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Optimization of Spiral MRI Using a Perceptual Difference Model

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Abstract

We systematically evaluated a variety of MR spiral imaging acquisition and reconstruction schemes using a computational perceptual difference model (PDM) that models the ability of humans to perceive a visual difference between a degraded “fast” MRI image with subsampling of k-space and a “gold standard” image mimicking full acquisition. Human subject experiments performed using a modified double-stimulus continuous-quality scale (DSCQS) correlated well with PDM, over a variety of images. In a smaller set of conditions, PDM scores agreed very well with human detectability measurements of image quality. Having validated the technique, PDM was used to systematically evaluate 2016 spiral image conditions (six interleave patterns, seven sampling densities, three density compensation schemes, four reconstruction methods, and four noise levels). Voronoi (VOR) with conventional regridding gave the best reconstructions. At a fixed sampling density, more interleaves gave better results. With noise present more interleaves and samples were desirable. With PDM, conditions were determined where equivalent image quality was obtained with 50% sampling in noise-free conditions. We conclude that PDM scoring provides an objective, useful tool for the assessment of fast MR image quality that can greatly aid the design of MR acquisition and signal processing strategies.