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Automatic detection of corrupted volumes in DTI data

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Abstract:
Introduction: A Diffusion Tensor Imaging (DTI) dataset comprises a set of volumes acquired along different gradient directions. However, some of these volumes can be corrupted by the presence of artifacts that can impact estimates of fractional anisotropy (FA). Here, we propose a method to automatically discard corrupted volumes in DTI data.
Subjects And Methods: Data set: 18 subjects (age:36±13yrs mean±SD; sex:11/7 M/F) were imaged on a GE Signa 3.0T (TR/TE=14s/84.4ms; 25 diffusion gradients with b=1000s/mm^2 and 5 images with b=0s/mm^2; 55 slices; voxel size=0.9375x0.9375x3mm^3; FOV=240x240mm^2). Data from 2 subjects have high levels of noise in some volumes and 7 subjects have artifacts in all volumes (Nyquist ghost, noise, shadows).
Methods: The proposed method discards volumes corresponding to corrupted gradient directions. To determine which volumes are to be discarded, we define a quality score (QS) as follows. First, we compute multiple FA estimates for each voxel by using a bootstrap approach similar to [1], i.e., by removing volumes from the dataset for each estimate. Second, we compute the 95% confidence intervals (CI) for each voxel from the multiple FA estimates. Third, we define QS as the double integral of the CI distribution. We compute the initial QS using all volumes. Then we compute a QS for the data without each volume, one at a time, and discard the volume associated with the maximum QS. We repeat this until the QS decreases.
Results: The algorithm correctly discards corrupted volumes in the 2 subjects with high noise in some volumes. However, it does not discard any of the volumes for subjects where there are artifacts in all or none of the volumes. Figure 1 shows an example of a noisy volume discarded by the algorithm and Figure 2 shows the impact of the corrupted volumes on the FA map (note the more prominent green horizontal lines in the FA map on the left).
Discussion: The method proposed here automatically discards corrupted volumes in DTI data resulting in more reliable FA maps. However, it is very conservative, removing only volumes that are seriously corrupted. Future

developments will include a slice-by-slice analysis to also detect small artifacts or artifacts present in all volumes.

Reference: [1] Heim S. (2004) Magn Res Med 52:582-589

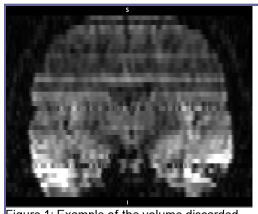

Figure 1: Example of the volume discarded by the algorithm.

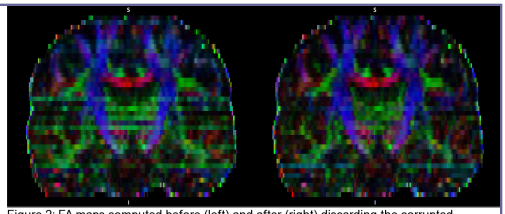

Figure 2: FA maps computed before (left) and after (right) discarding the corrupted volumes.

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Topic (Complete): 104: Brain, white matter: Imaging

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