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Poster presentation

Spatio-temporally constrained reconstruction for highly accelerated flow MRI

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Introduction

Due to the inherent long scan times, single and multi-directional cine phase-contrast MRI [1] has limited practical value in a clinical setting [2]. Using parallel imaging combined with constrained reconstruction procedures [3], acceleration factors on the order of 4-6 have been shown practicable for flow quantification [4]. Recently, k-t PCA(5) was proposed to further constrain reconstruction. By using principle component analysis (PCA) on the training data, the number of unknowns to be solved for can be reduced thereby permitting acceleration factors excelling those of previous methods. In this work, the k-t PCA method is extended by introducing spatial compartment-specific basis sets to improve reconstruction accuracy at very high undersampling factors (method termed k-t PCA+ hereafter).

Purpose

Implementation and validation of compartment based spatio-temporally constrained reconstruction of highly undersampled cine phase-contrast MRI.

Methods

In k-t PCA, the acquired signal in the spatial-temporal frequency domain is decomposed into spatially dependent weightings and time-dependent basis functions [5]. This method is extended by defining spatial compartments based on correlation analysis of temporal signal variations. Compartment specific temporal basis sets are subsequently used to constrain the dynamic behavior of the reconstructed image. This significantly reduces the number of unknowns in the reconstruction resulting in more accurate results.

To validate the proposed algorithm, transverse cine phase-contrast velocity data were obtained at the level of the pulmonary artery in healthy subjects on a 1.5 T Philips Achieva system (Best, NL), (FOV:320 × 260 mm2, matrix:128 × 104, temporal resolution:20 ms). To permit accuracy assessment, fully sampled (reference) data were decimated by a nominal acceleration factor of R, and all reconstruction results were compared to the reference. Three compartments were automatically defined relating to ascending aorta, descending aorta, and remaining pixels.

Results

Figure 1 shows flow profiles of the ascending and descending aorta for R = 30 reconstructed with k-t SENSE, k-t PCA and k-t PCA+ along with the result from fully sampled data. Using k-t PCA+ excellent reconstruction fidelity is achieved. In contrast to k-t PCA and k-t SENSE, k-t PCA+ does not suffer from temporal filtering effects. The root-mean-square error (RMSE) of reconstruction as a function of acceleration factor is shown in Figure 2.

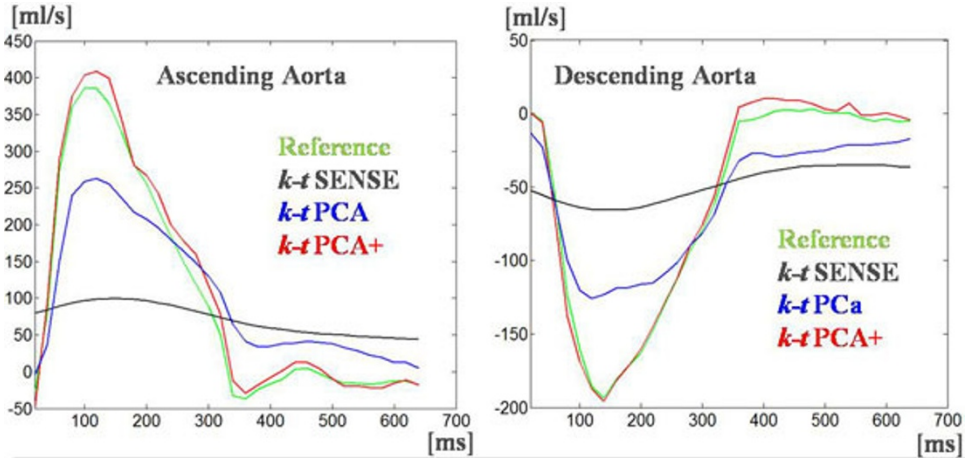

Figure 1
Flow profiles through the ascending (left) and descending (right) aorta calculated on the fully sampled dataset (green) as well as on a highly undersampled dataset (R = 30 and 6 training profiles) reconstructed by *k-t* SENSE (black), *k-t* PCA (blue and *k-t* PCA+ (red).

Conclusion

We demonstrated that k-t PCA+ can achieve excellent reconstruction accuracy of phase-contrast MRI at very high acceleration factors. Up to 11-fold net scan acceleration with very little error in flow profiles relative to the fully sampled reference data has been realized indicating the potential of the method to significantly reduce scan times.

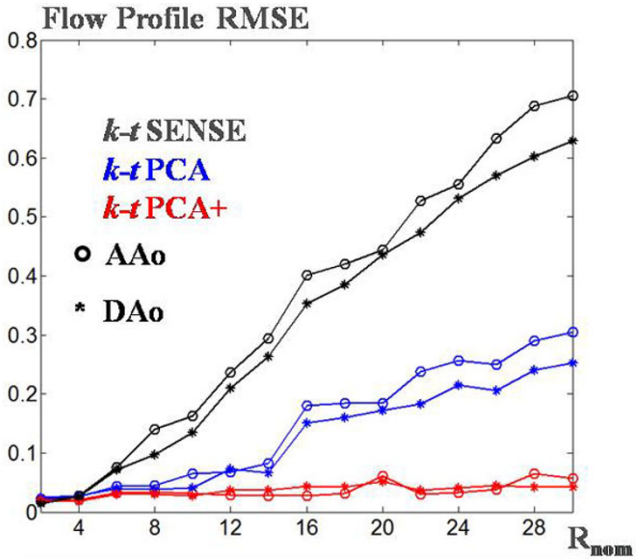

Figure 2
Flow profile RMSE relative to the fully sampled profiles, plotted over the nominal accelerated rate (12 training profiles) for flow profiles through ascending (circles) and descending (crosses) aorta, calculated from undersampled data reconstructed with *k-t* SENSE (black), *k-t* PCA (blue) and *k-t* PCA+ (red).

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