Translation First PROPELLER MRI Correction

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Introduction and Theory: PROPELLER MRI is a well-known approach for correction of multi-shot axial T2W images corrupted by in-plane rigid body motion [1]. The standard PROPELLER correction algorithm compensates for in-plane rotation before in-plane translation; however, it is possible to correct in-plane translation first using center of mass (COM) consistency properties [2-4]. This allows the use of complex k-space values (instead of magnitude only [5]) in the subsequent rotation correction step. This improves rotation accuracy and enables the detection of all alignments over the full 360º range – impossible using only magnitude k-space data.

Standard PROPELLER motion correction steps (adapted from [1])	PROPELLER motion correction steps including proposed alternative methods
1. Data collection	1. Data collection
2. Phase correction	2. Phase correction
3. Rotation correction (image-based [1]; k-space based [5] using k-space magnitude data only)	**3. Center of Mass Translation correction**
	4. Rotation correction (using **complex** k-space data)
4. Translation correction (image based)	5. Translation correction (image based) – *optional refinement*
5. Correlation weighting (through-plane motion)	6. Correlation weighting (through-plane motion)
6. Final reconstruction	7. Final reconstruction

Table 1. PROPELLER MRI motion correction algorithmic steps: standard versus proposed alternative

Methods and Results: TSE, GraSE and EPI versions of PROPELLER were implemented using the R1.2.2 Philips Advanced Research And Development Integrated Sequence-programming Environment (PARADISE) on a 3.0T Achieva scanner (Best, The Netherlands). TSE PROPELLER was used to validate the accuracy of the standard and alternative algorithm by acquiring multiple data sets of a stationary phantom using a T/R head coil (TR/TE = 3000/80, matrix/TSE factor/blades =256/24/17). Different known 2D offsets and angulations ranging from 1-5 mm/degrees were applied. All scans shared the same preparation and gain settings allowing for combination of blades from different acquisitions to create composite data sets exhibiting motion corruption. Detected motions were compared to the known offsets and angulations when using the various forms of the correction algorithm.

Mean Absolute Error	+IMG Trans (Standard)	+COM Trans -IMG Trans	+COM Trans +IMG Trans
Translation X, Y [mm]	0.32, 0.31	0.10, 0.33	0.06, 0.16
Rotation [°]	0.21	0.08	0.08

Table 2. Effect of translation-first correction versus standard correction: image-based translation correction (IMG Trans), center of mass translation correction (COM Trans). Rotational alignment using complex k-space was performed in the cases with COM Trans correction.

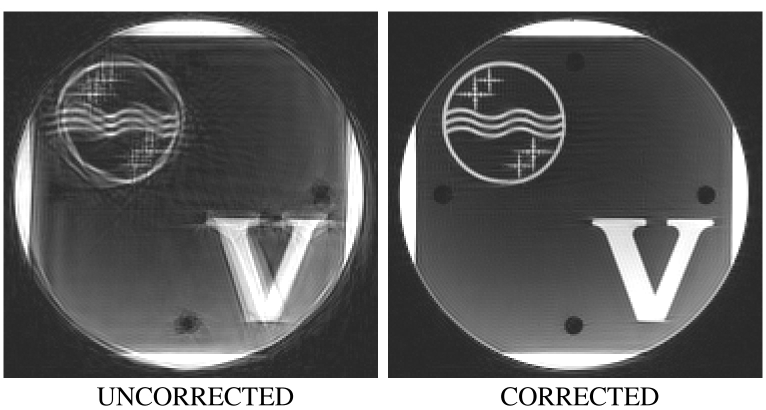

Figure 1. Uncorrected and corrected reconstructions. The corrupted dataset is a composite of individual datasets acquired with different known in-plane off-centers (2D translations) and in-plane angulations.

Discussion: The proposed COM translation correction yields improved translation and rotation results over the standard algorithm with TSE PROPELLER. It remains to be seen if this holds true for GraSE and EPI versions. Through-plane and/or non-rigid motion may still confound correction, and results could improve by eliminating severely inconsistent blades earlier in the correction process perhaps by examining each blade's DC value.

References:

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Acknowledgements: The author would like to thank the Vanderbilt University Institute of Imaging Science headed by John Gore and its staff for assistance in collecting data. Special thanks to Ken Wilkens and John Fellenstein for phantom construction.