**White Matter Structure Assessment from Reduced HARDI Data using Low-Rank Polynomial Approximations**

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- Diffusion MRI is an imaging modality that measures Brownian motion of water molecules (“diffusion”) in brain or heart tissue.
- In fibrous tissue the motion of the molecules is anisotropic.
- We use different modeling techniques to describe the anisotropy at a voxel level (locally) as well as globally, by extracting white matter connectivity maps of the brain.
- In this work, we present a novel mathematical model that accurately estimates white matter fiber orientations using less measurements than are typically available.

**Diffusion MRI modalities**

Diffusion Tensor Imaging (DTI): Each image voxel is represented by a diffusion tensor.

High Angular Resolution Diffusion Imaging (HARDI): Each image voxel is represented by an orientation distribution function (ODF) or a higher-order tensor.

**White matter fibers as rank-one tensors**

White matter fibers may be represented as linear-forms:

\[ f(x) = (v \cdot x)^n, \quad x \in S^2, \quad v \in \mathbb{R}^3 \]

where \( v \) specifies the fiber orientation.

**Fiber tracking**

By tracking the principal directions of the tensors (or the ODFs) we obtain a white matter connectivity map of the brain.

**Results**

- **Simulated data**
  The signal was simulated using a two-tensor model (prolate tensor model) and corrupted by Rician noise.

Fig. 1: Top to bottom: SNR 40 and 20. Left to right: 64, 32 and 12 gradient directions.

- **Comparisons on synthetic 3D phantom (ISBI challenge, May 2012)**

Fig. 2: From left to right: SNR 10, 20 and 30.

- **In vivo brain data**

**Acknowledgements:**

This work was made possible in part by the NIH/NIGMS Center for Integrative Biomedical Computing, 2P41 RR0112553-12.

**References**

