

Overview

- DTI with high angular resolution (**HAR-DTI**) is critical for deriving accurate scalar metrics, e.g., FA, MD, AD and RD.
 - High angular diffusion imaging (**HARDI**) acquisitions are limited in clinical practice.
 - Scalar metrics derived by diffusion tensor imaging (DTI) with low angular resolution (**LAR-DTI**) are unreliable.
- We propose a High Angular Resolution DTI Estimation Network (**HADTI-Net**).
 - Estimating an enhanced DTI model from a minimal set of gradient directions.

Preliminary Analysis

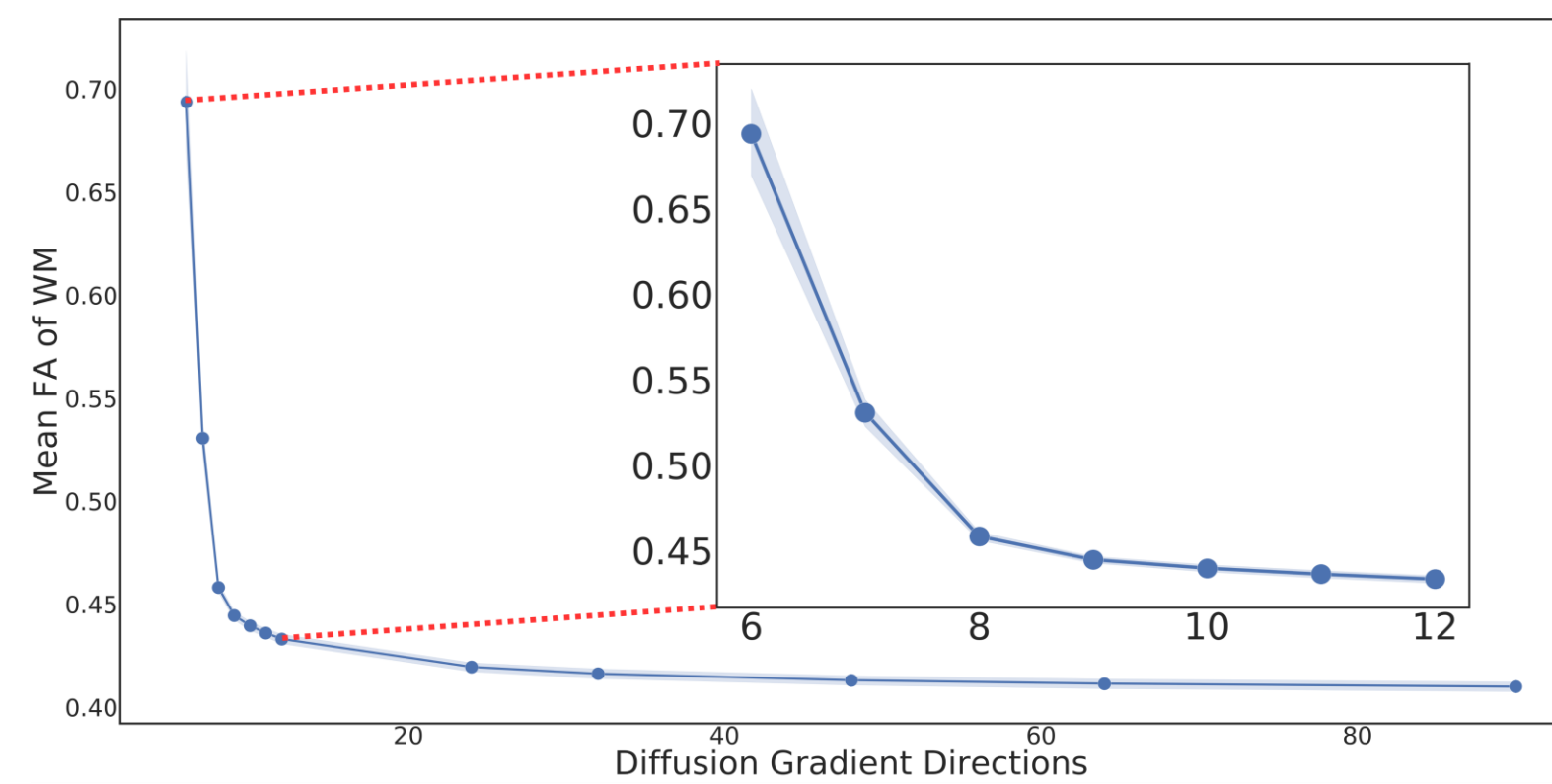


Fig.1 The mean FA of WM is significantly impacted by the number of diffusion weighted directions used for estimating DTI.

Diffusion Gradient Sampling and HADTI-Net

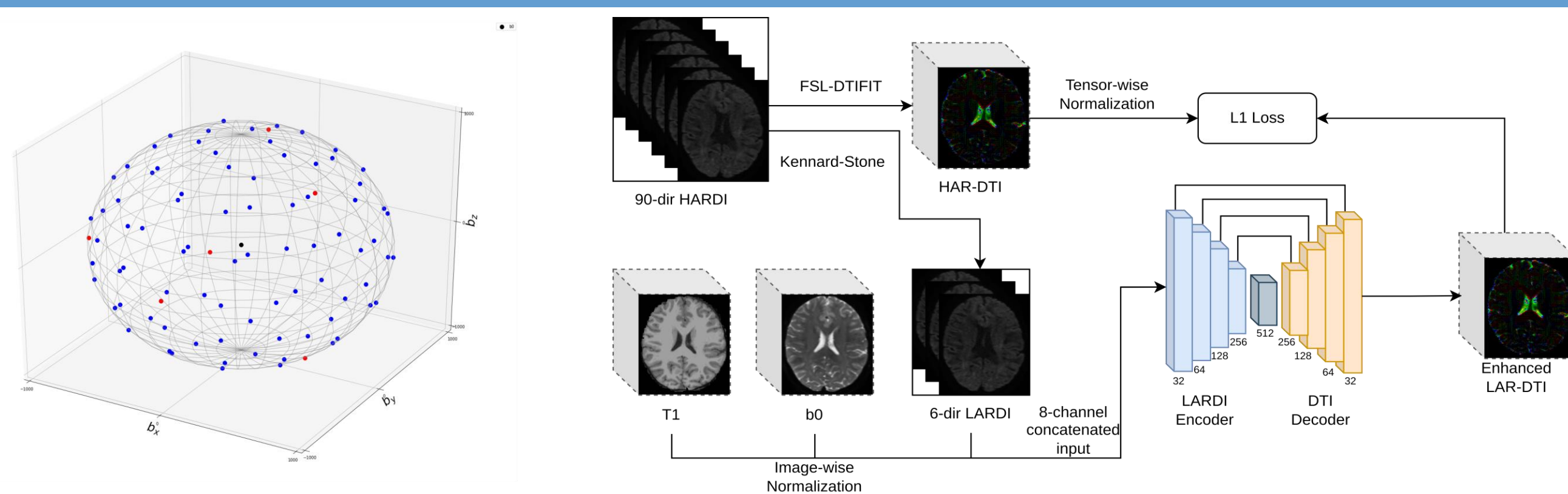


Fig.2 A random minimal set of 6 evenly distributed directions (red dots) is subsampled from 90 DWIs (blue dots). The HADTI-Net employs this minimal set of gradient directions to generate the enhanced DTI model.

Results: Qualitative Comparisons

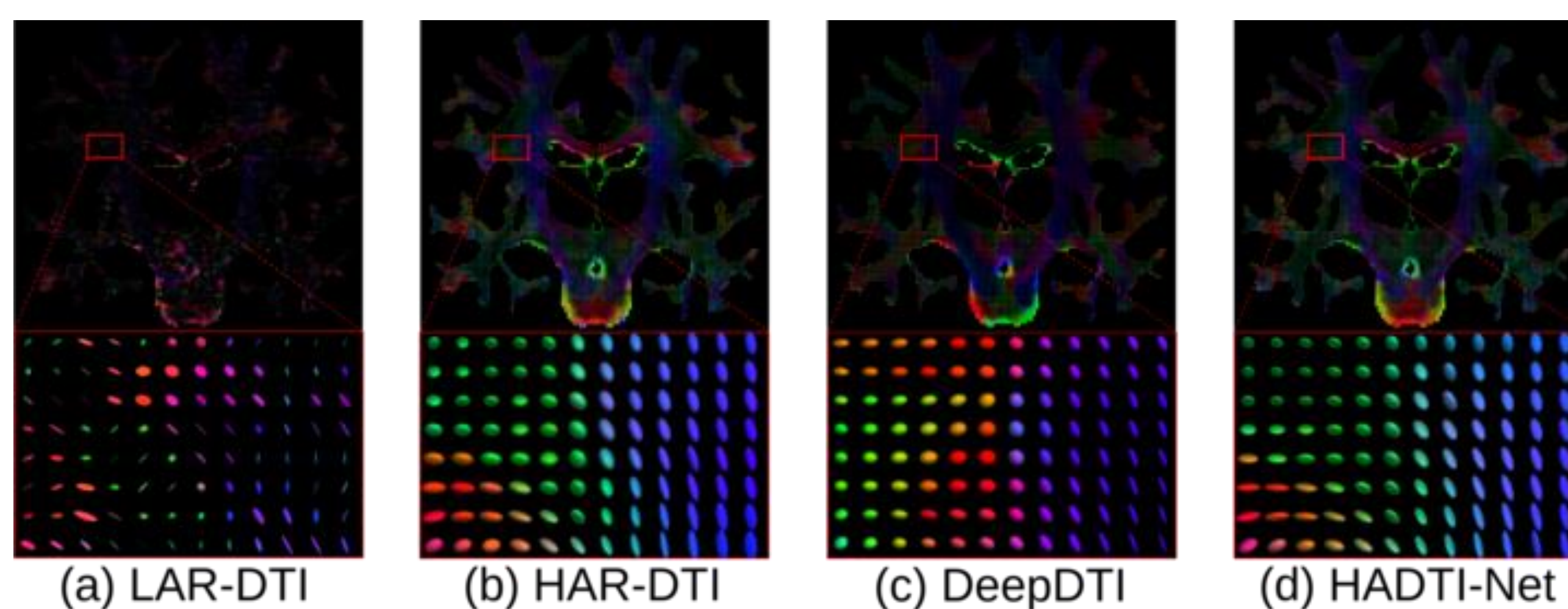


Fig.3 Qualitative comparisons of DTI generated by different methods in coronal views. a) Low angular resolution DTI. b) High angular resolution DTI, which is treated as the ground truth. c) DeepDTI [3]. d) The enhanced LAR-DTI by HADTI-Net.

Results: Quantitative Comparisons

Method	FA	MD	AD	RD
White Matter				
MAE ↓				
LAR-DTI	0.2732±0.0810 *	0.0000±0.0000	0.0004±0.0003 *	0.0002±0.0001 *
DeepDTI	0.1349±0.0094 *	0.0000±0.0001	0.0002±0.0002 *	0.0001±0.0000 *
HADTI-Net	0.0595±0.0213	0.0000±0.0000	0.0001±0.0001	0.0000±0.0000
SSIM ↑				
LAR-DTI	0.2652±0.0818 *	0.6069±0.1191	0.2692±0.1024 *	0.2865±0.1078 *
DeepDTI	0.6260±0.0314 *	0.7113±0.1732	0.5024±0.1371 *	0.5932±0.1256 *
HADTI-Net	0.8401±0.0574	0.7337±0.1479	0.7227±0.1038	0.7367±0.1243
Cross-correlation ↑				
LAR-DTI	0.3941±0.1002 *	0.9170±0.0926	0.5511±0.1175 *	0.6016±0.1595 *
DeepDTI	0.7331±0.0633 *	0.9108±0.1432	0.7597±0.1810 *	0.8701±0.1009 *
HADTI-Net	0.8980±0.0671	0.9372±0.0895	0.9019±0.0943	0.9291±0.0772

Fig.4 Quantitative comparisons between HADTI-Net and different state of the art methods. Common DTI-derived scalar metrics are used. * indicates significantly worse results when compared to HADTI-Net.

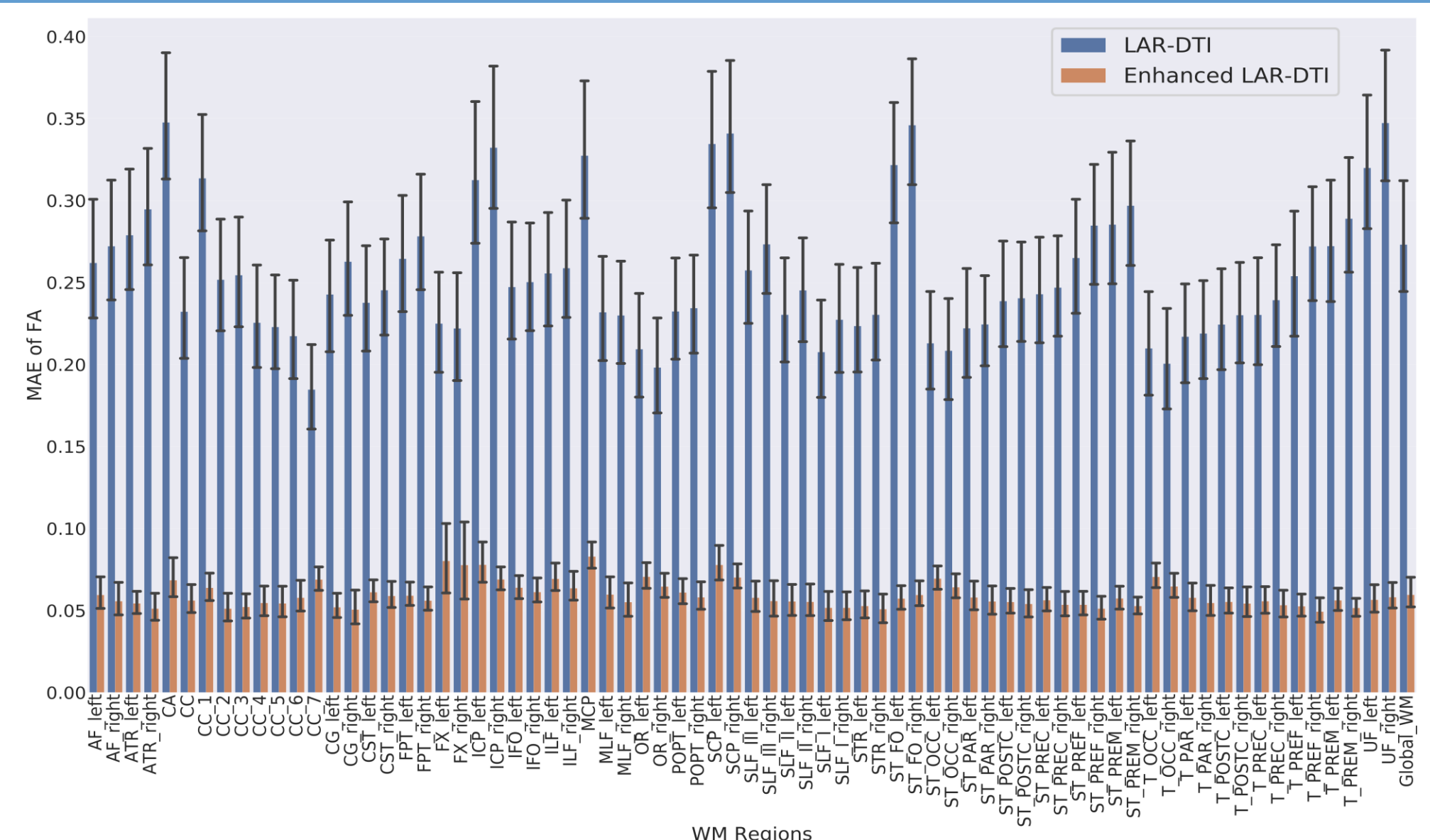


Fig.5 Mean absolute FA differences for LAR-DTI and enhanced LAR-DTI by HADTI-Net in 72 WM tracts and the entire WM region.

Conclusions

HADTI-Net is proposed to estimate the enhanced DTI model from a set of minimal evenly distributed directions. The experiment results prove that HADTI-Net can generate scalar metrics that are comparable to those derived by HAR-DTI.

References

- [1] Alexander, A.L., Lee, J.E., Lazar, M., and Field, A.S. (2007). Diffusion tensor imaging of the brain. 395 Neurotherapeutics 4, 316–329.
- [2] Tang, Z., Wang, X., Zhu, L., Cabezas, M., Liu, D., Barnett, M., et al. (2022). TW-BAG: Tensor-wise brain-aware gate network for inpainting disrupted diffusion tensor imaging. IEEE-DICTA.
- [3] Tian Q, Bilgic B, Fan Q, et al. DeepDTI: High-fidelity six-direction diffusion tensor imaging using deep learning[J]. NeuroImage, 2020, 219: 117017.