

Purpose: To employ Delaunay Triangulation of projection orientations in 3D electron paramagnetic resonance imaging (EPRI) for multidimensional angular interpolation and the dual tessellation (Voronoi diagram) for weighting coefficients enabling reconstruction by single stage inverse Radon Transform without the necessity of regriding data.

Methods: Standard 3D pulsed EPR oxygen images were acquired of an OX063 phantom with projections in an approximately uniform but none rectilinear fashion. The projection orientation was mapped to a unit sphere, and the Delaunay triangulation was calculated for these points on the surface. Projections were interpolated to the incenter of each triangulation using a weighted mean of projections located at the vertices. The Voronoi diagram was then calculated, partitioning the surface of the sphere such that each projection was associated with a spherical polygon. The area of these polygons was used as a weighting coefficient for calculation of the discrete surface integral in the filtered backprojection (FBP) algorithm.

Results: We were able to successfully reconstruct images using angular interpolation and the FBP algorithm without decomposition of the problem into stages of 1D interpolation and line integrals. Examination of images indicates improved ability to resolve oxygen concentration of phantoms.

Conclusions: Direct single stage reconstruction from non rectilinear sampling is an important progression in ERPI as it avoids the filtering effects of interpolation in regriding and multistage reconstruction. Proper analysis of the angular distributions of projections will allow for unrestricted sampling choices and potential optimization. Since sampling requirements of the discrete inverse Radon transform scale rapidly with higher dimension, angular projection interpolation is an important technique for artifact avoidance that must be reproduced in the move from single to multistage reconstruction. This work will form the basis for future investigation into the reconstruction of EPRI.