An analytical g-factor framework for k-t-GRAPPA/PEAK-GRAPPA

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Purpose: The goal of this work is to establish an analytical g-factor framework for the analysis of noise transfer and temporal frequency filtering characteristics of time-resolved k-space based parallel imaging methods. The presented framework extends the known g-factor (1,2) for non-time-resolved methods. **Methods:** The theoretical framework is derived for k-t-GRAPPA (3) and PEAK-GRAPPA (4) and additionally applied to a Sliding Window (SW) and a non-time-resolved GRAPPA reconstruction for reference. The analysis comprises temporal frequency resolved g_{xf}-factors and temporal frequency combined g_{xf}^{avg}-factors to capture temporal frequency characteristics and the total noise distribution, respectively. The theory is demonstrated on a short-axis cardiac CINE data set. Statistical validation was performed based on time-resolved pseudo replica images as in (5). **Results:** Figure 1 summarizes main results for SW, k-t-GRAPPA and PEAK-GRAPPA: *(a)* temporal frequency resolved g_{xf}-factor maps for k-t-GRAPPA and *(b)* temporal averaged noise distribution maps with values below 1, indicating noise suppression, as well as *(c)* the temporal average root mean square error (tRMSE) showing the expense of increased temporal bias, *(d)* temporal frequency resolved g_{xf}-factors for two pixels (i.e. within moving and static tissue) which reflect method-dependent temporal frequency filtering characteristics. **Discussion and Conclusion:** Analytically derived values are in excellent agreement with the statistical results (Fig.1). The benign SNR behavior of k-t-methods is confirmed and different temporal frequency filtering characteristics between the three methods are revealed. The signal and noise transfer for k-t-/PEAK-GRAPPA exhibits increased values in the area of moving tissue, while values in static tissue reflect a strong noise reduction due to temporal filtering.
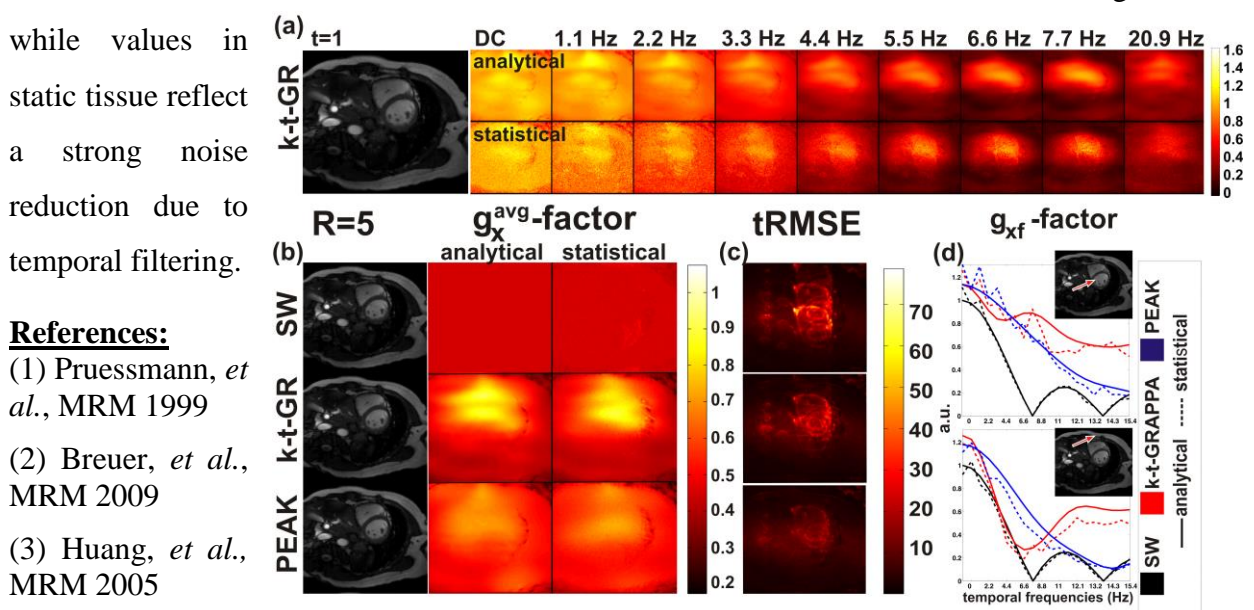
References:
(1) Pruessmann, *et al.*, MRM 1999

(2) Breuer, *et al.*, MRM 2009

(3) Huang, *et al.*, MRM 2005

(4) Jung, *et al.*, MRM 2008

(5) Robson, *et al.*,

Figure 1: *(a) temporal frequency resolved g-factor maps, (b) analytical and statistically derived total noise distribution maps, (c) the temporal average bias, (d) temporal frequency resolved g-factors for two single pixels*