Computational MRI

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Magnetic Resonance Imaging (MRI) is a non-invasive imaging modality. Unlike Computed Tomography (CT), MRI does not use ionizing radiation. In addition, MRI provides a large number of flexible contrast parameters. These provide excellent soft tissue contrast. Since its invention more than 30 years ago, MRI has improved dramatically both in imaging quality and speed. This has revolutionized the field of diagnostic medicine. Imaging speed is a major part of this revolution as it is essential in many MRI applications. Improvements in MRI hardware and imaging techniques have enabled faster data collection, and hence faster imaging. However, we are currently at the point where fundamental physical and physiological effects limit our ability to simply encode data more quickly.

This fundamental limit has led many researchers to look for computational methods, in which both the data acquisition and data modeling are used to recover the underlying information. One success story is the application of compressed sensing to MRI in which sparsity models are used to recover images from randomly under sampled MRI data to reduce scan time. This year, several MRI manufacturers have presented clinical products that are FDA approved and leverage compressed sensing for speeding MRI. While the early work focused on accelerating static 2D and 3D images, today, computational MRI is being use for "X" number of dimensions in which multiple image parameters, and motion dynamics are being resolved with clinically feasible scan times. New acquisitions schemes mix various tissue and physical parameters, while new approaches are being developed to model these interactions and reconstruct the underlying parameters from fewer measurements. These recent approaches, which are based on randomized sequences, learning and exploitation of redundancies, such as sparsity and low rank are used to enable comprehensive single scan exams which provide all the necessary information for clinical diagnosis. This talk will review the progress of computational MRI and present results from our group in dynamic and multi-contrast MRI with applications in pediatric imaging.