Improved Spatiotemporal Association of Structure and Function in Pulmonary MRI

By

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ABSTRACT

Magnetic Resonance Imaging (MRI) is an appealing modality for imaging various aspects of lung physiology due to its safety profile and ability to image both structure and function. Unfortunately, the ability to image structure and function simultaneously or in rapid succession remains difficult to apply in practice and while such structure-function techniques have shown promise in evaluating pulmonary disease, image acquisition and post-processing to realize simultaneous evaluation of pulmonary structure and function remains complex and difficult to disseminate. Specifically, such methods have been limited due to the need for multiple acquisitions, contrast agents, and motion corruption and image misalignment that necessitates the use of complex post-processing. In this work I develop a semi-automated pipeline to compute measures of hemodynamics in the lungs and apply it to two different populations: Idiopathic Pulmonary Fibrosis (IPF) and Adult Survivors of Premature Birth. I show that I can detect quantitative impairment of hemodynamics on a regional scale in these two

populations relative to healthy subjects. Additionally, I apply advanced motion correction methods to improve the quality of morphological images in two populations that are typically difficult to image with MRI: IPF and neonatal bronchopulmonary dysplasia (BPD). Finally, I develop an advanced technique to reconstruct improved dynamic structural images with inherently aligned functional information. Overall, the goal of this dissertation is to advance the field by developing workflows for improving structure-function imaging in the lungs.