Di-Chromatic Super Resolution Interpolation of Magnetic Resonance Imagery

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Introduction: MR imaging of hyperpolarized C13 has demonstrated the incredible ability to image metabolism. Unfortunately, due to the limited amount of signal, the spatial resolution of the imagery is relatively poor (compared to standard MR imagery). To better inform the clinician, the metabolic imagery is interpolated up to the size of the corresponding proton image. Typically, either nearest-neighbor or linear interpolation is used. In this work, we developed an interpolation algorithm, called Di-chromatic Super Resolution, that uses the high resolution proton imagery to inform the values of the final interpolated metabolic image.

Methods: The main idea behind this work is that the interpolated metabolic image should adhere to the values collected where data exists, and the gradient of the interpolated values should mimic those of the high resolution proton image. This idea is encapsulated into a convex optimization problem, a convenient formulation because there exists a global solution which can be determined with known methods. We elected to solve the optimization problem using the Fast Iterative Shrinkage Threshold algorithm (with line search), which has a quadratic convergence rate.

Results: The algorithm is tested on metabolic imagery generated with hyperpolarized pyruvate from data of the prostate, heart, and brain. Results were validated either with 1) a problem with known ground truth or 2) by artificially reducing the resolution of a metabolic image and then attempting to recover it. Finally, false color interpolated imagery was fused using the Constrained Least Squares fusion algorithm, which optimally maximizes information content while retaining color. In all cases, the super-resolved imagery better reflects the metabolic activity in the imaged region.

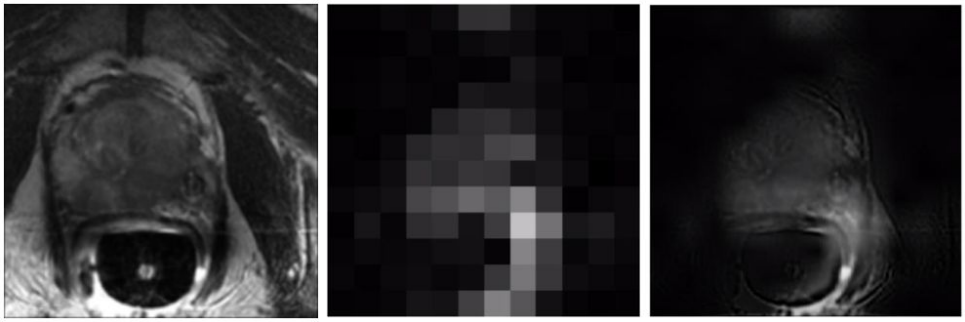

Figure: Results of di-chromatic super-resolution interpolation algorithm on metabolic imagery of the prostate: (Left) Proton image, (Center) metabolic image at natural resolution, (Right) Super-resolved image.