Abstract

Application of Accelerated Acquisition and Highly Constrained Reconstruction Methods to MR

Kang Wang

Under the Supervision of Dr. Charles Mistretta, Dr. Sean Fain and Dr. Frank Korosec

At the University of Wisconsin-Madison

There are many Magnetic Resonance Imaging (MRI) applications that require rapid data acquisition. In conventional proton MRI, representative applications include real-time dynamic imaging, whole-chest pulmonary perfusion imaging, high resolution coronary imaging, MR T_1 or T_2 mapping where multiple images are needed along the parametric dimension, *etc.* The requirement for fast acquisition and novel reconstruction methods is either due to clinical demand for high temporal resolution, high spatial resolution, or both. Another important category in which fast MRI methods are highly desirable is imaging with hyperpolarized (HP) contrast media, such as HP ^{3}He imaging for evaluation of pulmonary function, and imaging of HP ^{13}C -labeled substrates for the study of *in vivo* metabolic processes. To address these needs, numerous MR undersampling methods have been developed and combined with novel image reconstruction techniques. The work presented in this thesis aims to develop novel data acquisition and image reconstruction techniques for the following applications. (1) Ultrashort echo time spectroscopic imaging (UTESI). The need for acquiring many echo images in spectroscopic imaging with high spatial resolution usually results in extended scan times, and thus requires k-space undersampling and novel imaging reconstruction methods to overcome the artifacts related to the undersampling. (2) Dynamic hyperpolarized ^{13}C spectroscopic imaging. HP ^{13}C compounds exhibit non-equilibrium T_1 decay and rapidly evolving spectral dynamics, and therefore it is vital to utilize the polarized signal wisely and efficiently to observe the entire temporal dynamic of the injected ^{13}C compounds as well as the corresponding downstream metabolites. (3) Time-resolved contrast-enhanced MR angiography. The diagnosis of vascular diseases often requires large coverage of human body anatomies with high spatial resolution and sufficient temporal resolution for the separation of arterial phases from venous phases. The goal of simultaneously achieving high spatial and temporal resolution has gained interest from various aspects of MR, including receiver coil array developments, k-space acquisition trajectory design and novel image reconstruction techniques. This thesis also includes discussion about the extension of the developed techniques to other applications where fast MRI is also favorable.