FAST AUTOMATIC SPIKE ARTIFACT ASSESSMENT IN DTI DATA FOR MONITORING POSSIBLE HARDWARE ISSUES

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Target audience: Investigators that need automatic quality monitoring for DTI data

Purpose: Spike-noise is a nuisance since its occurrence cannot be influenced by sequence design or protocol parameters and the sources are not easy to identify. Spikes can arouse from e.g. erroneous shielding, gradient or receiver coils, cable connections, components of the receiver chain or loose mechanical connections. Further external source are electrical discharges due to low humidity or electrical devices that operate at high frequency in the scanner room. Especially Echo-Planar-Imaging (EPI) based Diffusion Tensor imaging is prone to this kind of artifact and occurrence could be easily identified visually within these kind of data. However, nowadays DTI series can comprise several thousand single slices, which make it cumbersome to evaluate these data for spike noise manually. Furthermore, data redundancy in recent DTI protocols (>30 directions, several b0 images) reduces the effect of spike noise on residual property maps like fractional anisotropy. Thus, these artifacts remain in general undetected in DTI. Thus, the aim of the study was to develop, implement and test a simple algorithm, which allows fast and automatic assessment of spike noise in DTI data sets.

Methods: The algorithm determines a single quantity as quality measure for each DTI data set. The basis for this quantity is the mean background signal extracted for each slice. Slices suffering from spike noise have a higher background signal compare to uncorrupted slices as explained in [1]. The median absolute deviation (MAD) is calculated for each slice with a median value that is determined for each slice position separately. The final quality measure is just the mean of MAD values of all slices and volumes of a single DTI measurement. This error measure was calculated retrospectively for DTI series acquired at a 3T MRI over a period of 5 years (>1500 data sets). The results were correlated to information about spike issues taken from service protocols provided by the manufacturer.

Results: Figure 1 show the quality measure plotted over the full time period of almost 5 full years. The horizontal green, yellow and red line indicates thresholds for normal, alarming and severe data corruption, respectively. The threshold levels were defined empirically. Error values of consecutive DTI data sets that crossed the red line (e.g. Aug2008, Jul2010, Jul2011) implied hardware issues, which were validated by consulting the service protocols.

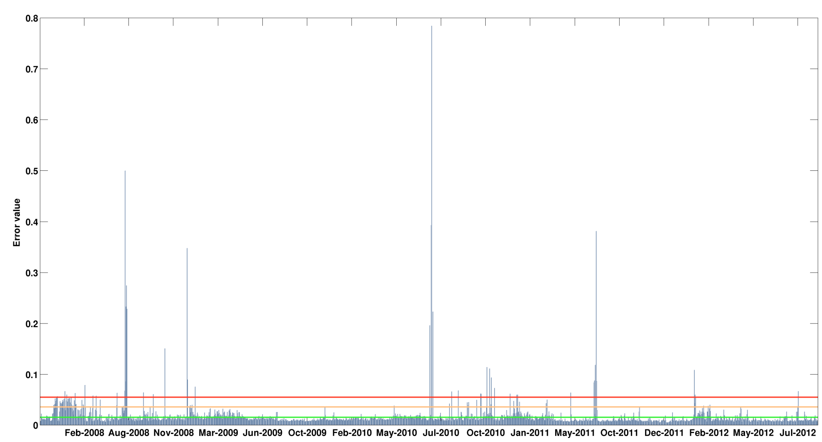

Fig. 1 Quality measure for DTI data sets taken from a 3T MRI over a period of 5 years. Values that cross the red line indicate a hardware issue.

Discussion: Using a simple measure that is fast and easy to calculate, we implemented an effective tool to monitor DTI data quality. However, this approach relies on correct background selection. A possible workaround could be the use of the 2D autocorrelation calculated for each slice, which does not rely on background selection. Nevertheless, this research shows that probing DTI data is a good measure for MR system performance. In order to use this approach for continuous monitoring of hardware performance and to detect issues, DTI data acquisition on regular basis (e.g. daily) is required. It can be used without access to raw data or scanner hardware and is thus independent of scanner vendor and model.

References: [1] Chavez, S., Storey, P., & Graham, S. J. (2009). Robust correction of spike noise: application to diffusion tensor imaging. Magnetic resonance in medicine : official journal of the Society of Magnetic Resonance in Medicine / Society of Magnetic Resonance in Medicine, 62(2), 510–9.