## An Enhanced Phase Correction Algorithm for PROPELLER DW MRI

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**INTRODUCTION:** Diffusion Weighted (DW) MR images are more sensitive to head rotation and non-rigid tissue motion as displacement in the presence of DW gradients induce additional spin phase. Figures 1 and 2 illustrate the effects of the superfluous spin phase on a PROPELLER blade in k-space. The superfluous spin phase generates phase artifacts in image space – blade shifts corresponds to linear phase, while the image energy dispersion results in a non-linear phase. An image-space correction technique based on the use of a triangular mask for phase correction has been proposed[(1)]. While this technique efficiently corrects for image energy dispersion, it re-centers each blade w.r.t. the k-space origin, effectively discarding data at one edge of the blade and shifting in zeros at the other edge[(2)]. Here we describe a refined technique using autocorrelation in image space to better handle the blade offsets with minimal data loss.

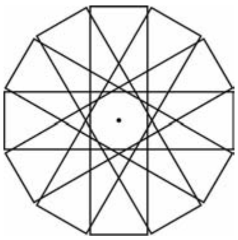


Figure 1.a

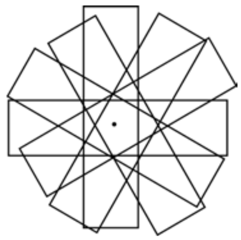


Figure 1.b

Figure 1.a depicts the ideal k-space PROPELLER trajectories. Figure 1.b shows the arbitrary shifts for each blade about k-space origin due to the rigid/bulk rotation

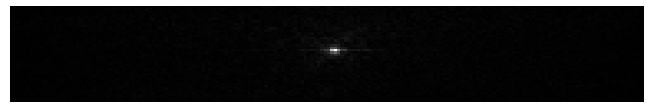


Figure 2.a

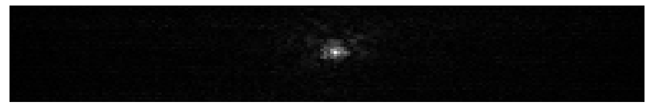
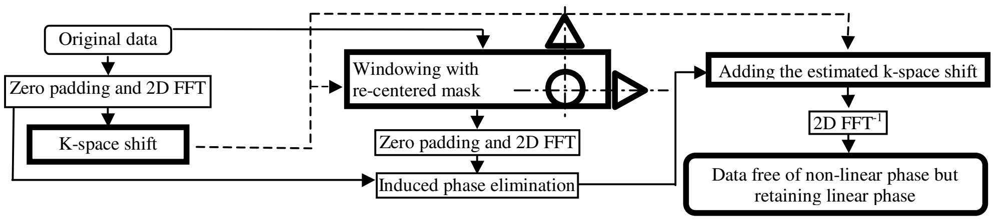


Figure 2.b

Non-rigid motion disperses image energy in k-space (figure 2.b) in contrast to the more coherent echo in an ideal image (figure 2.a)

**METHOD:** Quantifying the blade offsets determines the actual k-space co-ordinates for each data point. This information is then used in the gridding phase of the reconstruction process to inherently compensate for the blade offsets. $arg\{E[S(x,y)*S^*(x-1,y)]\}$ gives the blade offset in the X direction and shift in the Y direction is given by $arg\{E[S(x,y)*S^*(x,y-1)]\}$[(3)]. The following flow chart depicts the improved algorithm (bold shapes indicate the modifications to the existing algorithm). The data used to validate the algorithm was collected from normal volunteers using a GE 3.0T Excite scanner.




**RESULTS:** The proposed algorithm follows the previous technique in eliminating the nonlinear phase, but estimates the linear phase and retains it in the data. The efficacy of the estimates in tracking the blade shifts is demonstrated in figure 3. Generally reconstruction following either technique results in comparable images. Figure 4 shows a particular case where the proposed algorithm yields better quality.

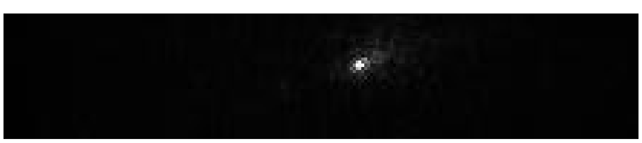


Figure 3.a Output of the proposed algorithm superimposed on the raw data

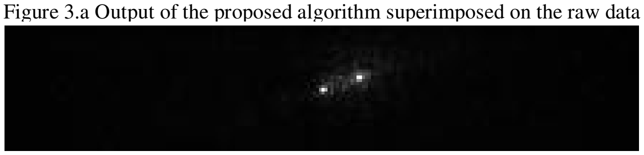


Figure 3.b Output of the previous algorithm superimposed on the raw data

K-space origins (the white mass) of the two images are indistinguishable in figure 3.a while they are obvious in figure 3.b

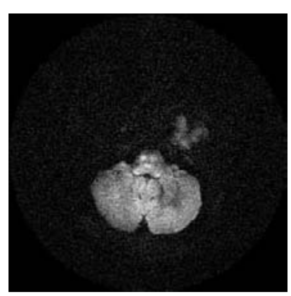


Figure 4.a Reconstruction following the proposed phase correction algorithm

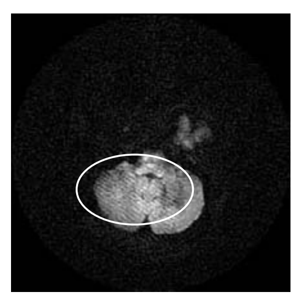


Figure 4.b Reconstruction following the previous phase correction algorithm

**REFRENCES:** (**1**) Pipe JG. Magn. Reson. Med. 1999;42:963-969 (**2**) Pipe JG, Farthing VG, Forbes KP. Magn. Reson. Med. 2002; 47:53-60 (**3**) Ahn CB, Cho ZH. IEEE Trans. Med. Imag. 1987; MI-6:32-36
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