1 Introduction

The following is a description of the algorithm used to generate submissions to the Sparse Reconstruction Challenge for Diffusion MRI (SPARC dMRI) of the MICCAI 2014 Workshop on Computational Diffusion MRI. A total of three submissions were generated for the challenge #1 using the three-shells datasets with 20, 30, and 60 gradients per shells (b-values of 1000, 2000, and 3000 s/mm²). We pre-processed the data using a 3D Non-Local Means denoising [1] on each DWIs separately.

2 Method description

We used the 3D-SHORE Cartesian basis [2] with a Tikhonov regularization on the Laplacian to fit the dMRI signal. We solve the optimisation problem

\[
\min_x \frac{1}{2} \|E - \Phi \cdot c\|^2_2 + \frac{1}{2} \|R \cdot c\|^2_2
\]

where \(E\) is the normalized diffusion signal, \(\Phi\) is the system matrix of size \((\text{number of q-points}) \times (\text{number of basis elements})\) (eq. 23 in [2]), \(c\) is the coefficient vector and \(R\) is the regularization matrix. We recast this optimization problem as a Quadratic Program and constrained the reconstructed signal at \(q = 0\) to be 1. We note that the present technique makes no attempt to promote sparsity on the coefficient vector.

For all datasets, we used \(\lambda = 0.005\) and a maximal radial order \((N_{\text{max}})\) of 8 for the 30 and 60 gradients per shell datasets and 6 for the 20 gradients per shell dataset in the construction of \(\Phi\).

From the fitted coefficients \(c\), we analytically compute the \(s^{th}\) order “radial moment” of the propagator \(\int_0^\infty P(r u) r^{2+s} \, dr\) (eq. 33 in [2]). For example, Tuch’s diffusion ODF (dODF) corresponds to \(s = -2\) and the classical dODF to \(s = 0\). The ODFs are computed on a sphere of 5780 points with \(s = 2\), promoting sharp angular profiles. The maxima extraction is performed discretely on min-max normalized ODFs and points with a relative amplitude \(\geq 0.5\) that are maximal inside a \(25^\circ\) neighbourhood are considered as true maxima.

The signal estimation is obtained by \(E_{\text{est}} = \Phi \cdot c\) where \(\Phi\) is a new system matrix computed from the desired q-points coordinates.

References
