WHOLE-BLADE PROPELLER DWI

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Introduction

PROPELLER [1] is a variant of multi-shot FSE technique, providing a high-resolution DWI with excellent immunity to off-resonance. Its self-navigated nature around the center of K-space also allows for motion correction. The odd/even echo phase inconsistencies in the non-CPMG echo train were addressed using the "split-blade" method [2], where the blade width was reduced by a factor of two, making the motion-related phase more difficult to remove [3]. Thus, this work applied the "whole blade" method [3] to create wider blades for robustly removing the motion-induced phase. The proposed scheme added the reference blade (only for b=0) to effectively remove the coil phase of odd/even echoes. This reference blade can also be used for GRAPPA kernel training for parallel imaging to further widen the blade and reduce the scan time.

Method

The motion-induced phase alternates the sign between even and odd echoes in a DW FSE sequence [3]. The whole blade approach makes the motion phase consistent for even and odd echoes. The flowchart of this approach is shown in Figure 1. After the whole blade is created, the motion phase can then be removed for each blade. The remaining reconstruction is the same as for conventional PROPELLER [1].
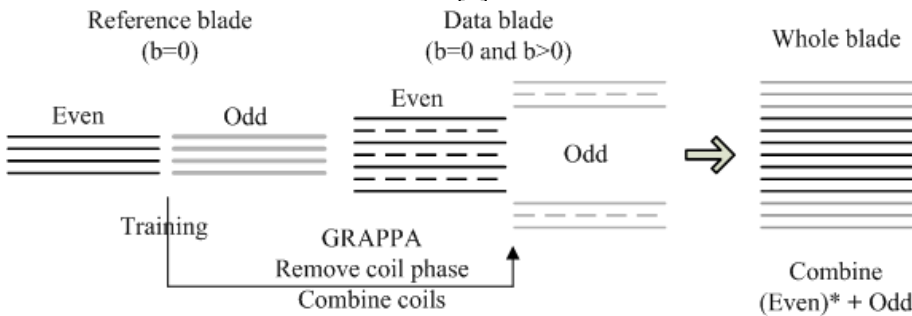

Fig. 1. Flowchart of combing even and odd echoes in K-space using whole blade method. The even and odd echoes of reference blades are used to remove the coil phase and GRAPPA training separately for even and odd echoes of data blades. The remaining phase of even echoes is conjugated to match the phase of odd echoes before combining them.

Results and Discussion

The volunteer data was acquired using a DW-PROPELLER sequence with Le Roux phase modulation [4, 5] on a GE SIGNA 3T scanner using FOV: 24 cm, matrix size: 192, and BW: +-50 KHz. Figure 2 shows the comparison of whole blade and split blade methods without and with parallel imaging, where the mutual calibration method [6] was used for split blade with the same kernel size as GRAPPA. The results of whole blade were comparable with split blade method in SNR and artifacts, indicating that the odd/even echo phase inconsistencies were successfully addressed. Furthermore, compared with split blade, whole blade method can either give more robust motion-induced phase removal for the same ETL (twice the blade width), or better SNR (halved ETL, shorter eff. TE) with the same robustness of removing the motion-induced phase.
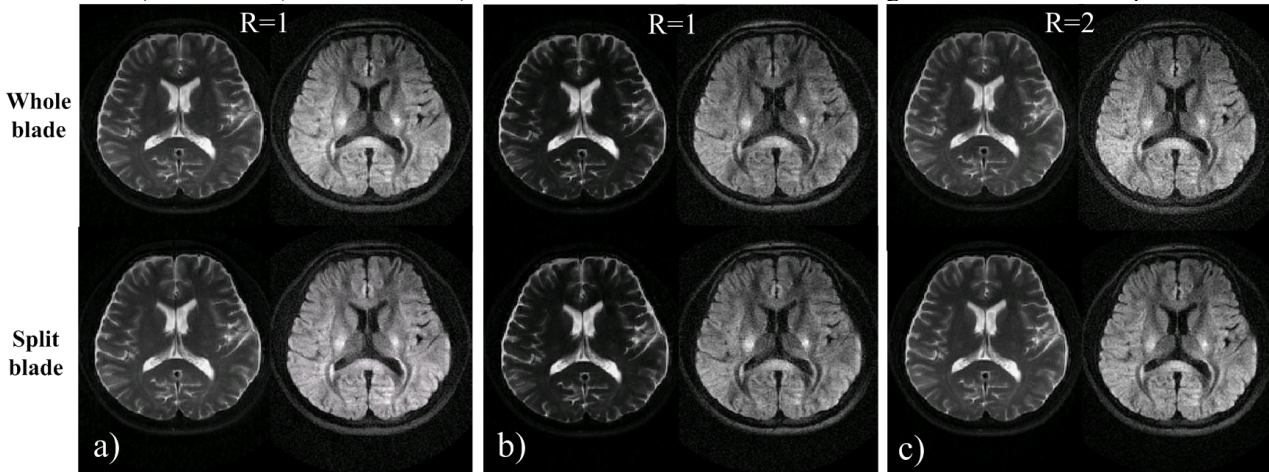

Fig. 2. Comparison of b0 and isotropic b=1000 DW images using whole blade (the first row) and split blade (the second row) methods without acceleration (R=1): (a) ETL = 16, (b) ETL = 32, and with acceleration (R=2): (c) ETL= 16.

References

[1] Pipe JG, et al, MRM (47), 42-53, 2002. [2] Pipe JG, 2003 ISMRM Proc, p. 2126. [3] Pipe JG, 2007 ISMRM Proc, p. 1486. [4] Le Roux P, JMR (155), 278-292, 2002. [5] Li Z, et al, 2009 ISMRM Proc, p. 3515. [6] Huo D, et al, 2008 ISMRM Proc, p. 756.