Constrained spherical deconvolution on signal and ODF values.

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For the purpose of the ISBI HARDI reconstruction challenge 2013 and for the categories DTI and HARDI we reconstructed the diffusion datasets using the Spherical Deconvolution Transform (SDT) [1], [2] and Constrained Spherical Deconvolution (CSD) [3].

The SDT is a sharpening operation which transforms the smooth diffusion ODF into a sharper fiber ODF. The method is inspired by CSD [3] with the main difference that the CSD is applied directly to the initial signal and the SDT directly to the ODFs.

The idea here is that an ODF for example the analytical Q-ball ODF ψ_{QBI} can be formed by convolution between the single fiber diffusion ODF kernel, R and the true fiber ODF ψ_{SDT}.

$$\psi_{QBI}(\mathbf{u}) = \int_{|w|=1} R(\mathbf{u}\cdot\mathbf{w})\psi_{SDT}(\mathbf{w})dw \tag{1}$$

Therefore, the deconvolution of ψ_{QBI} can recover a sharper ψ_{SDT}. We can derive the formulat for the ψ_{SDT} using symmetric spherical harmonics.

$$\psi_{SDT}(\mathbf{u}) = \sum_{j=1}^{R} 2\pi P_{l_j}(0)\frac{c_j}{f_j}Y_j(\mathbf{u}) \tag{2}$$

For the derivation of the formula see [1].

The deconvolution is a fast converging iterative process. The main choice to be considered both for SDT and CSD is the estimation of the single fiber response function R. We assume that R is derived from a prolate tensor. The eigenvalues of this tensor are estimated from the voxels with FA > 0.7.

The diffusion weighted datasets for SNR 10 and 20 were denoised with the adaptive nonlocal means [4] using a rician noise model. As proposed in [5], each DW images were processed independently.

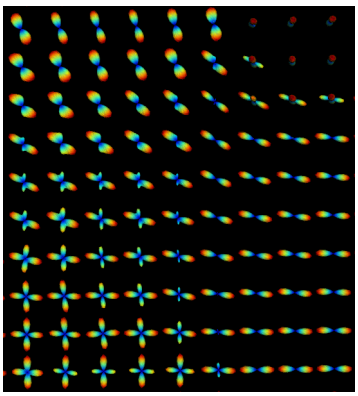

Fig. 1. A detail of our CSD-based reconstruction ODFs with the denoised test data set (SNR 10) provided by the organizers of the HARDI reconstruction challenge 2013

The code will is available in dipy.org.

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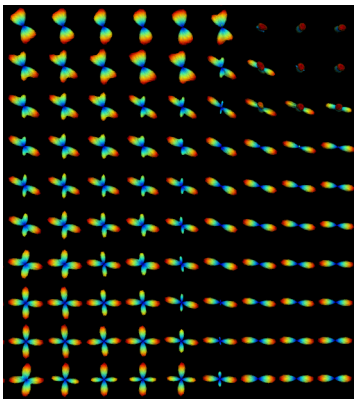

Fig. 2. A detail of our SDT-based reconstruction ODFs with the denoised test data set (SNR 10) provided by the organizers of the HARDI reconstruction challenge 2013

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References

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