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Motion Correction for 3D Projection Reconstruction

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PURPOSE:

To correct MR data sets acquired with a 3D radial trajectory for translational and rotational motion.

METHOD/MATERIALS:

MR Data were acquired with VIPR (Vastly undersampled Isotropic Projection Imaging), a 3D radial *k*-space trajectory that provides high spatial and isotropic resolution with tolerable artifact despite angular undersampling factors of 3-10. A gradient echo sequence with N_r=256 samples per readout, a bandwidth of 125 kHz, and a TR of 3.7 ms was used in SPGR and TRUE FISP mode.

A sphere in *k*-space was sampled in 10 interleaves (subsets).

The first interleave (12 s) was assumed to be free of motion. Each projection of the following 9 interleaves was corrected for inter-view rotational and translational motion based on this reference set. First, rotational motion was estimated from a similarity measure between the k-space magnitude of the new projections and the reference projections as suggested by Pipe in the 2D case. The projections were assigned the corrected azimuthal angles Q¢ and horizontal angles j¢ for the reconstruction. Then the center of mass (COM) within each projection of the first interleave was calculated from the sinogram (1D Fourier transform of the data). For a static object, the COM within a projection can be predicted for any angle from the first interleave. Any motion component parallel to the projection-axis causes a shift of the COM. This can be corrected for by multiplication with a linear phase term in *k*-space. The algorithm was tested on a high resolution phantom with translational motion mimicking the diaphragm (+-2.5 cm). It was then applied to the human head with voluntary motion. Both scans were repeated without motion to test the accuracy of the predictions from the first interleave.

RESULTS:

In the case of no motion, the algorithm predicted the COM location with a root mean square error of 0.03 (phantom) and 0.21 (head) pixels for translational motion. Correction for rotational motion was successfully implemented in 2D simulations and remains to be evaluated in the 3D case.

CONCLUSIONS:

We investigated a novel technique to correct for translational motion of rigid bodies in three dimensions. Based on initial simulations this method should be applicable to rotational motion. Projections in 3D radial MRI inherently contain information for these corrections without prolonging imaging time. The algorithm requires one interleave free of motion, e.g. an initial breathhold. The image quality improved significantly with the motion correction technique. These properties could be used to mimimize motion artifacts in several clinical applications.