Random Undersampling Methods for Spatio-Temporal Sparse Dynamic MRI

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1 Introduction

This topic was proposed by Prof. John Pauly as a combined project for EE368 (Digital Image Processing) and EE369C (Medical Image Reconstruction).

2 Theory

Compressed sensing in MRI typically takes advantage of sparsity in the image or an image-transform space in order to accelerate scan times without loss of image information [1]. Recent research has extended these approaches to take advantage of not only spatial sparsity (via the wavelet but also temporal sparsity in dynamic MRI acquisitions. Dynamic MR images contain redundant information in both space and time, allowing representation with few sparse transform coefficients [2].

Whereas uniform undersampling results in coherent aliasing, appropriately designed random undersampling methods produce incoherent aliasing, which appears noise-like in image reconstructions. Compressed sensing in dynamic MRI utilizes these two concepts to sample well below the Nyquist-Shannon sampling rate in hybrid k-t space [2].

3 Goals

This project seeks to determine optimal spatio-temporal undersampling techniques in dynamic MRI scenes. Specifically, the focus will be on temporally-dense and spatially-sparse sampling. Any increase in temporal or spatial resolution in MRI inherently requires a decrease in the resolution of the other domain. By aggressively undersampling in the spatial domain, high temporal resolution becomes possible. Compressed sensing techniques increase the degree to which the k-space data can be undersampled without significant loss of image information.

Random undersampling schemes in both Cartesian and spiral acquisitions will be investigated and assessed. All data that will be used is made freely-available courtesy of Prof. Michael Lustig at UC Berkeley and Dr. Shreyas Vasanawala at Stanford's Lucille Packard Children's Hospital.

This project will not make use of Android devices.

References

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