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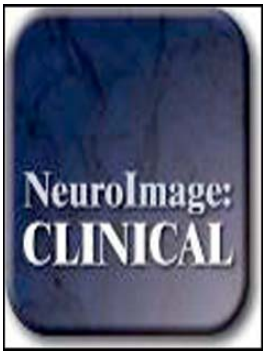

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Performance of unscented Kalman filter tractography in edema: analysis of the two-tensor model

Ruizhi Liao[a,b], Lipeng Ning[a], Zhenrui Chen[a], Laura Rigolo[a], Shun Gong[a,c], Ofer Pasternak[a], Alexandra J. Golby[a], Yogesh Rathi[a], Lauren J. O'Donnell[a]

[a] *Brigham and Women's Hospital, Harvard Medical School, Boston, MA, USA*

[b] *Massachusetts Institute of Technology, Cambridge, MA, USA*

[c] *Shanghai Changzheng Hospital, Shanghai, China*

Abstract

Diffusion MRI tractography is increasingly used in pre-operative neurosurgical planning to visualize critical fiber tracts. However, a major challenge for conventional tractography, especially in patients with brain tumors, is tracing fiber tracts that are affected by vasogenic edema, which increases water content in the tissue and lowers diffusion anisotropy. One strategy for improving fiber tracking is to use a tractography method that is more sensitive than the traditional single-tensor streamline tractography.

We performed experiments to assess the performance of two-tensor unscented Kalman filter (UKF) tractography in edema. UKF tractography fits a diffusion model to the data during fiber tracking, taking advantage of prior information from the previous step along the fiber. We studied UKF performance in a synthetic diffusion MRI digital phantom with simulated edema and in retrospective data from two neurosurgical patients with edema affecting the arcuate fasciculus and corticospinal tracts. We compared the performance of several tractography methods including traditional streamline, UKF single-tensor, and UKF two-tensor. To provide practical guidance on how the UKF method could be employed, we evaluated the impact of using various seed regions both inside and outside the edematous regions, as well as the impact of parameter settings on the tractography sensitivity. We quantified the sensitivity of different methods by measuring the percentage of the patient-specific fMRI activation that was reached by the tractography.

We expected that diffusion anisotropy threshold parameters, as well as the

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