A hybrid machine learning-based magnetic resonance image reconstruction

A machine learning-based magnetic resonance image reconstruction algorithm that combines the benefits of both linear GRAPPA and nonlinear RAKI methods.

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Applications

- Parallel imaging in MRI
- Multiband/Simultaneous Multi-Slice imaging acceleration

Key Benefits & Differentiators

- Better noise resilience compared to GRAPPA, and fewer blurring artifacts compared to RAKI.
- 6-fold acceleration for any sequence by allowing greater undersampling of acquired data
- Network is trained using subject-specific/scan-specific auto calibration signal data; does not require a training database
- Requires no change to data acquisition, could be used in conventional MRI scanners
- Flexibility for different weights on linear and non-linear components

Overview

GRAPPA, one of the most clinically-used linear reconstruction methods for parallel imaging, suffers from noise amplification. As an alternate, a nonlinear method that utilizes subject-specific convolutional neural networks for k-space reconstruction, Robust Artificial-neural-networks for k-space Interpolation (RAKI) was proposed and shown to improve noise resilience over linear methods. Advancing this RAKI method, researchers at the University of Minnesota have now developed a method to reconstruct images from undersampled k-space data using a residual machine learning algorithm that combines the benefits of both linear GRAPPA and nonlinear RAKI reconstructions. This hybrid method, called residual RAKI (rRAKI), offers significant improvement in image quality compared to linear method, and improves upon RAKI in highly accelerated simultaneous multi-slice imaging. Specifically, the convolutional neural network in the residual network removes the noise amplification arising from coil geometry in the linear part. Experiments in brain imaging show that rRAKI has noticeable advantages over linear methods in terms of noise resilience, produces sharper images and generates fewer blurring artifacts compared to RAKI. Furthermore, rRAKI maintains the scan-specific reconstruction offered by the RAKI method. Lastly, implementation of rRAKI does not require changes to hardware or data acquisition methods, and can have significant image quality improvements especially in lower strength MRI systems.

Phase of Development

Phantom and human cardiac studies at 3T clinical field strength.

Desired Partnerships

This technology is now available for:

- License
- Sponsored research
- Co-development

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Researchers

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References

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