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Non-Cartesian k-space reconstruction to improve acquisition efficiency

A non Cartesian k space reconstruction method using self-calibrated, region specific interpolation kernels for highly accelerated acquisitions in MRI.

IP Status: US Patent Pending; **Application #:** 16/853,308

Applications

Technology ID

2019-114

Category

Engineering & Physical Sciences/MRI & Spectroscopy
Life Sciences/MRI & Spectroscopy
Software & IT/Algorithms
Software & IT/Image & Signal Processing
Gap Funding/Software & IT
Gap Funding/Medical Tech

Learn more

- MRI parallel imaging
    - Non-Cartesian imaging
    - 3D imaging
    - 4D high-resolution imaging using kooshball acquisition

Key Benefits & Differentiators

- Eliminates lengthy reference scans or long reconstruction times
- Determines interpolation kernels based on the data itself rather than requiring an additional reference scan
- Highly accelerated reconstruction with comparable image quality to TT-GRAPPA (currently available non-Cartesian) technique; 3-5 times faster than CG-SENSE technique
- Provides increased temporal resolution without loss of spatial resolution
- Ideal for free-breathing scanning as there is no calibration steps

Overview

In MRI scanning, parallel imaging techniques such as GRAPPA use properties of multicoil receiver arrays to recover missing k space data points using nearby acquired k space samples. In conventional non Cartesian GRAPPA with through time GRAPPA (TT GRAPPA), the use of region specific interpolation kernels has demonstrated improved reconstruction quality in dynamic imaging for highly accelerated acquisitions. However, TT GRAPPA requires the acquisition of a large number of separate calibration scans, which lengthens overall scan duration; for every ~20 s data acquired, there is a ~3 min calibration data acquisition step.

To eliminate calibration steps and reduce overall scan time, researchers at the University of Minnesota have developed a new reconstruction method named Self calibrated Interpolation of Non Cartesian data with GRAPPA (SING) to self calibrate region-specific interpolation kernels from dynamic undersampled measurements. The SING method synthesizes calibration data to adapt to the distinct shape of each region-specific interpolation kernel geometry, and uses a novel local k space regularization through an extension of TT GRAPPA. This calibration approach is used to reconstruct non Cartesian images at high acceleration rates while mitigating noise amplification. Researchers have shown that SING offers visually and quantitatively similar reconstruction quality to TT GRAPPA, and provides improved reconstruction quality over conjugate gradient SENSE in both numerical phantom and in vivo cine data sets. In the SING method, the computational burden is spent up-front and is low for subsequent data; and can be highly parallelized for rapid application such as for free-breathing scans.

Phase of Development

Demonstrated in a 3T clinical field strength scanner for cardiac imaging with radial acquisition.

Desired Partnerships

This technology is now available for:

- License
- Sponsored research
- Co-development

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Researchers

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References

1. Chieh, Seng Wei, Mostafa Kaveh, Mehmet Akçakaya, and Steen Moeller. , https://doi.org/10.1002/mrm.28033, Magnetic resonance in medicine 83, no. 5 (2020): 1837-1850.