuroimage, 2005. 26(3): p. 673-84. [10] Basser, P.J. and Pierpaoli, C., JMR B, 1996. 111(3): p. 209-19. [11] Pierpaoli, C. and Basser, P.J., MRM, 1996. 36(6): p. 893-906. [12] Pajevic, S. and Pierpaoli, C., MRM, 1999. 42(3): p. 526-40. [13] Peled, S., et al., Brain Res, 1998. 780(1): p. 27-33. [14] http://www.fmrib.ox.ac.uk/fsl/ [15] http://www.cs.ucl.ac.uk/research/medic/camino/index.htm [16] http://www.trackvis.org/ [17] http://www.slicer.org/ [18] http://www.nitrc.org/projects/dtitk/ [19] http://teem.sourceforge.net/nrrd/ [20] http://www.vtk.org/

Acknowledgements

Development of this software was in part supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD), the NICHD Intramural Program, the National Institute on Drug Abuse, the National Institute of Mental Health, and the National Institute of Neurological Disorders and Stroke as part of the NIH MRI Study of Normal Pediatric Brain Development with supplemental funding from the NIH Neuroscience Blueprint.