TRELLIS MOTION CORRECTION: INITIAL RESULTS IN VIVO

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Introduction: Previously, simulations have shown the TRELLIS algorithm to be highly effective at reducing rigid-body motion artifacts [1]. Now motion correction with TRELLIS has been achieved in practice, both for a moving phantom and *in vivo*. The algorithm offers efficiency advantages over existing techniques such as PROPELLER [2], as all collected data is used for both motion detection and image reconstruction and excessive oversampling of the centre of k-space is avoided.

Method and Results: Data are acquired and processed using the TRELLIS technique described in [1]. In summary, k-space is filled using orthogonal overlapping strips and phase and frequency encode directions are alternated such that the frequency encode direction always runs lengthwise along each strip. The overlap between strips is used to produce a system of equations that, when solved, quantify the motion of the subject. Both rotational and translational motion can then be corrected in k-space by rotating and phase-correcting individual strips.

TRELLIS has been implemented on a GE 1.5 T scanner using a modified version of the standard FSE sequence. To mitigate blurring caused by T2-decay, the order of acquisition of lines within each strip is reversed for neighbouring strips. This results in a more gradual modulation through k-space than would otherwise be the case. Each strip is also multiplied by an inverse filter approximating T2-decay to further improve the situation.

In order to fairly compare the results of TRELLIS with a standard FSE acquisition, a moving phantom has been constructed. A computer-controlled pneumatics system moves a phantom constructed from acrylic and containing $CuSO_4$ solution. This allows sequences to be tested with reproducible motion (both translation and rotation). Resulting images are shown in Fig.1: (a) shows the phantom imaged using an interleaved FSE sequence when subject to the same motion; (b) and (c) show the results of the TRELLIS acquisition with motion correction switched off (b) and on (c).

A normal adult volunteer was imaged and instructed to move their head occasionally during the scan. Fig. 1 (d) shows the result from a standard interleaved FSE sequence with an echo train length of 16. Results using TRELLIS are show in Fig. 1 (e) and (f) without motion correction and with motion correction respectively.

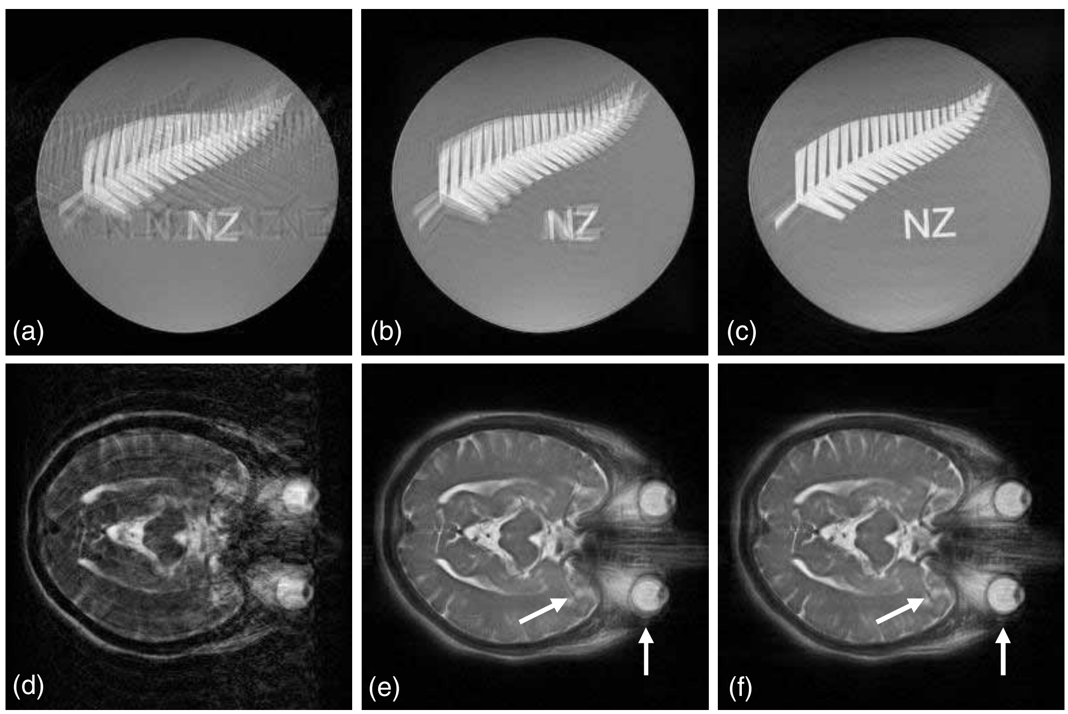

Fig. 1: Images obtained using standard interleaved FSE with an echo train length of 16 are shown in (a) and (d); images reconstructed using TRELLIS with motion correction switched off are given in (b) and (e); and images reconstructed using TRELLIS with motion correction are shown in (c) and (f). Due to the relatively small amount of motion in the *in vivo* case, the difference between (e) and (f) is slight. Note, however, the improved appearance of the middle cerebral artery and the eye in (f) as indicated by arrows.

Discussion: The TRELLIS algorithm has proved effective at reducing motion artifacts for both a moving phantom and a human subject. This is in agreement with previous results obtained using simulations. It is also interesting to note that the TRELLIS sequence is relatively robust to motion even without the application of motion correction performed in post-processing (a trait likely shared by PROPELLER). This is perhaps due to the damaging modulation of k-space that results from motion in standard interleaved sequences. This does not apply here; such disruptions to k-space are inherently more gradual. TRELLIS has an efficiency advantage over existing methods. All collected data is used for both motion correction and image reconstruction. Unlike PROPELLER, k-space is sampled evenly without increased oversampling near the origin. Thus the same acquisition time and SNR as in a conventional algorithm (sampling twice then averaging as is often done in practice) can be achieved. TRELLIS has been demonstrated here using a square FOV but is equally applicable to a rectangular FOV. Currently, no assumptions are made about the nature of the motion as a function of time. Incorporating prior knowledge of the maximum possible values of velocity or acceleration, for example, should further improve results.

References:

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