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Statistical Estimation with noisy Rician/non-central chi distributed MR images

Divya Varadarajan, Justin P. Haldar **Motivation & Introduction** Method Non-central Chi Rician Sum of squares (SoS) Acquisition Distributed $x_{i+1} = \arg\min_{Ax \ge 0} \frac{1}{2\sigma^2} ||Ax - \tilde{y}(x_i)||^2 + \mathcal{R}(x)$ Distributed where **A** is a dictionary : $x \to y$, $\tilde{y} = y \frac{I_n(\frac{x_i y}{\sigma^2})}{I_{n-1}(\frac{x_i y}{\sigma^2})}$, **y**: Observed image, +... x_{i+1} : Estimated image at the $(i + 1)^{th}$ iteration, R(x): regularization Histogram Of Magnitude Histogram Of SoS Magnitude G(x|x_i) (Majorant) H(x) (NLL) Image Image Image

- Magnitude or SoS data used extensively in quantitative experiments.
- Rician or non-central chi(NCC) Negative log likelihood (NLL) is complicated and non convex!!!
- Estimation using Gaussian approximation is not accurate in low SNR

New estimation technique:

- Optimizes Rician/NCC NLL
- Iterative method based on majorize-minimize approach
- Each iteration has a least square fomulation

Example Application : Estimation of spherical harmonic coefficients in diffusion MRI

Simulation

- A noisy voxel with two tensors was simulated
- SH coefficients were estimated from this noisy data using the Rician NLL based MM approach.
- Diffusion profile and quantitative parameters like generalized fractional anisotropy and absolute error were calculated

Rician NLL based estimation gives more accurate results!!!





Example Application : Denoising

Simulation



5 times Avg Ref Image

Noisy Image



0 10 20 30 40 50 iterations Noisy Image Ref. Image ST w/o reg. Random Noise





Conclusion

MM Tikhonov Regularization MM

- MM TV Regularization
- A novel optimization method was developed for estimating Rician/NCC data from its non-convex likelihood.
- Two example applications denoising and estimation of SH coefficients were demonstrated.

Future work

• Estimate the SH coefficients from multi-shell diffusion data acquisition.

References

D. Varadarajan, J. P. Haldar.

<u>A Quadratic Majorize-Minimize Framework for Statistical Estimation with Noisy Rician- and Noncentral Chi-Distributed MR Images.</u> *IEEE International Symposium on Biomedical Imaging: From Nano to Macro*, San Francisco, 2013, pp. 708-711.

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