Acceleration and correction of phase contrast velocimetry for angiography and hemodynamic quantification

Kevin M. Johnson

Magnetic Resonance Imaging (MRI) can be utilized to provide non-invasive assessments of the cardiovascular system. Currently, clinical evaluations of most vascular diseases utilize morphological imaging sequences, often requiring the administration of external contrast agents. Phase Contrast (PC) is an MRI method capable of assessing both the morphology and quantitative velocity of arteries, veins, and any other moving tissue. Unfortunately, the utilization of PC clinically is often hindered by extended imaging times and errors in velocity measures. The work in this thesis, aims to provide methods to correct errors and accelerate phase contrast imaging. Thin slice calibration methods are developed to measure and correct for trajectory errors in phase contrast sequences, which cause velocity offsets and image distortions. These corrections are shown to reduce linear phase variations in PC, significantly reducing errors in flow quantification. With eddy current corrections, new sampling patterns can be performed and a novel dual-echo 3D radial trajectory is designed that adds the ability to perform off- resonance corrections. This sequence is demonstrated to improved performance over single echo sequences and is demonstrated for high-resolution intracranial angiography, quantification of relative pressure and wall shear stress(WSS), fat/water separated PC, respiratory gated, non-contrast enhanced renal angiography, and in combination with contrast enhanced MR, high resolution visualization of intracranial contrast kinetics.