Method for MR Image Reconstruction Using a Difference Map Algorithm

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Description:

Many Magnetic Resonance Imaging (MRI) techniques are time constrained (e.g. MRI of solids, or functional MRI (fMRI)). As a result, they may try to use a compressed data sampling approach to speed the image acquisition. In compressed sampling, an under-sampled k-space data set is acquired, instead of the full, dense-sampling of k-space points. However, missing k-space points introduce artifacts in the Fourier-transform approach to image reconstruction, which can make the approach unusable.

Yale researchers in the Barrett lab have recently developed a method for image reconstruction that uses reasonable constraints on the sparse data, along with a difference map algorithm, in order to ‘fill in’ the missing k-space data. The approach results in an image that is nearly artifact-free, and that can lead to higher spatial resolution. The method makes Difference Mapping (DM) applicable to MRI images for the first time. It is faster and can handle much larger data sets than commonly used interpolation tools. Most importantly, it makes much higher image quality possible for the most common reconstruction method in use, the Fast Fourier Transform.

The Barrett team has solved the difficulty of adapting DMs to the MRI field by exploiting physical MRI data constraints to make unique physical projections of what images are physically possible. The tool has demonstrated the impressive reconstruction of sparse, compressed MRI and fMRI data sets. Further work is now underway to extend the application of the tool to the de-noising of dense data.

Ideal image     Dense image     FFT construction     D map construction

If you look closely, the Difference map construction actually yields an image that is sharper and closer to the ideal image (using an L2 distance metric) than the dense sampling case, despite the fact we only have 20% of the ‘dense sampling’ information at the outset.

Field of Application: MRI of solids, general sparse MRI construction (specifically fMRI), denoising/sharpening of even densely sampled data, radial sampling of k-space.

Advantages: Faster (n*\text{log}(n) time), can handle much larger data sets than commonly used interpolation tools, makes much higher image quality possible.

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