Diffusion-weighted PROPELLER with a novel unaliasing technique for small Field of View imaging

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Diffusion-weighted (DW) imaging is widely used in clinical imaging. To address the strong distortion encountered in EPI-based DW techniques, split-blade DW-PROPELLER [1] was proposed. With PROPELLER, when imaging a small Field of View (FOV) of a large object, No-Phase-Wrap (NPW) is usually applied to remove aliased signal in each blade before combining them [2]. However, with this conventional NPW [2], the blade width, already very narrow in DW-PROPELLER, is further reduced. This not only increases scan time, but also makes it more vulnerable to motion. Recently an innovative parallel imaging technique called mutual calibration [3] was introduced for DW-PROPELLER. In this work, we propose a new method based on this technique to achieve the same goal as conventional NPW, without sacrificing the blade width or scan time. Phantom and in vivo DW spine images suggest this is a promising alternative to conventional NPW.

TECHNIQUE Exclusively designed for spit-blade DW-PROPELLER, mutual calibration utilizes the relationship between two perpendicular blades for parallel imaging. As illustrated in Figure 1, for a regular blade without acceleration (purple dots), after we perform Fourier transform in the kx direction (step a) into the hybrid (x, ky) space (blue dots), we can do zero padding in the x direction (step b, green dots) to effectively increase FOV in the x direction. This is possible because any aliasing in this x direction is removed by the filter during data acquisition. After zero-padding, data in the

Figure 1. Recon flow chart

hybrid space are inverse Fourier transformed back to k-space (gray dots in the horizontal blade) in step c. Similarly we can obtain the vertical blade from the split-blade DW-PROPELLER data. After this step, the phase encoding direction is "accelerated" relative to the readout direction, allowing the use of mutual calibration [3] (step d) to estimate the "missed" data (red dots). This effectively increases FOV in the phase encoding direction and the aliasing is removed. Following the regular propeller reconstruction (step e), the image with "increased" FOV (gray circle) is cropped to generate the final image with desired FOV without aliasing (purple circle).
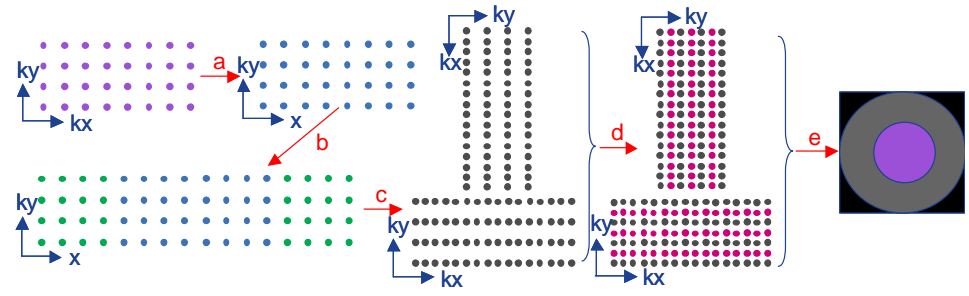
EXPERIMENTS Phantom and volunteer data were acquired on a GE SIGNA 3T scanner (General Electric, Milwaukee, WI, USA). Axial phantom imaging parameters include ETL = 16, b value = 500 s/mm^2, FOV = 14x14 cm^2, matrix size = 192x192, slice thickness = 5 mm, with 8-channel brain coil. NPW factor = 2 was used for conventional NPW data (scan time was doubled). Imaging parameters for C-spine are similar except that FOV = 18x18 cm^2, with multi-channel CTL spine coil.

RESULTS AND DISCUSSION The feasibility is demonstrated in Figure 2 with phantom images acquired (a) with and (b) without conventional NPW. Obviously there is aliasing artifact (yellow arrows) in (b) without NPW. If the proposed concept is used to reconstruct the image from the same data used for Figure 2(b), the aliasing artifact is eliminated (Figure 2c) and the image quality is comparable to conventional NPW result. It is important to note that its acquisition time is only half of the conventional NPW data. An application is shown in Figure 3 by the b = 0 and b = 500 images of the C-spine. No aliasing is observed in the C-spine images. It is also believed that DW-PROPELLER with the new unaliasing algorithm is more robust to motion artifacts due to its wider blade, in addition to the benefit in scan time.

REFERENCES: [1] Pipe, J. 11th ISMRM. p2126, 2003. [2] Gaddipati, A. US Patent 7023207, 2006. [3] Huo, D. 16th ISMRM. P756, 2008.
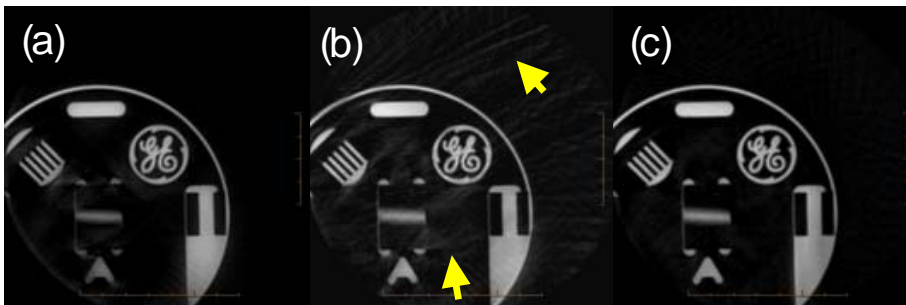
Fig. 2 Phantom images acquired with (a) and (b) without conventional NPW, and (c) proposed algorithm on non-NPW data. (b) and (c) were reconstructed from the same data set whose scan time is half of that for data set (a).

Fig. 3 C-spine images (b = 0 and b = 500, respectively) using the proposed technique.