A Novel Multishell Acquisition with Increased b-Shells and Sparse ORientations (MAISSOR)

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Introduction

Advancements in diffusion acquisition protocols and modelling have been made possible with improvements in MRI hardware. However, time constraints still leave a need for optimizing these acquisition protocols to obtain the most accurate information in a given acquisition time. In this experiment, diffusion acquisition protocols are tested to determine accuracy of diffusion outputs. Standard HARDI-style diffusion acquisitions are tested against a Novel Multi-shell Acquisition with Increased b-Shells and Sparse Orientations (MAISSOR). Acquisitions are tested using various diffusion models, to test the accuracy of diffusion metrics, as well as the accuracy in determining tractography properties. Results show that a MAISSOR type acquisition performs better in calculating both diffusion metrics and fiber orientation distribution functions when compared to standard HARDI-type acquisitions.

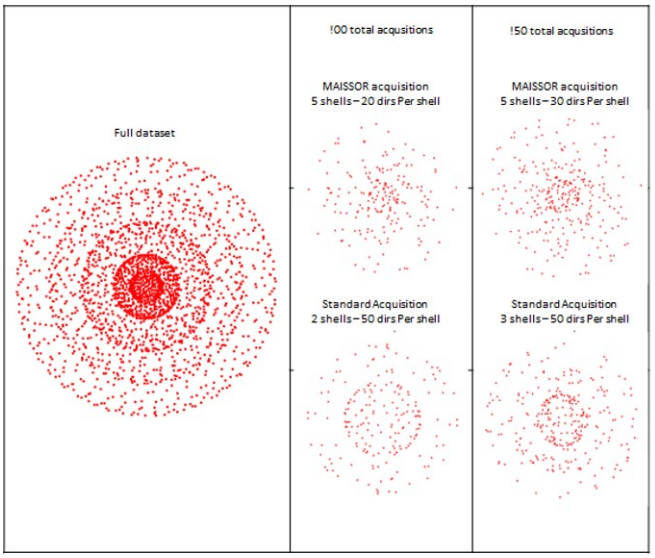


Fig.1 Example of 2 standard acquisition protocols with 100 and 150 total acquisitions (bottom row) and 2 MAISSOR acquisition protocols (top row)

Experimental

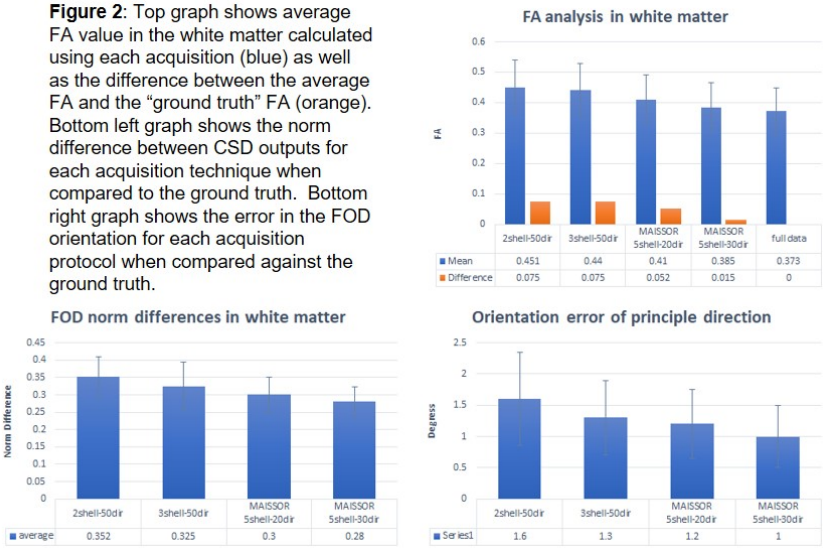
Experiments will be performed on human subjects on the Siemens 3T Prisma. Currently, experiments are run on a downloaded MASSIVE dataset[1]. Both MAISSOR and HARDI-type acquisition data (**Fig.1)** was extrapolated, and analyses were performed separately to assess the accuracy of diffusion metrics against the ground truth.

DTI[2] and constrained spherical deconvolution (CSD)[3] were performed on the entire brain for each of the datasets. The FA values for each dataset was averaged over the entire white matter and compared to the ground truth. FODs were created using CSD and were compared using two methods. First, the FODs were decomposed into spherical harmonic coefficients, and compared to ground truth across acquisition protocols to determine inaccuracy in FOD estimates. The orientation accuracy of the FODs were also determined by comparing the orientation of the principle direction of the FODs to that of the ground truth.

Results and Discussion

The DTI and CSD results shown in **Fig.2** indicate that for a given acquisition time, the MAISSOR acquisition performs better than common HARDI acquisitions. Accuracies in diffusion metrics such as FA can lead to improvements in biomarker accuracy, while improvements in FOD accuracy lead to more accurate tractography results.

Figure 2: Top graph shows average FA value in the white matter calculated using each acquisition (blue) as well as the difference between the average FA and the "ground truth" FA (orange). Bottom left graph shows the norm difference between CSD outputs for each acquisition technique when compared to the ground truth. Bottom right graph shows the error in the FOD orientation for each acquisition protocol when compared against the ground truth.



Conclusions

Diffusion imaging acquisition techniques are a widely studied field. The advent and improvement of MRI technology, has allowed for greater data collection, and understanding of the results that can be determined.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida.

References

[1] Froeling, M., *et al.*, *Magn. Reson. Med.*, **77**, 1797–1809 (2017). [2] Le Bihan, D., *et al.*, *J. Magn. Reson. Imaging*, **13**, 534–546 (2001). [3] Tournier, J.-D., *et al., Neuroimage*, **23**, 1176–1185 (2004).