AbstractID: 7847 Title: Highly Accelerated MRI using Undersampled Acquisition and HYPR Processing

During the past several years there has been a growing body of research developments that might be considered the beginning of a "Post Nyquist Era" in medical imaging. Investigators at Stanford and Cal Tech have shown that the iterative non-Fourier reconstruction "Compressed Sensing" method can be used to reconstruct single images with far less than the required number of Nyquist samples [1,2] for image data sets that satisfy certain sparsity requirements. The recent developments in parallel imaging also permit the reconstruction of relatively artifact free images by synthesizing missing k-space information using sensitivity profiles from multiple coils[3,4]. Our group has been investigating the use of VIPR, a vastly undersampled radial imaging technique [5,6] that almost immediately provides full spatial resolution after a small number of excitations at the expense of streak artifacts. In 3D these artifacts are quite incoherent and provide little degradation of image quality. Data undersampling factors of several hundred relative to the Nyquist criterion have been achieved. Recently VIPR has been combined with a new reconstruction method called HYPR (HighlY constrained PRojection reconstruction) [7] that exploits the spatio-'temporal' redundancy in medical image sequences involving any serial change in an imaging variable such as time, echo time, diffusion tensor encoding direction, etc. Using HYPR in combination with VIPR, angular undersampling factors on the order of 1000 in phase contrast angiography have been achieved with good image quality. A fundamental characteristic of HYPR is its ability to provide higher SNR than competing acceleration technique. The HYPR technique has been applied to X-ray CT angiography where clinically acceptable time-resolved angiographic image series have been reconstructed using 1/46th of the conventional x-ray dose.

Educational Objectives

1. To understand the advantages of 3D radial undersampling for increasing spatial and temporal resolution.
2. To understand how HYPR provides further acceleration with substantial preservation of SNR.
3. To understand how HYPR may be applied in a wide variety of medical imaging applications.

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