

# MOTION CHARACTERIZATION AND COMPENSATION IN MAGNETIC RESONANCE IMAGING WITH RADIAL TRAJECTORIES

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Magnetic resonance imaging (MRI) is a powerful imaging modality for noninvasive diagnostics and basic research applications. A plethora of pulse sequences provide access to unique contrast mechanisms, and qualitative and quantitative measures. Additionally, it uses no ionizing radiation, making it ideal for screening, longitudinal studies, and pediatric imaging. Unfortunately, MRI is hindered by long acquisition times due to physical constraints and stringent sampling requirements. This limitation increases costs and introduces challenges for imaging moving objects.

Great effort has been put into accelerating MRI acquisition, with substantial success. Recent developments have focused on constrained reconstructions to produce artifact-free images from undersampled data. Many of these techniques leverage properties of novel, non-Cartesian  $k$ -space trajectories to produce incoherent undersampling artifacts. Specifically, radial trajectories have received renewed attention due to their capabilities in accelerated acquisitions, reduced field-of-view imaging, and ultra-short  $T_E$  imaging.

Radial trajectories are also robust to motion artifacts, exhibiting localized blurring rather than global image corruption. Additionally, radial projections provide self-navigating information, such that motion parameters can be extracted from individually acquired  $k$ -space lines or small subsets of projections. This work utilizes characteristics of two- and three-dimensional radial  $k$ -space trajectories to improve MRI in the presence of motion.

Patient populations for neurological imaging may suffer impairment, making it impossible to remain still for long cranial acquisitions. For such applications, this work proposes a novel technique to extract motion parameters from three-dimensional radial samples. The method uses the estimated patient motion to correct the data during reconstruction, reducing the appearance of motion artifacts.

In cardiovascular imaging, the periodic nature of the cardiac cycle is exploited to create a series of images capturing myocardial contraction and blood flow dynamics. Data are combined from successive heartbeats to fulfill the sampling requirements for individual time frames. Respiratory motion introduces a secondary challenge for thoracic and abdominal imaging. The work in this thesis investigates respiratory motion patterns the abdomen to determine parameters for gated acquisitions. Furthermore, this work demonstrates advantages of retrospective methods for simultaneous cardiac and respiratory gating, including a strategy for evaluating respiratory influence on blood flow using a double-gated radial phase contrast acquisition.