Variable Field-of-View Shapes for Radial Trajectories
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Introduction: Radial-based imaging trajectories, such as projection-reconstruction, cones, and PROPELLER, have many applications [1-4] because of their increased robustness to motion and flow over Cartesian trajectories, and support for shorter TEs and TRs. We have developed new methods that design these trajectories for variable field-of-view (FOV) shapes and sizes.

Methods: Our method applies to trajectories that acquire data on radial lines or blades in k-space. The separation between acquired lines, \( \delta k \), introduces aliasing in the direction perpendicular to the lines, \( \alpha + \pi/2 \), and thus limits the FOV in that direction:

\[
\text{FOV}(\alpha + \pi/2) = \frac{1}{\delta k}.
\]  

Both \( \delta k \) and \( \alpha \) are determined by the angle of the next line or blade, so they must be calculated by iteration. The angles and separations are sequentially designed, and the discontinuity at the end of the design can be removed by scaling. This causes some distortion of the resulting FOV, so the design should be repeated using a slightly larger FOV when the scaling factor is large.

The 2D PR and cones design algorithm is described in [5]. For PROPELLER design, the 2D PR algorithm is slightly modified to account for the blade geometry and the number of lines per blade. For 3D PR trajectories, the polar and azimuthal angle spacing are designed separately using a polar FOV that is circularly symmetric about the \( z \)-axis and an azimuthal FOV which is limiting only in \( x \) and \( y \). First, the polar angles are designed using the 2D PR algorithm and then interpolated to form a spiralling path on a sphere, which is azimuthally sampled.

Results: Figure 1 shows sample trajectories and the resulting point spread functions (PSFs), demonstrating the flexibility of shapes that can be designed with our algorithms. The in vivo results in Fig. 2 show that anisotropic FOV shapes will reduce aliasing artifacts from undersampled isotropic FOVs.

Discussion and Conclusion: Our algorithms accurately and efficiently reproduce the desired FOV shapes for PR, PROPELLER and 3D cones imaging trajectories. Using non-isotropic shapes tailored to the imaging area or volume results in a more efficient scan. This translates into reduced scan times and reduced aliasing artifacts, making radial trajectories and their applications more practical.